County of Los Angeles

Draft
Environmental Impact Report
SCH No. 2005051143
Volume XX
Appendix 4.22 – Appendix 5.0

MISSION VILLAGE

Prepared for:

Los Angeles County
Department of Regional Planning
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NEWHALL RANCH
Newhall Ranch Company

OCTOBER 2010

County of Los Angeles

Draft Environmental Impact Report

SCH No. 2005051143

Volume XX
Appendix 4.22 – Appendix 5.0

MISSION VILLAGE

Project No.	04-181
Vesting Tentative Tract Map No.	61105
SEA Conditional Use Permit No.	RCUP200500080
Oak Tree Permit No.	ROAK200500032
Oak Tree Permit No.	T200500043
Conditional Use Permit (Off-Site Improvements)	RCUP200500081

Substantial Conformance Determinations for Grading and Hillside Management Guidelines

NEWHALL RANCH
Newhall Ranch Company

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OCTOBER 2010

DRAFT
ENVIRONMENTAL IMPACT REPORT
for
MISSION VILLAGE

SCH No. 2005051143

County Project No. 04-181
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(Off-Site Improvements)

Volume XX
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October 2010

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Water Quality

Prepared for

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MISSION VILLAGE
WATER QUALITY TECHNICAL REPORT

Prepared by

Geosyntec consultants

engineers | scientists | innovators

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Project Number WW1301

September 2010

Mission Village
Water Quality Technical Report

Prepared for

Newhall Land
Valencia, California

Prepared by

Geosyntec Consultants
Oakland, California

September 2010

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Acronyms

ASCE: American Society of Civil Engineers
BAT: Best Available Technology
BCT: Best Conventional Technology
BMP: Best Management Practice
BOD: Biochemical Oxygen Demand
CASQA: California Stormwater Quality Association
CEQA: California Environmental Quality Act
CTR: California Toxics Rule
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
EPA: Environmental Protection Agency
HOA: Home Owners Association

IRWD:	Irvine Ranch Water District
LACDPW:	Los Angeles County Department of Public Works
LARWQCB:	Los Angeles Regional Water Control Board
MBAS:	Methylene Blue Activated Substances
MEP:	Maximum Extent Practicable
MPN:	Most Probable Number
MS4:	Municipal Separate Storm Sewer System
NCDC:	National Climatic Data Center
NPDES:	National Pollutant Discharge Elimination System
NSWQ:	National Storm Water Quality Database
PAH:	Polycyclic Aromatic Hydrocarbons
PCB:	Polychlorinated Biphenyl
PDF:	Project Design Feature
PIPP:	Public Information and Participation Program
RWQCB:	Regional Water Quality Control Board
SAR:	Sodium Adsorption Ratio
SCR:	Santa Clara River
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
TSS:	Total Suspended Solids
USGS:	United States Geological Survey
WEF:	Water Environment Federation
WDR:	Waste Discharge Requirements
WMA:	Watershed Management Area
WMC:	Watershed Management Committee
WRP:	Water Reclamation Plant

1 INTRODUCTION

This report addresses the potential impacts of the proposed Mission Village Project (the Project), a portion of the Newhall Ranch Specific Plan, on water quality in the Project's receiving waters. To evaluate potential impacts of the Project on water quality, pollutants of concern are identified based on regulatory and other considerations. Potential changes in water quality are addressed for pollutants of concern based on runoff water quality modeling, literature information, and professional judgment. Impacts take into account Project Design Features (PDFs) selected to be consistent with the Los Angeles County Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit, including the Standard Urban Stormwater Mitigation Plan (SUSMP) requirements. 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 requirements, and LID Ordinance/Manual standards; and reference to receiving water quality benchmarks, including Total Maximum Daily Load (TMDL) wasteload allocations and water quality standards from the Basin Plan and California Toxics Rule.

The report also assesses the potential for post-development stormwater runoff discharge rates, velocities, and durations to cause accelerated stream erosion and to impact stream habitat, and includes PDFs to address these impacts.

The purpose of this Water Quality Technical Report is to assess the Project's potential impacts on surface water and groundwater quality and hydrology in the receiving surface waters and to identify Project Design Features for inclusion in the Project. Geosyntec Consultants has prepared a Sub-Regional Stormwater Mitigation Plan (SWMP) for the Newhall Ranch Specific Plan (NRSP) (Geosyntec, 2008). This Mission Village Water Quality Technical Report is an independent component of, and is consistent with, the framework for stormwater water quality and hydromodification management established by the Sub-Regional SWMP, and provides the project-level analysis for Mission Village.

The U.S. Army Corps of Engineers (Corps) and the California Department of Fish and Game (CDFG), as lead agencies, have prepared a Joint Draft Environmental Impact Statement/Draft Environmental Impact Report (DEIS/DEIR) for the Newhall Ranch Resource Management and Development Plan (RMDP) and Spineflower Conservation Plan (Impact Sciences, 2009). The Newhall Ranch RMDP consists of those measures and project design features necessary to avoid, minimize and mitigate the adverse biological effects of improvements, facilities, and activities associated with build-out of the NRSP, Entrada, and Valencia Commerce Center projects that will require federal and state permits and agreements from the Corps and CDFG. Essentially, the RMDP is the biological mitigation program for the NRSP, Entrada, and Valencia Commerce Center projects. The RMDP has been prepared to plan, define, and govern the implementation of

various avoidance, minimization and mitigation measures required for implementation of the Project, including onsite and offsite drainage facilities, bridges, building pads, roads, trails, and facilities associated with the approved Newhall Ranch WRP.

Potential hydrologic impacts related to stormwater volume and velocity from the 50-year storm event and the 50-year capital flood event are addressed in "Drainage Concept for Mission Village VTTM 61105" prepared by Psomas (Psomas, 2009) and the "Flood Technical Report" prepared by Pacific Advanced Civil Engineering, Inc. for the Mission Village Project (PACE, 2007). Potential biological impacts of the Mission Village Project are addressed in the "Mission Village Biota Report, Los Angeles County, California" prepared by Impact Sciences, Inc. (Impact Sciences, 2006). An engineering analysis of streambed fluvial stability in the Santa Clara River has also been prepared by Pacific Advanced Civil Engineering, Inc. (PACE, 2006).

The approved Newhall Ranch Specific Plan was the subject of extensive environmental review in the previously certified Newhall Ranch Program EIR (State Clearinghouse No. 95011015) and related Revised Additional Analysis, Volume VIII (May 2003). This Project was assessed at the program level as part of the environmental analysis conducted for the Newhall Ranch Specific Plan. Portions of that analysis, including the certified Flood Section (Section 4.2 – Newhall Ranch Specific Plan EIR) and the certified Revised Additional Analysis (Section 2.3, Floodplain Modifications), have been used in the development of this Project Water Quality Technical Report.

2 ENVIRONMENTAL SETTING

2.1 Physical Setting

The Project site is located within the Newhall Ranch Specific Plan area, which is in an unincorporated portion of Los Angeles County, approximately 30 miles northwest of downtown Los Angeles. The developed portion of the Project (tract map site) is located within the northeastern corner of Newhall Ranch. The eastern site boundary abuts Six Flags Magic Mountain Theme Park, the proposed Entrada Project (VTTM 53295) lies to the east, with the existing community of Westridge and the proposed Legacy Village (VTTM 61996) Project further to the southeast and south, respectively. The proposed Homestead Project (VTTM 60678) within Newhall Ranch lies to the west of the project boundaries, and the proposed Landmark Village (VTTM 53108) lies northwest at the confluence of Castaic Creek and the Santa Clara River (Figure 2-1). For the purposes of this report, the "project developed area" or "tract map site" refers to the proposed location of the Mission Village tract map improvements (Vesting Tentative Tract Map No. 61105), while the "project" or "project site" includes the tract map site and various off-site project impacts, including a utility corridor, roadway extension, an Edison substation, and potable and reclaimed water tank sites.

The Project impact boundary depicted on Figure 2-1 includes the developed portion of the Project (Mission Village tract map site), as well as offsite project impact areas described above

and areas that will be temporarily impacted by the extension of underground utilities in existing developed areas.

The tract map site lies on steep canyons overlooking the south bank of the Santa Clara River and consists of 1,261.8 gross acres, of which 217 acres are within the Santa Clara River corridor and will not be developed. The site is downstream of an additional 1,100 acre offsite watershed. The extension of Magic Mountain Parkway to the east of the tract map boundary to The Old Road will impact a portion of a 550 acre offsite watershed that extends into the existing Westridge development. Topography across the site is relatively steep, with elevations ranging from 960 feet to 1,980 feet above mean sea level. Habitat on the project site varies in quality from high biological value in riparian areas associated with the Santa Clara River channel to highly disturbed habitat such as upland agricultural areas.

The three tributary watersheds to the Santa Clara River lie within the Project boundary: Middle Canyon, Magic Mountain Canyon, and Lion Canyon. Lion Canyon and Middle Canyon are unimproved in the existing condition. The Magic Mountain Canyon tributary watershed drains to an existing concrete channel (Line "A" PD1052) that runs through the Six Flags Magic Mountain Theme Park (Psomas, 2009).

The Project lies downstream from two water reclamation plants. The Saugus Water Reclamation Plant is located 4 miles upstream from the Project, across Bouquet Canyon Road at Soledad Canyon Road, and the Valencia Water Reclamation Plant is located 1.5 miles upstream, just north of Magic Mountain Parkway at the Old Road. Both treatment plants discharge treated wastewater into reaches of the river lying upstream from the Project.

2.2 Project Area Land Uses

The Project site is located within the Newhall Ranch Specific Plan area, which was approved by the Los Angeles County Board of Supervisors in May 2003. The Newhall Ranch Specific Plan is a comprehensive document that guides future development of the Newhall Ranch property and serves as the zoning for the entire Specific Plan area. The Specific Plan contains a conceptual development plan, development regulations, design guidelines, and implementation mechanisms consistent with the goals, objectives, and policies of the Los Angeles County General Plan and Santa Clarita Area Plan. The NRSP is a large, master-planned development including approximately 21,000 homes and five million square feet of commercial uses, along with recreational and mixed uses and public facilities. A complete description of the land uses included in the NRSP can be found in the Newhall Ranch Specific Plan (SCH # 95011015; February, 1999).

The proposed Project is to develop the 1261.8 gross acre Mission Village tract map site, along with 146.3 acres of land for several off-site, project-related components[1]. This total acreage (1,408.1 ac) defines the project area analyzed for potential water quality impacts. The proposed Mission Village Project represents the development of the northeast portion of The Mesas Village in the Newhall Ranch Specific Plan. The land uses proposed as part of the Project are consistent with the Newhall Ranch Specific Plan. The Project consists of the development of single-family and multi-family residences (including condominiums, duplexes, and apartments), mixed-use/commercial development, an elementary school, parks, a library, a fire station, open space, and recreational centers. Other land uses within the Project site include a Spineflower reserve in the northeastern portion of the site. Facilities and infrastructure proposed to support the Project include roads (including the Commerce Center Drive Bridge), trails, drainage improvements, flood protection (including buried bank stabilization within and adjacent to the Santa Clara River), potable and reclaimed water systems (including water tanks), sanitary sewer system, and dry utility systems (Table 2-1 and Figure 2-2). Existing land use in the developed portion of the Project area consists of open space, agriculture, and oil and gas extraction wells with associated access roads.

The proposed Project includes construction of the Commerce Center Drive Bridge component of the Specific Plan. The Commerce Center Drive Bridge would serve central portions of the Newhall Ranch Specific Plan. The new bridge would span the width of the Santa Clara River, equating to a roadway segment of approximately 1,300 feet in length and 120-129 feet in width. Bridge supports would be constructed consistent with the Newhall Ranch RMDP and consist of concrete piers to be located within the River Corridor SMA/SEA 23. Each support would be spaced approximately 100 feet apart. In addition, abutments and bank stabilization, consistent with the RDMP, would be required on the south side of the bridge to protect against the erosive forces of floodwater in the river. Bank Stabilization for the north abutment to be provided as part of the SR126 interchange and Henry Mayo project.

[1] Portions of the proposed utility corridor, roadway extension, water tanks, water quality basin, and Edison substation are outside the boundaries of the Newhall Ranch Specific Plan.

Table 2-1: Proposed Land Use Areas within the Mission Village Project Developed Area

Land Use	Area (Gross Acres)
Single Family Residential	170.7
Multi-Family Residential	300.8
Mixed Use/ Commercial	65.7
Transit	1.2
Library	3.3
Fire Station	1.5
School	9.5
Recreation	12.5
Open Space[1]	314.8
Spineflower Preserve	65.7
Park	29.0
Utilities	3.3
River Corridor	217.1
Water Quality Basin Parcels	18.2
Roads[2]	48.5
Total	**1261.8**

[1] Open Space includes debris basins, graded lots, and natural open space other than the Santa Clara River Corridor
[2] Acreages of minor roads have been included in the acreages of surrounding land uses. See Figure 2-2.

2.3 Associated Off-Site Project Components

In addition to the 1261.8 acre tract map site, the Project also includes approximately 140.2 acres of off-site development within the 592.3 acre off-site temporary and permanent impact boundary that has been included in the water quality impact analysis.

2.3.1 Roadway Improvements

The Project proposes to construct an extension of Magic Mountain Parkway, which would provide regional access to I-5. The Magic Mountain Parkway extension easterly to The Old Road would require the construction of 19.0 acres of off-site roadway improvements as well as adjacent graded slopes which will remain open space. The Parkway extension would proceed southwest from its existing terminus near The Old Road for a distance of approximately 5,000 feet before intersecting with the Project site.

A planned extension of Magic Mountain Parkway from the western Project boundary (within the NRSP), is considered in the water quality impact analysis, although it is not an off-site Project component as it would be constructed as part of another NRSP project. This extension is approximately 3,000 feet trending to the southwest and encompasses 6.1 acres of roadway which is proposed to drain to the Project's drainage system.

2.3.2 Water Tank

The Project includes construction of two proposed 4.0 million gallon water tanks. Portions of two water tanks are located off site just south of the Project boundary. Proposed condition impacts for the off-site water tank and access road would comprise approximately 2.1 acres. This area will drain into the Project storm drain system.

2.3.3 Utility Corridor

The Project also includes a 110 acre utility corridor that runs parallel to SR–126 on the north side of the Santa Clara River, from the approved Newhall Ranch Water Reclamation Plant near the Ventura County line to I-5 and then south to the Los Angeles County Sanitation District 32 Water Reclamation Plant. The utility corridor would serve to extend municipal services to the site. The utilities will be placed underground and a maintenance access road and potential future trail will be constructed above ground. As the impact area for the maintenance access road and trail have not yet been determined, the impacts of these Project components are assessed qualitatively in this report.

2.3.4 Edison Substation

A power substation will be constructed as part of the Project on a 3.0 acre pad adjacent to the Edison powerlines in the Potrero area of the NRSP, west of the Project (two locations are analyzed in the Mission Village EIR).

2.3.5 Water Quality Basin and Drainage Improvements

One of the water quality basins for the Project, Basin D, is proposed to be located off-site, at the northeast corner of the Project boundary adjacent to the Santa Clara River corridor (see Figure 2-2). The portion of the basin and surrounding buffer and access road that is off-site will comprise approximately 6.1 acres.

2.4 Proposed Drainage Improvements – Project and Santa Clara River

The proposed improvements on the Project site that would occur in and adjacent to the Santa Clara River pursuant to the Newhall Ranch RMDP, including bank stabilization, storm drain outfalls, and associated energy dissipaters, are described below. At limited locations on the Project site, such as at outlet structures, access ramps, or bridge abutments, grouted rip-rap or reinforced concrete would be used to minimize erosion. Within the Project area, approximately 17 percent of the River corridor would be protected with flood protection improvements, while 83 percent of the River corridor would remain in a natural state. Approximately four percent of the area would be protected using buried soil cement and the remaining 13 percent (those areas along the utility corridor) would be protected using turf reinforcement mats (PACE, 2007).

2.4.1 Proposed Project Drainage Improvements

Runoff from the developed portions of the Project and upstream runoff will flow through the site via a storm drain system and will discharge to the Santa Clara River through four new outfalls

after passing through the water quality treatment control BMPs (see Section 5.3 for further detail).

2.4.2 Energy Dissipaters

To reduce storm flow velocities and prevent erosion at stormwater discharge points into the Santa Clara River, energy dissipaters consisting of either rip-rap or other larger reinforced concrete standard impact-type energy dissipaters would be constructed at the four new storm drain outlets, pursuant to the requirements of the Newhall Ranch RMDP. These energy dissipaters would slow the rate of flow of runoff into the River to prevent erosion of the stream channel.

2.4.3 Bank Stabilization

The Conceptual Backbone Drainage Plan of the Newhall Ranch Specific Plan provides drainage and flood control protection to developed uses while preserving the Santa Clara River as a natural resource. The Drainage Plan utilizes several criteria that are to be implemented by projects that develop within the Specific Plan area. The primary criteria are as follows:

- Flood corridor must allow for the passage of Los Angeles County Capital Flood discharge without the permanent removal of natural River vegetation (except at bridge crossings);
- The bank stabilization for the River will generally be established outside of the "waters of the United States" as defined by federal laws and regulations and as determined by the delineation completed by the ACOE in August 1993;
- Where the ACOE delineation width is insufficient to contain the Capital Flood flow, the flood corridor will be widened by an amount sufficient to carry the Capital Flood flow without the necessity of permanently removing vegetation or significantly increasing velocity; and
- Soil cement will occur only where necessary to protect against erosion adjacent to the proposed development. Where existing bluffs are determined to be stable and there is no adjacent proposed development, no bank protection will be built.

The Project would include buried soil cement along the Santa Clara River adjacent to and downstream of the Project site. In total, approximately 2,900 linear feet (LF) of bank stabilization would be constructed as part of the Project. This would include approximately 1,700 LF on the south bank fronting the Project site, and 1,200 LF downstream of the Project on the north bank, east of the WRP (PACE, 2007). The majority of the Project frontage on the south bank of the Santa Clara River does not require river bank stabilization. The bank stabilization along portions of the southerly side of the Santa Clara River would be designed and constructed to retain the river's significant riparian vegetation and habitat, to allow the river to continue to function as a regional wildlife corridor, and to provide flood protection pursuant to Los Angeles County standards. Turf Reinforcement Mat (TRM) or a similar bank stability

protection along the utility corridor would be provided by installing approximately 16,000 LF of TRMs along the southern edge of the utility corridor from Chiquito Canyon to the easterly end of the previously approved Newhall Ranch WRP.

Portions of the proposed bank protection would consist of buried soil cement to provide scour and freeboard flood control protection. Soil cement bank protection provides a stable riverbank protection material, in terms of both surface erosion and structural stability. Additionally, soil cement bank protection will be mostly buried. The exposed top portion of the soil cement will be aesthetically and vegetatively compatible with the natural earth and vegetated bank area.

2.5 Receiving Water Bodies and Beneficial Uses

2.5.1 Santa Clara River

The Project will discharge from its storm drain and water quality control facilities directly to Santa Clara River Reach 5[2] at the upper end of the reach. The tentative tract map site boundary comprises 1261.8 gross acres within a 2,650 acre drainage area within the 1,634 square-mile Santa Clara River Watershed. The offsite improvement area constitutes 140.2 acres within the same 1,634 square-mile Santa Clara River Watershed.

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 2-2). Santa Clara River Reach 5 is listed and has specific beneficial uses assigned to it. As identified in Table 2-2, the existing and potential beneficial uses of Santa Clara River Reach 5 include the following:

- MUN: Community, military, or individual water supply systems including, but not limited to, drinking water supply (a potential beneficial use)
- 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
- 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

[2] The SCR is divided into reaches for purposes of establishing beneficial uses and water quality objectives. 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 (EPA). Both of these reach classifications are used by the LARWQCB and the EPA in various documents, which at times is a source of confusion. This report will use the LARWQCB reach numbers.

- 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 2-2: Beneficial Uses of Receiving Waters

Water Body	Beneficial Uses[1]														
	MUN	**IND**	**PROC**	**AGR**	**GWR**	**FRSH**	**REC1**	**REC2**	**WARM**	**COLD**	**WILD**	**RARE**	**MIGR**	**SPWN**	**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 – Potential beneficial use; *Asterixed MUN designations are designated under SB 88-63 and RB 89-03. Some designations may be considered for exemptions at a later date.
Source: Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994, as amended)

The Santa Clara River (SCR) watershed drains an area of 1,634 square miles in the Transverse mountain range of southern California. 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 SCR flows generally from east to west from its headwaters near Acton to the Pacific Ocean near the City of Ventura, approximately 40 miles downstream of the NRSP subregion.

Artificial streamflow in the Santa Clara River is derived from discharges of treated effluent from two wastewater treatment plants and runoff from agricultural fields and existing urban areas. Discharges from agricultural land use are decreasing as some of these areas are converted to urban use. There are two regional wastewater reclamation plants in the area, both operated by the County Sanitation Districts of Los Angeles County, which discharge tertiary-treated wastewater to the Santa Clara River. 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 Project 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 Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California (Balance Hydrologics, 2005 (provided in Appendix E)).

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. Geologic faults in the area have brought 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 mudstone formations are dominant. 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 and clays and to 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.

Flows

Downstream of the Valencia WRP, the SCR is perennial past the Los Angeles/Ventura County line (Systech, 2002) 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 entirely infiltrates 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 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 gauge 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 of 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.

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, 2006). 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.

2.6 Tributaries to the Santa Clara River – Existing and Proposed Condition

The three tributary watersheds to the Santa Clara River lie within the Project boundary: Middle Canyon, Magic Mountain Canyon, and Lion Canyon (Figure 2-1). Lion Canyon and Middle Canyon are unimproved in the existing condition. The Magic Mountain Canyon tributary watershed drains to an existing concrete channel (Line "A" PD1052) that runs through the Six Flags Magic Mountain Theme Park (Psomas, 2009). Each of the tributaries has 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 Lion Canyon is an ephemeral stream; it contains water only during rainy periods and is dry during non-rainy periods. The same is true for each of the tributaries within the Project boundary.

Project runoff from the developed portion of the Project will not be discharged to the tributaries; all Project runoff will be discharged to the Santa Clara River after receiving treatment in the Project PDFs.

The 0.84 square mile (539 acre) Lion Canyon watershed is a tributary to the southern bank of the Santa Clara River. The total length of the mainstem channel is approximately 4,761 feet, with an average overall slope of 4.6 percent. Approximately 280 acres (52 percent) of the watershed area is located within the NRSP boundary, the remainder is upstream in the Legacy Village project (see Figure 2-1). The creek flows in a general east to west direction and joins the Santa Clara River floodplain valley. Generally, the soils in the watershed are characterized as Castaic and Saugus soils with Saugus loam, and predominately are 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 and Chaparral.

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 is proposed (see Appendix F for further detail). This design will utilize boulder step-pool structures, biotechnical stabilization, soil cement, turf reinforcement mat (TRM) 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. Drainage improvements will also include two culverted road crossings in Lion Canyon. A culverted crossing will be located at the mouth of the canyon to provide maintenance access. Another culverted crossing will be provided for the extension of Magic Mountain Parkway through the Project.

The 1.32 square mile (847 acre) Magic Mountain Canyon watershed is a tributary to the southern bank of the Santa Clara River. The total length of the mainstem channel is approximately 4,813 feet, with an average overall slope of 3.4 percent. Approximately 178 acres (27 percent) of the watershed is located within the NRSP boundary. Generally, the soils in the watershed are characterized as Castaic and Saugus soils and Castaic-Balcom silty clay loams, and predominately are 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. The total length of the mainstem channel is approximately 7,967 feet, with an average overall slope of 3.7 percent. Approximately 272 acres (80 percent) of the watershed is located within the NRSP boundary. Generally, the soils in the watershed are characterized as Castaic-Balcom silty clay loams, and predominately are classified as being in hydrologic soil group "C" (higher runoff potential). This watershed is dominated by California sagebrush scrub, with small pockets of mixed chaparral and California grassland. The stream channel flows through California grassland, agricultural areas, alluvial scrub, and live oak woodland. A freshwater marsh is present at the Santa Clara River confluence.

The Middle Canyon and Magic Mountain Canyon drainages will be incorporated into the Project’s storm drain system in the post-development condition.

2.7 Existing 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.

The existing 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 (see Figure 2-1 for monitoring locations):

1. Newhall Ranch Tributary Stormwater Monitoring. Two storm events were monitored in Potrero Canyon, San Martinez Grande Canyon, Middle Canyon, Chiquito Canyon, and an unnamed tributary in Long Canyon. This data is relevant in terms of characterizing the existing stormwater runoff within the Project area. 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.

2. Newhall WRP. The Newhall Ranch is required to conduct pre-startup water quality monitoring at upstream and downstream locations from the outfall of the approved Newhall WRP. Wet and dry weather monitoring data were collected from two stations in the SCR from the spring of 2004 through 2007: 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. Additionally, dry weather monitoring has been conducted at three stations (RSW-001U, RSW-001D, RSW-002D) as required by the Newhall WRP NPDES Permit (LARWQCB, 2007). These stations are referred to below as the "Newhall WRP NPDES Stations."

3. LA County Monitoring. The County of Los Angeles conducts in-stream monitoring on the mainstem of the SCR at a mass emission station located at The Old Road, upstream of the Project area. Both dry weather and wet weather monitoring data are available. Wet weather monitoring data are available from November 2002 through February 2009. The LA County monitoring data are the most current and are the only source of wet weather monitoring in the SCR immediately upstream of the Project area.

4. USGS Monitoring. The USGS collected a large number of water quality data in the SCR near the county line from 1951 through 1995. These data provide a historical perspective of wet and dry weather water quality in the SCR immediately downstream from the Project area.

2.7.1 Wet Weather Water Quality Monitoring

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, 0.25 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 2-3 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 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 613 storms exceeding 0.1 inches that occurred from October 1968 to December 2008. The average storm duration for storms greater than 0.1" in the 40 year Newhall rain gauge record is 11.4 hours.

Table 2-3: 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 WRP Pre-Startup Monitoring. Newhall Land has conducted pre-startup receiving water quality monitoring for the approved Newhall Ranch WRP 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 2-4). Grab sampling methods were used. Table 2-4 shows the depths and durations of storm events monitored.

Table 2-4: Depth and Duration of Storms Monitored for Newhall WRP

Date	Depth (in)[1]	Duration
12/07/04	0.12	6
2/17/05[3]	0.6	12
2/18/05[2,3]	4.45	12
11/9/05	0.12	6
11/10/05[3]	0.2	1
2/17/06	0.31	7

[1] Based on rainfall measured at the Newhall rain gauge.
[2] NR-3 only sampled
[3] Estimated due to lack of gauge data.

LA County Department of Public Works Monitoring Data. The Los Angeles County Department of Public Works (LACDPW) has conducted mass emission dry and wet weather monitoring in the Santa Clara River for seven seasons - from 2002 through 2009 (LACDPW, 2009). 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 twenty-six storm events over 7 years. Composite samples were collected for most parameters; grab sampling was used for bacteria analyses. Table 2-5 lists the rainfall depths and durations of the twenty-six monitored storm events based on hourly rainfall measurements at the Newhall rain gauge. The storm event on 1/14/2006 was not included in the data summaries as it was less than 0.1”, the minimum storm depth to generate runoff. The median of the twenty-five remaining storm events is 0.64”, roughly equivalent to the median storm depth for the Newhall rain gauge from 1968 through 2008 (0.60 inches).

Table 2-5: Depth and Duration of Storms Monitored by LACDPW at S29

Date	Rainfall Depth (inches)[1]	Storm Duration (hours)[1]
11/8/2002	1.6	21
12/16/2002	1.9	5
2/11/03	8.0	32
3/15/03	2.0	16
10/31/2003	0.30	4
12/25/2003	1.80	14

Date	Rainfall Depth (inches)[1]	Storm Duration (hours)[1]
1/1/2004	0.4	9
10/17/2004	0.64	7
10/26/2004	2.22	13
1/7/2005	9.99	92
10/17/2005	1.61	14
12/31/2005	0.6	4
1/14/2006[2]	0.08	2
2/17/2006	0.32	7
12/9/2006	0.47	2
12/16/2006	0.12	2
1/30/2007	0.44	16
2/19/2007	0.24	5
2/22/2007	0.32	3
9/21/2007	0.98	16
11/29/2007	0.34	6
12/6/2007[3]	0.43	48
11/26/2008	1.22	17
12/15/2008	1.22	19
2/5/2009[4]	2.2	40
2/13/2009[4]	0.32	3

[1] Based on rainfall measured at the Newhall rain gauge
[2] This storm was not included in monitoring summary since it is <0.1"
[3] The Newhall gauge noted accumulations for this storm event. LA County recorded this storm with a depth of 0.43" and duration of 9 hours.
[4] The depths and durations for storms in 2009 are those recorded by LA County.

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. 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.

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) is an inverse function of the hardness. Chloride comprises a large proportion of the TDS and is responsible for impairments in its own right. 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. A chloride TMDL was approved for these reaches in 2005.

Results for concentrations of TSS, TDS, chloride and hardness for the four datasets are listed in Table 2-6 through Table 2-9. 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 2-6: Average Concentrations of General Constituents and Nutrients 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 CaCO3)	2,225	1,205	147	59	107
Chloride (mg/L)	870	125	3	3	11

Table 2-7: Newhall Ranch WRP Startup Wet Weather Water Quality Data for General Constituents and Nutrients in the Santa Clara River, 2004 - 2006

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
TSS	0.1 – < 1.0	NR1	32	107	58
		NR3	32	235	112
	≥ 1.0	NR3	-	-	43,360
TDS	0.1 – < 1.0	NR1	622	1,136	855
		NR3	698	2,020	1,076
	≥ 1.0	NR3	-	-	2,100
Hardness (mg/L as $CaCO_3$)	0.1 – < 1.0	NR1	304	464	387
		NR3	352	670	475
	≥ 1.0	NR3	-	-	832

- = no or insufficient data; NA – not applicable

Table 2-8: LACDPW Stormwater Monitoring for Selected General Constituents at the SCR Mass Emission Station (S29) during 2002-2009

Constituent	2-day Preceding Rainfall (in)	No. of Samples	Minimum	Maximum	Average
TSS (mg/L)	0.1 – < 1.0 inches	14	26	2,202	729
	≥ 1.0 inches	11	53	6,591	1,482
TDS (mg/L)	0.1 – < 1.0 inches	14	130	732	419
	≥ 1.0 inches	11	28	364	197
Hardness (mg/L)	0.1 – < 1.0 inches	14	70	428	223
	≥ 1.0 inches	11	15	170	101
Chloride (mg/L)	0.1 – < 1.0 inches	14	16	118	60
	≥ 1.0 inches	11	3	52	22

- = no or insufficient data; NA – not applicable

Table 2-9: USGS Water Quality Data for Selected General Constituents in the Santa Clara River at the County Line during 1951 – 1995

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Average
TSS (mg/L)	0.1 – < 1.0 inches	10	10	248	4,730	2,291
	≥ 1.0 inches	41	41	107	51,200	10,711
Specific Conductance (uS/cm)	0.1 – < 1.0 inches	33	33	831	4,220	2,246
	≥ 1.0 inches	42	42	637	3,240	1,309
Hardness (mg/L)	0.1 – < 1.0 inches	27	27	270	1,500	773
	≥ 1.0 inches	37	37	250	1,200	546
Chloride (mg/L)	0.1 – < 1.0 inches	34	34	21	290	122
	≥ 1.0 inches	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 2-6 to Table 2-9 are sometimes very high, due to the highly erodible, easily transportable, sandy alluvial soils and sediments. Highest TSS concentrations were measured at some of the tributary canyons (Table 2-6), but were also observed in the SCR (
Table 2-7 and Table 2-9). These latter results show the capacity of high flows in the Santa Clara River for sediment transport and support the conclusion 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 in the larger storms than the smaller storms at the downstream sites on the SCR. This pattern is also evident in the upstream LACDPW station, to a lesser extent.

The water quality objective for TSS in the Basin Plan is a narrative standard, which states, "water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses".

TDS. Stormwater monitoring data collected in the NRSP tributaries (Table 2-6) 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. It is highly unlikely that this is a land use effect. Elevated TDS levels in runoff at Site A and B is 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 streams 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 concentrations of TDS in the Santa Clara River were moderate to high, ranging from 216 mg/L to 2,100 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. The Basin Plan objective for TDS in Santa Clara River Reach 5 is 1,000 mg/L.

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 the tributaries represented by Sites A and B, with their much higher salt content.

TDS concentrations were generally lower in the larger storms, reflecting a dilution effect.

Hardness. Hardness is a measure of the multivalent 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 could be due to natural high levels of calcium and magnesium in the local soils and sedimentary formations (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 2-7, Table 2-9) than at the LACDPW station (Table 2-8). 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 2-9) showing higher average hardness concentrations than those measured at NR-1 and NR-3 (
Table 2-7).

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 2-6) 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 2-8) were lower than those measured at the downstream USGS site (Table 2-9).

Overall, the average chloride concentrations during recent stormwater monitoring were highly variable and ranged between 3 mg/L and 120 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 Basin Plan objective for chloride is 100 mg/L.

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. Table 2-10 through Table 2-13 summarizes available data for these nutrients. Only nitrate+nitrite (N) was measured in the Newhall Ranch Tributary Stormwater Monitoring.

Table 2-10: Average Concentrations of Nitrate from Newhall Ranch Tributary Stormwater Monitoring in 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 2-11: Newhall WRP Pre-Startup Wet Weather Water Quality Data for Selected Nutrients in the Santa Clara River during 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	<0.005
		NR3	5	0	<0.005	<0.005	<0.005
	≥ 1.0	NR3	1	0	<0.005	<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; NA – not applicable

Table 2-12: LACDPW Stormwater Monitoring of Nutrients at the SCR Mass Emission Station (S29) during 2002-2005

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Dissolved phosphorus (mg/L)	0.1 – < 1.0 inches	14	14	0.05	0.43	0.23
	≥ 1.0 inches	11	11	0.10	0.45	0.26
Total phosphorus (mg/L)	0.1 – < 1.0 inches	14	14	0.30	1.29	0.62
	≥ 1.0 inches	11	11	0.18	0.94	0.54
Nitrate-N (mg/L)	0.1 – < 1.0 inches	14	9	<0.08	1.85	0.81
	≥ 1.0 inches	11	9	<0.08	1.36	0.74
Nitrite-N (mg/L)	0.1 – < 1.0 inches	14	4	<0.03	1.00	0.12
	≥ 1.0 inches	11	3	<0.03	0.87	0.13
Ammonia-N (mg/L)	0.1 – < 1.0 inches	14	6	<0.03	1.35	0.17
	≥ 1.0 inches	11	8	<0.03	1.09	0.23
TKN as N (mg/L)	0.1 – < 1.0 inches	14	14	0.70	8.70	2.61
	≥ 1.0 inches	11	11	0.45	31.7	4.32

- = no or insufficient data; NA – not applicable

Table 2-13: USGS Water Quality Data for Selected Nutrients in the Santa Clara River at the County Line during 1951 to 1995

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

- = no or insufficient data

Phosphorus. Recent wet weather monitoring showed somewhat consistent total phosphorus levels, averaging 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 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. The Basin Plan water quality objective for phosphorus is a narrative standard, which states, "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".

Nitrogen. Nitrate + nitrite-nitrogen was the only nutrient measured in the NRSP tributary stormwater monitoring. As shown in Table 2-10, measured nitrate-nitrogen concentrations 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). High nitrate levels can be associated with runoff from agricultural areas and nurseries, or associated with excessive fertilization of landscaping in residential areas; however, Station E, which is downstream of residential development, showed relatively low nitrate concentrations.

Most of the more recent nitrate monitoring data summarized in Table 2-10, Table 2-11, and Table 2-12 were relatively low (averaging 0.8 to 3.0 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 generally ranged between the concentrations found for ammonia and nitrate (about 0.4 to 4.3 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 as described above.

Selected Metals and Pesticides

The metals cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) can be toxic at high concentrations. They occur naturally in soils and sediments, and can be present in urban runoff. Aluminum is one of the more abundant elements in the earth's crust. The organophosphorous pesticides chlorpyrifos and diazinon are especially toxic to a number of aquatic organisms and in the past have been frequently detected downstream from urban and agricultural land uses. Cyanide is a highly toxic substance and originates from both man-made and natural sources.

Table 2-14 though Table 2-17 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 2-14: Average Concentration of 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 Canyon
Total Copper (µg/L)	15	175	170	10	70
Total Lead (µg/L)	6.1	54	95	8	37
Total Zinc (µg/L)	40	330	330	30	225
Total Cadmium (µg/L)	0.3	11.2	2.0	0.4	1.9

Table 2-15: Newhall Ranch WRP Pre-Startup Wet Weather Water Quality Data for 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 (µg/L)	0.1 – < 1.0	NR1	1	1	27	27	27
		NR3	1	1	19	19	19
Total Aluminum (µg/L)	0.1 – < 1.0	NR1	1	1	740	740	740
		NR3	1	1	770	770	770
Dissolved Copper (µg/L)	0.1 – < 1.0	NR1	1	1	4.6	4.6	4.6
		NR3	1	1	3.6	3.6	3.6
Total Copper (µg/L)	0.1 – < 1.0	NR1	2	2	4.6	5.2	4.9
		NR3	2	2	4.8	7.0	5.9
Dissolved Lead (µg/L)	0.1 – < 1.0	NR1	1	0	<0.07	<0.07	-
		NR3	1	0	<0.07	<0.07	-
Total Lead (µg/L)	0.1 – < 1.0	NR1	2	2	0.6	1.3	1.0
		NR3	2	2	0.6	0.9	0.8
Dissolved Zinc (µg/L)	0.1 – < 1.0	NR1	1	1	12	12	12
		NR3	1	1	8.7	8.7	8.7
Total Zinc (µg/L)	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	<0.01
		NR3	1	0	<0.01	<0.01	<0.01
Chlorpyrifos	0.1 – < 1.0	NR1	1	0	<0.6	<0.6	<0.6
		NR3	1	0	<0.6	<0.6	<0.6

- = no or insufficient data; NA – not applicable

[1] Water Quality Standards are CTR acute criteria calculated with minimum measured hardness value for monitoring location.

Table 2-16: LACDPW Stormwater Monitoring for Metals, Pesticides, and Cyanide at the SCR Mass Emission Station (S29) during 2002-2005

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Dissolved aluminum (µg/L)	0.1 – < 1.0 inches	14	4	<50	1,390	264
	≥ 1.0 inches	11	4	<50	3,680	420
Total aluminum (µg/L)	0.1 – < 1.0 inches	14	14	383	18,000	5,770
	≥ 1.0 inches	11	11	131	19,650	5,161
Dissolved copper (µg/L)	0.1 – < 1.0 inches	14	14	3.3	11.5	6.4
	≥ 1.0 inches	11	11	3.8	22.6	8.4
Total copper (µg/L)	0.1 – < 1.0 inches	14	14	7.3	91.3	29.8
	≥ 1.0 inches	11	11	9.4	53.3	31.1

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Dissolved lead (µg/L)	0.1 – < 1.0 inches	14	3	<0.44	3.3	0.5
	≥ 1.0 inches	11	8	<0.44	12.5	2.4
Total lead (µg/L)	0.1 – < 1.0 inches	14	14	1.4	39	8.6
	≥ 1.0 inches	11	11	1.1	110	29.9
Dissolved zinc (µg/L)	0.1 – < 1.0 inches	14	12	<1	27	14
	≥ 1.0 inches	11	11	12	37	24
Total zinc (µg/L)	0.1 – < 1.0 inches	14	14	11	292	71
	≥ 1.0 inches	11	11	42	353	126
Dissolved cadmium (µg/L)	0.1 – < 1.0 inches	14	0	<0.05	<0.05	<0.05
	≥ 1.0 inches	11	1	<0.05	0.74	0.10
Total cadmium (µg/L)	0.1 – < 1.0 inches	14	8	<0.05	3.47	0.53
	≥ 1.0 inches	11	8	<0.05	1.30	0.75
Chlorpyrifos (µg/L)	0.1 – < 1.0 inches	14	0	<0.02	<0.02	<0.02
	≥ 1.0 inches	11	0	<0.02	<0.02	<0.02
Diazinon (µg/L)	0.1 – < 1.0 inches	14	3	<0.003	0.41	0.04
	≥ 1.0 inches	11	5	<0.003	0.43	0.07
Cyanide (µg/L)	0.1 – < 1.0 inches	14	4	<0.005	0.01	0.003
	≥ 1.0 inches	11	3	<0.005	0.59	0.06

Table 2-17: USGS Water Quality Data for Selected Metals, Pesticides and Indicator Bacteria in the Santa Clara River at the County Line during 1951 to 1995

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

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Total Zinc (µg/L)	0.1 – < 1.0 inches	1	1	150	150	150
	≥ 1.0 inches	0	0	-	-	-
Diazinon (µg/L)	0.1 – < 1.0 inches	1	1	0.02	0.02	0.02
	≥ 1.0 inches	0	0	-	-	-

- = no or insufficient data

Metals. Table 2-14 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.

Concentrations of dissolved copper (3.6 to 8.4 µg/L) were below the CTR acute criteria for the average hardness of 250 mg/L (32 µg/L). Concentrations of total copper measured in the Santa Clara River (4.6 to 91 µg/L, total copper) exceeded the respective CTR acute criteria for the average hardness of 250 mg/L (33 µg/L, total copper) in 9 of 25 samples for the LACDPW station (there were no exceedances at other SCR stations). Concentrations of dissolved and total lead measured in the Santa Clara River (<0.07 µg/L to 23 µg/L, dissolved lead; 0.8 to 110 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). Concentrations of dissolved zinc measured in the Santa Clara River (8.7 µg/L to 37 µg/L, dissolved zinc) were well below the respective CTR acute criteria for the average hardness of 250 mg/L (250 µg/L, dissolved zinc); concentrations of total zinc in the Santa Clara River range from 11 to 353 µg/L, with data from the LACDPW gauge exceeding the CTR criteria for an average hardness of 250 mg/L (260 µg/L, total zinc) in 2 of 25 samples (there were no exceedances at the other SCR stations).

Measured aluminum concentrations showed a very wide range of concentrations at the mass emission station (Table 2-16).

Pesticides. Data for pesticides are very limited. Chlorpyrifos was not detected at LACDPW station, and Diazinon was detected in about a third of samples (8/25) with an average concentration of 0.04 µg/L in small storms and 0.07 µg/L in larger storms (Table 2-16). Diazinon and Chlorpyrifos were not detected further downstream in the SCR during Newhall WRP wet weather sampling (Table 2-15) but were detected in the one wet weather sample taken in the historical USGS data (Table 2-17). 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 7 of 25 samples collected at the LACDPW station. Concentrations observed at the LACDPW station were very low, exceeding the CTR criterion for freshwater acute aquatic of 22 µg/L in only one instance (Table 2-16).

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. Table 2-18 through 2-21 summarize FIB data for the four datasets. Averages are presented as geometric means.

Table 2-18: 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)	38,700	>160,000	120,000	>89,400	>19,600
Fecal coliform (MPN/100ml)	3,300	590	4,200	>19,600	19,600

NA – not applicable

Table 2-19: 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	Geometric Mean
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

- = no or insufficient data; NA – not applicable

Table 2-20: LACDPW Stormwater Monitoring for Fecal Indicator Bacteria at the SCR Mass Emission Station during 2002-2005

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Geometric Mean
Total coliform (MPN/100mL)	0.1 – < 1.0 inches	14	14	17,000	1,600,000	101,000
	≥ 1.0 inches	11	11	50,000	500,000	198,000
Fecal coliform (MPN/100mL)	0.1 – < 1.0 inches	14	14	230	300,000	7,000
	≥ 1.0 inches	11	11	3,000	300,000	36,000
Fecal Enterococci (MPN/100mL)	0.1 – < 1.0 inches	14	14	800	300,000	27,000
	≥ 1.0 inches	11	11	9,000	500,000	68,000

[1] Represents the Geomean of the data.

Table 2-21: USGS Water Quality Data for Fecal Indicator Bacteria in the Santa Clara River at the County Line during 1951 - 1995

Constituent	2-day Preceding Rainfall (in)	No. of Samples	No. of Detects	Minimum	Maximum	Geo-mean
Fecal Coliform (CFU/100mL)	0.1 – < 1.0 inches	3	3	80	720	300
	≥ 1.0 inches	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 (MPN) 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.

Summary

Table 2-22 and Table 2-23 summarize the average values from wet weather monitoring data for all monitoring locations within the Project area.

Table 2-22: Summary of Average Wet Weather Monitoring Data (2-Day Antecedent Rainfall of 0.1 - 1.0 in)

	LACDPW Mass Emission Station	NRSP Area Tributary Monitoring					Newhall WRP Startup Monitoring		USGS Wet Weather Monitoring
Constituent	***S29***	***Site A***	***Site B***	***Site C***	***Site D***	***Site E***	***NR1***	***NR3***	***USGS***
General and Conventional Parameters									
TSS (mg/L)	729	835	41,100	36,000	5,650	6,645	58	112	2,291
TDS (mg/L)	419	7,380	2,825	190	160	205	855	1,076	1,437 [1]
Hardness (mg/L)	223	2,225	1,205	147	59	107	387	475	773
Chloride (mg/L)	59.6	870	125	3	3	11	-	-	122
Nutrients									
Total P (mg/L)	0.62	-	-	-	-	-	0.4	0.4	1.28
Nitrate-N (mg/L)	0.81	17.5[2]	3.0[2]	1.6[2]	15.3[2]	2.8[2]	3.2	3.0	2.1[2]
Nitrite-N (mg/L)	0.12	-	-	-	-	-	<0.005	<0.005	-
Ammonia-N (mg/L)	0.17	-	-	-	-	-	0.2	0.1	0.16
TKN (mg/L)	2.61	-	-	-	-	-	0.3	0.4	0.64
Metals and Pesticides									
Dissolved copper (µg/L)	6.4	-	-	-	-	-	4.6	3.6	-
Total copper (µg/L)	29.8	15	175	170	10	70	4.9	5.9	30
Dissolved lead (µg/L)	0.5	-	-	-	-	-	<0.07	<0.07	7.8
Total lead (µg/L)	8.6	6.1	53.5	95.2	7.6	36.8	1	0.8	-
Dissolved zinc (µg/L)	14	-	-	-	-	-	12	8.7	10
Total zinc (µg/L)	71	40	330	330	30	225	17.5	15	150
Dissolved aluminum (µg/L)	264	-	-	-	-	-	27	19	-
Total aluminum (µg/L)	5,770	-	-	-	-	-	740	770	-
Diazinon (µg/L)	0.05	-	-	-	-	-	<0.01	<0.01	0.02
Chlorpyrifos (µg/L)	<0.05	-	-	-	-	-	<0.6	<0.6	-

Constituent	LACDPW Mass Emission Station	NRSP Area Tributary Monitoring					Newhall WRP Startup Monitoring		USGS Wet Weather Monitoring
	S29	*Site A*	*Site B*	*Site C*	*Site D*	*Site E*	*NR1*	*NR3*	*USGS*
Cyanide (mg/L)	<0.01	-	-	-	-	-	-	-	-
Indicator Bacteria									
Fecal Coliform[3] MPN/100mL	101,000	3,300	590	4,200	>19,600	19,600	87	258	300
Total Coliform[3] MPN/100mL	7,000	38,700	>160,000	120,000	>89,400	>19,600	284	549	-

[1] Derived from Specific Conductance
[2] Nitrate + Nitrite-N
[3] Bacteria averages are represented as Geometric Means
ND = non detected, - = no or insufficient data

Table 2-23: Summary of Average Wet Weather Monitoring Data for 2-Day Precedent Rainfall of > 1 inch.

Constituent	USGS Wet Weather Monitoring	LACDPW SCR Mass Emission Station	Newhall WRP Startup Monitoring
	11108500	*S29*	*NR3*
General and Conventional Parameters			
TSS (mg/L)	10,711	1,482	43,360
TDS (mg/L)	838[1]	101	2,100
Hardness (mg/L)	546	197	832
Chloride (mg/L)	61	22	-
Nutrients			
Total P (mg/L)	1.02	0.54	13.4
Nitrate-N (mg/L)	1.7[2]	0.74	1.4
Nitrite-N (mg/L)		0.13	ND
Ammonia-N (mg/L)	-	0.23	0.5
TKN (mg/L)	0.69	4.32	46.0
Metals			
Dissolved copper (µg/L)	-	8.4	-
Total copper (µg/L)	-	31.1	-

Constituent	USGS Wet Weather Monitoring	LACDPW SCR Mass Emission Station	Newhall WRP Startup Monitoring
	11108500	*S29*	*NR3*
Dissolved lead (µg/L)	ND	2.4	-
Total lead (µg/L)	ND	29.9	-
Dissolved zinc (µg/L)	-	24	-
Total zinc (µg/L)	-	126	-
Dissolved aluminum (µg/L)	-	420	-
Total aluminum (µg/L)	-	5,161	-
Indicator Bacteria			
Fecal Coliform (MPN/100 mL)	2,700	36,000	≥1600
Total Coliform (MPN/100 mL)	-	198,000	≥1600

[1] Derived from Specific Conductance
[2] Nitrate + Nitrite-N
ND = Not Detected in Sample, - = no or insufficient data

2.7.2 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 four sources (see Figure 2-1 for locations):

- LACDPW sampling at the SCR mass emission station
- USGS Water Quality Monitoring
- Newhall Ranch WRP pre-startup monitoring (2004-2007)
- Newhall Ranch NPDES monitoring (2008-2009)

These sites were described above under Wet Weather Monitoring (Section 2.3.1). The LACDPW station is on the SCR above Newhall Ranch, 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.

General Constituents

Tables 2-24 through 2-26 report summary statistics for dry weather monitoring of selected nutrients in the three datasets.

Table 2-24: LACDPW Dry Weather Monitoring for Selected General Constituents at the SCR Mass Emission Station (S29) during 2002-2009

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
TSS (mg/L)	15	15	1	1320	135
Hardness (mg/L)	15	15	330	510	411
TDS (mg/L)	15	15	696	942	806

Table 2-25: Newhall WRP Pre-Startup Dry Weather Monitoring for Selected General Constituents in the SCR during 2004-2007

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
TSS (mg/L; DL = 1 mg/L)	NR1	98	97	<1	342	42
	NR3	98	97	<1	676	76
Hardness (mg/L)	NR1	98	98	150	568	323
	NR3	98	98	185	684	380
TDS (mg/L)	NR1	98	98	504	2,806	853
	NR3	98	98	576	1,396	930
Chloride (mg/L)	NR1	48	48	97	130	116
	NR3	48	48	102	140	122

Table 2-26: Newhall WRP NPDES Dry Weather Monitoring for Selected General Constituents in the SCR during 2008-2009

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
TSS (mg/L; DL = .5 mg/L)	RSW-001U	4	4	3.8[1]	36	18.1
	RSW-002D	4	4	2.7[1]	33	17.6
Hardness (mg/L)	RSW-001U	4	4	187	338	257
	RSW-002D	4	4	189	335	256
TDS (mg/L)	RSW-001U	4	4	694	1,028	873
	RSW-002D	4	4	870	950	904
Chloride (mg/L)	RSW-001U	4	4	111	120	115
	RSW-002D	4	4	114	135	122

[1] Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated; detected, but not quantified (DNQ).

Table 2-27: USGS Dry Weather Water Quality Monitoring Data for Selected General Constituents in the SCR at the County Line during 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	2408
Chloride (mg/L)	355	355	30	585	140

TSS. Average concentrations of TSS appeared highly variable between the monitoring stations. The USGS dataset showed relatively high average concentrations, which may have included samples taken during times of higher erosion or larger dry weather flows. Differences may also be due to physical factors such as substrate material, local flow regime, and tributary influences.

Hardness, TDS and Chloride. The average concentrations of dissolved constituents, hardness, TDS, and chloride were more similar between the monitoring locations and times. However, the USGS County Line station again consistently recorded higher averages (approximately double) than the other stations. The data suggests that the water flowing in the SCR in the NRSP area during dry weather is hard and turbid, with moderate levels of other dissolved salts, including chloride.

Nutrients

Tables 2-27 through 2-29 report summary statistics for dry weather monitoring of selected nutrients in the three datasets.

Table 2-28: LACDPW Dry Weather Monitoring of Nutrients at the SCR Mass Emission Station (S29) during 2002-2009

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Dissolved phosphorus (mg/L)	15	14	<0.05	0.30	0.18
Total phosphorus (mg/L)	15	14	<0.05	0.67	0.23
Nitrate-N (mg/L)	15	13	<0.17	1.78	1.16
Nitrite-N (mg/L)	15	2	<0.03	0.60	0.08
Ammonia-N (mg/L)	15	2	<0.03	0.81	0.08
TKN (mg/L)	15	15	0.23	1.31	0.60

- = no or insufficient data

Table 2-29: Newhall WRP Pre-Startup Dry Weather Monitoring for Selected Nutrients in the SCR during 2004-2007

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Total phosphorus (mg/L)	NR1	98	98	0.05	1.4	0.6
	NR3	98	97	<0.008	1.0	0.5
Nitrate-N (mg/L)	NR1	98	98	0.97	4.9	2.4
	NR3	98	97	<0.01	5.1	2.4
Nitrite-N (mg/L)	NR1	98	36	<0.005	0.2	<0.005
	NR3	98	31	<0.005	0.3	<0.005
Ammonia-N (mg/)	NR1	98	68	<0.005	0.4	0.1
	NR3	98	72	<0.005	0.4	0.1
TKN (mg/L)	NR1	95	89	<0.04	3.4	0.7
	NR3	95	91	<0.04	1.5	0.7

Table 2-30: Newhall WRP Pre-Startup Dry Weather Monitoring for Selected Nutrients in the SCR during 2008-2009

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Total phosphorus (mg/L)	RSW-001U	4	4	0.22	0.64	0.4
	RSW-002D	4	4	0.22	0.67	0.4
Nitrate-N (mg/L)	RSW-001U	4	4	1.41	2.33	1.8
	RSW-002D	4	4	1.29	2.45	1.9
Nitrite-N (mg/L)	RSW-001U	4	3	<0.01	0.21	0.07
	RSW-002D	4	3	<0.01	0.22	0.07
Ammonia-N (mg/)	RSW-001U	4	3	<0.03	0.06	0.04
	RSW-001D	4	2	<0.03	0.07	0.03
	RSW-002D	4	3	<0.03	0.1	0.05
TKN (mg/L)	RSW-001U	4	4	0.57[1]	0.98	0.77
	RSW-002D	4	3	<0.46	1.4	0.74

[1]Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated; detected, but not quantified (DNQ).

Table 2-31: USGS Dry Weather Water Quality Monitoring Data for Selected Nutrients in the Santa Clara River at the County Line during 1951 - 1995

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

Phosphorus and Nitrogen. The average concentrations for all nutrients showed a very similar and simple pattern. Concentrations generally increased downstream and were higher in the historical dataset. Lower average values at the mass emission station could reflect its location above the Valencia WRP, and/or the low number of dry weather samples at this station. Higher average concentrations at the USGS gauge (Table 2-29) compared with the Newhall WRP startup monitoring data (Table 2-28) could be due to greater nutrient loading over its period of record due to historically greater WRP discharge concentrations and/or less responsible use of fertilizers, as well as the higher TSS, and hence particulate nutrients, observed at this site.

Metals and Pesticides

Tables 2-30 through 2-32 report summary statistics for dry weather monitoring of selected metals and pesticides for the three datasets.

Table 2-32: LACDPW Dry Weather Monitoring for Metals and Pesticides at the SCR Mass Emission Station (S29) during 2002-2009

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Dissolved copper (µg/L)	15	15	0.99	3.8	2.4
Total copper (µg/L)	15	15	4.41	34	13
Dissolved lead (µg/L)	15	0	<0.17	<0.17	<0.17
Total lead (µg/L)	15	13	<0.17	8.2	1.3
Dissolved zinc (µg/L)	15	11	<1	26	8
Total zinc (µg/L)	15	13	<1	52	21
Dissolved cadmium (µg/L)	15	3	<0.05	41	3
Total cadmium (µg/L)	15	4	<0.05	72	5
Dissolved aluminum (µg/L)	15	0	<100	<100	<100
Total aluminum (µg/L)	15	3	<100	7500	566
Chlorpyrifos (µg/L)	15	0	<0.05	<0.05	<0.05

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Diazinon (µg/L)	15	1	<0.01	0.23	<0.01

- = no or insufficient data

Table 2-33: Newhall WRP Pre-Startup Dry Weather Monitoring for Selected Metals, Pesticides in the SCR during 2004-2007.

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Dissolved copper (µg/L)	NR1	31	31	2.2	5.8	3.6
	NR3	31	31	2.3	5.5	3.6
Total copper (µg/L)	NR1	42	42	2.3	11	4.4
	NR3	42	42	2.1	15	5.2
Dissolved lead (µg/L)	NR1	31	8	<0.05	0.7	<0.05
	NR3	31	7	<0.05	0.6	<0.05
Total lead (µg/L)	NR1	42	38	<0.05	4.6	0.6
	NR3	42	39	<0.05	5.8	0.9
Dissolved zinc (µg/L)	NR1	31	31	7.8	22.2	14.1
	NR3	31	31	5.4000001	18.6	11.8
Total zinc (µg/L)	NR1	42	42	8.5	30	16
	NR3	42	42	7.8	51	17
Dissolved aluminum (µg/L)	NR1	25	14	<5	290	36
	NR3	25	11	<5	750	54
Total aluminum (µg/L)	NR1	25	25	12	2100	325
	NR3	25	25	49	3300	530
Diazinon (µg/L)[1]	NR1	42	1	<0.01	2	<2
	NR3	42	2	<0.01	33.5	<2

[1] Detection limits changed over time.

Table 2-34: Newhall WRP Pre-Startup Dry Weather Monitoring for Selected Metals, Pesticides in the SCR during 2008-2009

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Total Copper (µg/L)	RSW-001U	4	4	1.5	3.7	2.9
	RSW-002D	4	4	1.4	3.9	2.9
Total Lead (µg/L)	RSW-001U	4	4	0.05[1]	0.54	0.29
	RSW-002D	4	4	0.06[1]	0.46	0.28

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Total Zinc (µg/L)	RSW-001U	4	4	11.5	15.2	13.5
	RSW-002D	4	4	9.3	14.5	12.7
Total Aluminum (µg/L)	RSW-001U	4	4	21	427	207
	RSW-002D	4	4	21	386	170
Diazinon (µg/L)	RSW-001U	4	0	-	-	<0.002
	RSW-002D	4	0	-	-	<0.002

[1]Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated; detected, but not quantified (DNQ).

Table 2-35: USGS Dry Weather Water Quality Monitoring Data for Selected Metals, Pesticides in the Santa Clara River at the County Line.

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
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	ND	ND	ND
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

ND = non detected

Metals. Concentrations of heavy metals in dry weather flows were generally low and, for the most part, reasonably similar. Total metal concentrations are generally controlled by TSS concentrations, and this is reflected in the difference between the historical data collected at the USGS site with high TSS and the more recent data with low TSS. Therefore the dissolved concentrations are more interesting to compare. Average dissolved copper concentrations were fairly similar and ranged from 1.8 – 4.2 µg/L. Average dissolved zinc concentrations were also fairly similar and ranged from 11 – 24 µg/L. Higher copper and zinc concentrations were observed at the upper SCR site, which may reflect its proximity to urban land uses; however, the data are too few to confidently assert a reason for these differences. Dissolved lead showed some large differences between the historical and more recent datasets, and this is likely due to difficulties in analyzing trace metals in the earlier dataset, and widespread use of leaded gasoline prior to 1995.

Pesticides. Diazinon was detected at the upstream LACDPW site and historically at the USGS site. The more extensive data set collected at the Newhall WRP start-up sites did not detect diazinon and this may be due to its recent phase-out by EPA for residential uses.

Fecal Indicator Bacteria

Tables 2-36 through 2-39 report summary statistics for dry weather monitoring of FIB for the three datasets. The concentrations of indicator bacteria indicated highly variable but generally elevated FIB concentrations in the SCR. Average concentrations of total coliform and fecal coliform were similar between the USGS station and the WRP startup monitoring stations. The mass emission station recorded much greater average concentrations, which is likely an artifact of the small dataset.

Table 2-36: LACDPW Dry Weather Monitoring at the SCR Mass Emission Station (S29) during 2002-2009

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Total coliform (MPN/100mL)	15	15	130	50000	3714
Fecal coliform (MPN/100mL)	15	15	20	5000	148
Enterococci (MPN/100mL)	15	14	<20	1300	140

Table 2-37: Newhall WRP Pre-Startup Dry Weather Monitoring for Indicator Bacteria in the SCR during 2004 – 2007

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Fecal coliform (CFU/100mL)	NR1	98	97	<2	2300	158
	NR3	98	97	<2	3000	187
Total coliform (MPN/100mL)	NR1	98	98	23	24,000	1227
	NR3	98	98	23	24,000	1452

Table 2-38: Newhall WRP Pre-Startup Dry Weather Monitoring for Indicator Bacteria in the SCR during 2008-2009

Constituent	Location	No. of Samples	No. of Detects	Min	Max	Average
Fecal coliform (MPN/100mL)	RSW-001U	4	3	<20	300	115
	RSW-002D	4	3	<20	170	92
Total coliform (MPN/100mL)	RSW-001U	4	3	<20	3000	1,827
	RSW-002D	4	3	<20	3000	982

Table 2-39: USGS Dry Weather Water Quality Monitoring Data for Indicator Bacteria in the Santa Clara River at the County Line during 1951-1995

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

Summary

Table 2-40 summarizes of all dry weather monitoring data available for the Santa Clara River in the NRSP area.

Table 2-40: Summary of Average Dry Weather Monitoring Data in the Santa Clara River

	USGS Wet Weather Monitoring	**SCR Mass Emission Station**	**Newhall WRP Startup Monitoring**				
Constituent	*11108500*	*S29*	*NR1*	*NR3*	*RSW-001U*	*RSW-001D*	*RSW-002D*
General and Conventional Parameters							
TSS (mg/L)	349	135	42	76	18		18
Hardness (mg/L)	881	411	323	380	257		256
TDS (mg/L)	1541[1]	806	853	930	873		904
Chloride (mg/L)	140	114	116	122	115		122
Nutrients							
Total P (mg/L)	1.13	0.18	0.6	0.5	0.40		0.40
Nitrate-N (mg/L)	4[2]	0.23	2.4	2.4	1.84		1.86
Nitrite-N (mg/L)	-	1.16	<0.005	<0.005	0.07		0.07
Ammonia-N (mg/L)	0.18	0.08	0.1	0.1	0.04	0.03	0.05
TKN (mg/L)	0.83	0.08	0.7	0.7	0.77		0.74
Metals							
Dissolved copper (µg/L)	1.8	2.4	3.6	3.6			
Total copper (µg/L)	20	13	4.4	5.2	2.9		2.9
Dissolved lead (µg/L)	7.8	<0.17	<0.05	<0.05			
Total lead (µg/L)	ND	1.3	0.6	0.9	0.29		0.28
Dissolved zinc (µg/L)	15.8	7.9	14.1	11.8			
Total zinc (µg/L)	45	21	16	17	13.5		12.7
Dissolved aluminum (µg/L)	-	36	36	54			
Total aluminum (µg/L)	-	566	325	530	208		170

ND = non detected, - = no or insufficient data

2.8 Groundwater

2.8.1 Groundwater Beneficial Uses

The Project 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 2-41.

Table 2-41: 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)

2.8.2 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, along with natural groundwater discharge mechanisms, such as discharge to the Santa Clara River, subsurface outflow beneath the River, and evapotranspiration by deep-rooted vegetation. There is no groundwater recharge at the west end of the valley, only natural mechanisms for groundwater discharge occur. .

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 Valley. 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. This difference is a direct result of WRP flows in the western half of the SCR that results in more constant recharge rates to the alluvial aquifer. 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 2-42 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 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 2-42 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 2-42: 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
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

Parameter	Units	Basin Plan Objective / Maximum Contaminant Level	Average Concentration			
			Alluvial Well E-15	Alluvial Well C	Alluvial Well B6	Saugus Well 206
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 (EPA) establish regulations for permitting of municipal and industrial stormwater discharges under the NPDES permit program. The EPA 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 EPA. 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, EPA 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 Project will discharge runoff to Santa Clara River Reach 5. Table 3-1 lists the water quality impairments for the Santa Clara River, including reaches upstream of the Project location, as reported in the 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. Reach 7 of the Santa Clara River (Bouquet Canyon Road to above Lang Gaging Station) is listed for coliform bacteria. Reach 6 (West Pier Highway 99 to Bouquet Canyon Road) is listed for coliform bacteria, chlorpyrifos, diazinon, and toxicity; ammonia and chloride are listed as "being addressed" in the reach. 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, including nitrate plus nitrite-nitrogen and ammonia; chloride; and indicator bacteria into the Water Quality Control Plan for Los Angeles Region (Basin Plan). The Indicator Bacteria TMDL, adopted by the Regional Board on July 8, 2010, must be submitted for review and approval to the State Water Resource Control Board (SWRCB), the State Office of Administrative Law, and the U.S. EPA. The wasteload allocations for municipal 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 SWRCB Management Measures for nonpoint source discharges.

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 Reach	Pollutants	303(d) List Proposed TMDL Completion	Potential Sources
7	Bouquet Canyon Rd to above Lang Gaging Station (5 miles upstream)	1) Coliform Bacteria	1) Requires TMDL/2019[2]	1) Nonpoint and Point Sources
6	West Pier Hwy 99 to Bouquet Cyn Rd (Directly upstream of Project site)	1) Coliform Bacteria 2) Chlorpyrifos 3) Diazinon 4) Toxicity 5) Ammonia 6) Chloride	1) Requires TMDL/2019[2] 2) Requires TMDL/2019 3) Requires TMDL/2019 4) Requires TMDL/2019 5) Approved TMDL/2004 6) Approved TMDL/2005	1) Source Unknown 2) Nonpoint and Point Sources 3) Source Unknown] 4) Source Unknown 5) Source Unknown 6) Nonpoint and Point Sources
5	Blue Cut Gaging Station to West Pier Hwy 99 (Project location)	1) High Coliform Count	1) 2019[2]	1) Nonpoint and Point Sources
3	Freeman diversion dam to "A" street [1] (25 miles downstream)	1) Total Dissolved Solids	1) 2019	1) Nonpoint and Point Sources
1	Estuary to Highway 101 Bridge (30 miles downstream)	1) Toxicity	1) 2019	1) Source Unknown
--	Estuary (40 miles downstream)	1) ChemA[3] 2) Coliform 3) Toxaphene	1) 2019 2) 2019[2] 3) 2019	1) Source Unknown 2) Nonpoint Source 3) Nonpoint Source

[1] Reach 3 is downstream of the Dry Gap in Reach 4.
[2] Indicator Bacteria TMDL adopted by LARWQCB in July 2010; not yet approved by SWRCB and US EPA.
[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

<table>
<tr><th>Impairing Pollutant</th><th>Numeric Water Quality Objective</th><th>Wasteload Allocation</th></tr>
<tr><td>Chloride
[(Resolution R4-2008-012 (Revision to Resolution No. 03-008)]</td><td>Reach 5: 150 mg/L only when chloride load reductions and/or chloride export projects are in operation and reduce chloride loading; otherwise: 100 mg/L</td><td>Conditional wasteload allocations (WLAs) for the Saugus WRP and the Valencia WRP were revised from the Chloride TMDL (03-008). Other NPDES discharges contribute a minor chloride load. Conditional WLAs are as follows:
<table>
<tr><th>WRP</th><th>Concentration-based Conditional WLA for Chloride (mg/L)</th></tr>
<tr><td rowspan="2">Saugus</td><td>150 (12 month average)</td></tr>
<tr><td>230 (daily maximum)</td></tr>
<tr><td rowspan="2">Valencia</td><td>150 (12 month average)</td></tr>
<tr><td>230 (daily maximum)</td></tr>
</table>
The source analysis indicates that nonpoint sources are not a major source of chloride. The conditional load allocations for nonpoint sources for Reach 5 is 150 mg/L (12-month average); 230 mg/L (daily maximum).

The conditional WLAs and load allocations for chloride for all point sources shall apply only when chloride load reductions and/or chloride export projects are in operation by the SCVSD. If these conditions are not met, WLAs shall be based on existing water quality objectives for chloride of 100 mg/L.
The source analysis indicates that nonpoint sources are not a major source of chloride. The load allocations for nonpoint sources for Reach 5 is 150 mg/L (12-month average); 230 mg/L (daily maximum).</td></tr>
<tr><td>Nitrogen Compounds
(Resolution No. 03-011)</td><td>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:
<table>
<tr><th colspan="3">TMDL Ammonia Water Quality Objective (mg/L as N)</th></tr>
<tr><td>Santa Clara River Reach</td><td>1-hr Avg</td><td>30-day Avg</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></td><td>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)</td></tr>
</table>

<table>
<tr><th>Impairing Pollutant</th><th>Numeric Water Quality Objective</th><th>Wasteload Allocation</th></tr>
<tr>
<td>Indicator Bacteria (Resolution R10-006)</td>
<td>
Numeric Targets:
<table>
<tr><th>Constituent</th><th>SCR Reach 5 Requirement</th></tr>
<tr><td>E. Coli
(Single Sample)</td><td>235/100 mL</td></tr>
<tr><td>E. Coli
(Geometric Mean)</td><td>126/100 mL</td></tr>
</table>
</td>
<td>
Wasteload Allocations are given in terms of allowable exceedance days. The numeric targets may not be exceeded more than the number of allowable exceedance days allotted in the tables below.
Interim Allowable Exceedance Days
(Enforceable 4 years after effective date of TMDL):
<table>
<tr><th>Time Period</th><th>Santa Clara River Reach 5</th></tr>
<tr><td>Dry Weather</td><td>17 allowable exceedance days of singe sample objectives.</td></tr>
<tr><td>Wet Weather</td><td>61 allowable exceedance days of singe sample objectives;</td></tr>
</table>
Allowable Exceedance Days
(Dry Weather enforceable 11 years after effective date of TMDL; Wet Weather enforceable 17 years after effective date of TMDL):
<table>
<tr><th>Time Period</th><th>Santa Clara River Reach 5</th></tr>
<tr><td>Dry Weather</td><td>5 allowable exceedance days of singe sample objectives:
0 allowable exceedances of geometric mean objectives</td></tr>
<tr><td>Wet Weather</td><td>16 allowable exceedance days of singe sample objectives;
0 allowable exceedances of geometric mean objectives</td></tr>
</table>
</td>
</tr>
</table>

The SWRCB approved the 2010 Integrated Report on August 4, 2010. The 2010 Integrated Report includes changes to the 2006 Clean Water Act Section 303(d) list of impaired water bodies and Clean Water Act Section 305(b) report on the quality of waters in California. The SWRCB has submitted the 2010 Integrated Report to the U.S. EPA for approval. The Santa Clara River impairments in the 2010 303(d) list are summarized in Table 3-4 below. Table 3-5 lists the 2010 Section 303(d) List of Water Quality Limited Segments Being Addressed by EPA Approved TMDLs. There are no changes in the listed impairments for Reach 1. New impairments are listed for nitrate in the estuary, toxicity in the estuary and Reach 3, iron in Reach 5 and Reach 6, and copper in Reach 6. Ammonia has been delisted in Reach 6.

Table 3-4: 2010 CWA Section 303(d) Listings for the Santa Clara River Mainstem

SCR Reach[1]	Geographic Description	Pollutants	TMDL Status/Proposed or USEPA Approved TMDL Completion Date	Potential Sources
7	Bouquet Canyon Rd to above Lang Gaging Station (5 miles upstream)	1) Coliform Bacteria	1) Requires TMDL/2019[2]	1) Nonpoint and Point Sources
6	West Pier Hwy 99 to Bouquet Cyn Rd (Directly upstream of Project site)	1) Chlorpyrifos 2) Coliform Bacteria 3) Copper 4) Diazinon 5) Iron 6) Toxicity	1) Requires TMDL/2019 2) Requires TMDL/2019[2] 3) Requires TMDL/2021 4) Requires TMDL/2019 5) Requires TMDL/2021 6) Requires TMDL/2019	1) Source Unknown 2) Nonpoint and Point Sources 3) Nonpoint and Point Sources 4) Source Unknown 5) Source Unknown 6) Source Unknown
5	Blue Cut Gaging Station to West Pier Hwy 99 (Project location)	1) Coliform Bacteria 2) Iron	1) Requires TMDL/2019[2] 2) Requires TMDL/2021	1) Nonpoint and Point Sources 2) Source Unknown
3	Freeman diversion dam to "A" street [3] (25 miles)	1) Total Dissolved Solids 2) Toxicity	1) Requires TMDL/2015 2) Requires TMDL/2021	1) Source Unknown 2) Source Unknown
1	Estuary to Highway 101 Bridge (30 miles)	1) Toxicity	1) Requires TMDL/2019	1) Source Unknown
--	Estuary (40 miles)	1) ChemA[4] 2) Coliform Bacteria 3) Toxaphene 4) Nitrate 5) Toxicity	1) Requires TMDL/2019 2) Requires TMDL/2019[2] 3) Requires TMDL/2019 4) Requires TMDL/2021 5) Requires TMDL/2019	1) Source Unknown 2) Nonpoint Source 3) Nonpoint Source 4) Source Unknown 5) Source Unknown

[1] Reach 3 is downstream of the Dry Gap in Reach 4.
[2] Indicator Bacteria TMDL adopted by LARWQCB in July 2010; not yet approved by SWRCB and US EPA.
[3] ChemA suite of chlorinated legacy pesticides include: Aldrin, chlordane, Dieldrin, Endosulfan I/II, Endrin, gamma-BHC, heptachlor, heptachlor epoxide, and Toxaphene.
Note: 2010 CWA Section 303(d) List approved by SWRCB 8/4/10; not yet approved by US EPA.

Table 3-5: 2010 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 6	1. Chloride	1) Nonpoint/Point Source	1) 2005
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) 2002 2) 2002

Note: 2008 CWA Section 303(d) List approved by LARWQCB 9/21/2009; not yet approved by State Board

3.3 California Toxics Rule

The California Toxics Rule (CTR) is a federal regulation issued by the EPA providing water quality criteria for potentially toxic constituents in receiving waters with human health or aquatic life designated uses in the State of California. CTR criteria are applicable to the receiving water body and therefore must be calculated based upon the probable hardness values of the receiving waters for evaluation of acute (and chronic) toxicity criteria. At higher hardness values for the receiving water, copper, lead, and zinc are more likely to be complexed (bound with) components in the water column. This in turn reduces the bioavailability and resulting potential toxicity of these metals.

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 and therefore are used in assessing Project impacts. For example, the average storm duration for storms greater than 0.1 inch in the 40 year Newhall rain gauge record is 11.4 hours. Acute criteria represent the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (one hour) 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.

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 Project area than the SCR 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 Project 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 Project area, although higher values are likely to occur.

In this document, the 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 EPA 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 (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 Basin Plan

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 ground waters. 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 Project

runoff on the receiving waters of the proposed project. Table 2-2 above lists the beneficial uses of applicable receiving waters.

The Basin Plan also contains water quality criteria for groundwater basins. For example, the Basin Plan requires that "Ground waters shall not contain taste or odor producing substances in concentrations that cause nuisance or adversely affect beneficial uses". Table 2-37 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 Project area. 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 wasteload 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 design criteria and guidance are also contained in the MS4 Permit, the SUSMP Manual, and in the *Los Angeles County Department of Public Works Stormwater Best Management Practice Design and Maintenance Manual For Publicly Maintained Storm Drain Systems* (LACDPW, 2009).

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 Project 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 Project 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).

The preliminary sizing of the treatment control facilities is set forth in this document and the Mission Village Drainage Concept Report (Psomas, 2009). Facility sizing will be finalized by the project engineer with the final hydrology study prior to issuance of a grading permit, which will be prepared and approved to ensure consistency with this analysis.

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). This document generally identifies potential locations for these types of improvements and preliminarily identifies appropriate BMPs.

The LARWQCB issued a letter in December 2006 that clarification the Board's compliance expectations for the development planning requirements in Part 4.D of the MS4 Permit (LARWQCB. 2006). Per the clarification letter, the three provisions in Part 4.D that are the essential requirements for compliance are to: (1) maximize the percentage of pervious surfaces to allow percolation of storm water into the ground; (2) minimize the quantity of storm water directed to impervious surfaces and the MS4; and (3) minimize pollution emanating from parking lots through the use of appropriate treatment control BMPs and good housekeeping practices.

The Project is required to incorporate appropriate SUSMP requirements into project plans as part of the development plan approval process for building and grading permits. This analysis will identify at a project level, and consistent with the framework, conclusions, and requirements of the NRSP Sub-Regional Stormwater Mitigation Plan (Geosyntec Consultants, 2007), the design specifications related to treatment control BMPs and other project features associated with the

Mission Village project. Design of these BMPs will be finalized by the project engineer with the hydrology study prior to issuance of grading permits to ensure consistency with this analysis.

3.6.3 Los Angeles County Low Impact Development Ordinance and Manual

Chapter 12.84 of the Los Angeles County Municipal Code requires the use of low impact development ("LID") standards in development projects. This chapter applies to all development within the unincorporated area of the County after January 1, 2009, except for those developments that filed a complete discretionary or non-discretionary permit application with the Los Angeles County Department of Regional Planning, Public Works, or any County-controlled design control board, prior to January 1, 2009. Although the Mission Village project is not subject to the requirements of Chapter 12.84 because the Project had filed a complete application prior to January 1, 2009, the LID standards in the Chapter are used as benchmarks in this report.

Chapter 12.84 requires that applicable development projects:

- Mimic undeveloped stormwater and urban runoff rates and volumes in any storm event up to and including the "50-year capital design storm event," as defined by LACDPW;
- Prevent pollutants of concern from leaving the development site in stormwater as the result of storms, up to and including a water quality design storm event; and
- Minimize hydromodification impacts to natural drainage systems.

To meet these standards, development projects that consist of five or more residential units, or nonresidential development, shall comply with the following:

- The excess volume (ΔV, defined as the post-developed runoff volume minus the pre-developed runoff volume for the 85th percentile storm event) from each lot upon which such development is occurring shall be infiltrated at the lot level, or in the alternative, the excess volume from the entire development site, including streets and public right-of-way, shall be infiltrated in sub-regional facilities. The tributary area of a sub-regional facility shall be limited to five acres, but may be exceeded with approval of the Director of LACDPW. When infiltration of all excess volume is not technically feasible, on-site storage, reuse, or other water conservation uses of the excess volume is required and shall be implemented as authorized by the Director of LACDPW.

LACDPW has developed a LID Standards Manual that outlines stormwater runoff quantity and quality control development principles, technologies, and design standards for achieving the LID Standards of Chapter 12.84. The LID Standards Manual requires that large scale residential and nonresidential development projects prioritize the selection of BMPs to treat stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in an integrated approach to protecting water quality and managing water

resources. The Manual states that BMPs should be implemented in the following order of preference:

- BMPs that promote infiltration.
- BMPs that store and beneficially use stormwater runoff.
- BMPs that utilize the runoff for other water conservation uses including, but not limited to, BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs that percolate runoff through engineered soil and allow it to discharge downstream slowly.

If compliance with the above LID requirements is technically infeasible, in whole or in part, the project must incorporate design features demonstrating compliance with the LID requirements to the maximum extent practicable. The LID goals of increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses will be considered by DPW in the determination of infeasibility.

The LID Standards Manual outlines site conditions where infiltration may not be possible:

- Locations where seasonal high groundwater is within 10 feet of the surface.
- Within 100 feet of a groundwater well used for drinking water.
- Brownfield development sites or other locations where pollutant mobilization is a documented concern.
- Locations with potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations with natural, undisturbed soil infiltration rates of less than 0.5 inches per hour that do not support infiltration-based BMPs.
- Locations where infiltration could cause adverse impacts to biological resources.
- Development projects in which the use of infiltration BMPs would conflict with local, State or Federal ordinances or building codes.
- Locations where infiltration would cause health and safety concerns.

The LID Standards Manual outlines where storage and reuse of the ΔV may not be possible:

- Projects that would not provide sufficient irrigation or (where permitted) domestic grey water demand for use of stored runoff due to limited landscaping or extensive use of low water use plant palettes in landscaped areas.
- Projects that are required to use reclaimed water for irrigation of landscaping.

- Development projects in which the storage and reuse of stormwater runoff would conflict with local, state or federal ordinances or building codes.
- Locations where storage facilities would cause potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations where storage facilities would cause health and safety concerns.

The LID Standards Manual also contains drainage analysis requirements for hydromodification impacts to off-site property. The LID Standards Manual provides for the following exemptions from conducting a full analysis for hydromodification impacts, although project applicants must still demonstrate that the project mitigates for hydromodification impacts to the satisfaction of the Director of Public Works:

- Projects that disturb less than one acre.
- Less than 10,000 square feet of new impervious area.
- Projects that do not increase impervious area or decrease the infiltration capacity of pervious areas compared to pre-project conditions.
- Projects that are replacement, maintenance, or repair of an existing permitted flood control facility.
- Projects within a watershed or subwatershed where a geomorphically-based watershed study has been prepared that establishes that the potential for hydromodification impacts is not present based on appropriate assessment and evaluation of relevant factors, including: runoff characteristics, soil conditions, watershed size and conditions, channel conditions, and proposed levels of development within the watershed.
- Projects that discharge directly or via a storm drain into concrete or significantly hardened channels, which in turn discharge into a sump area under tidal influence, or other receiving water that is not susceptible to hydromodification impacts.
- Projects that have hydrologic control measures that include sufficient subregional, regional, in-stream control measures, or a combination thereof such that hydromodification will not occur.

3.6.4 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, Section D.1 required the County and its Co-permittees 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 Section 4.D(9) of the MS4 Permit, the NRSP Sub-Regional Stormwater Mitigation Plan (Geosyntec Consultants, 2007) provides an alternative hydromodification control performance standard for the NRSP projects, including Mission Village, which is sub-region specific and is based on hydrodynamic modeling and geomorphic assessment. The Mission Village Project 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 the NSRP Sub-Regional Stormwater Mitigation Plan. See further Section 5.3 below. Under Section 4.D(9) of the MS4 Permit, compliance with the NRSP Sub-Regional Stormwater Mitigation Plan hydromodification control performance standard is used to evaluate impacts to surface water quality from hydromodification.

3.7 Construction Permits

Pursuant to the CWA Section 402(p), requiring regulations for permitting certain stormwater discharges, the State Water Resources Control Board (SWRCB) issued a statewide general NPDES Permit for stormwater discharges from construction sites [(NPDES No. CAR000002) Water Quality Order 2009-0009-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 September 2, 2009)].

Under this Construction General Permit, discharges of stormwater from construction sites with a disturbed area of one or more acres (effective July 1, 2010) are required to either obtain individual NPDES permits for stormwater discharges or to be covered by the Construction General Permit. Coverage under the Construction General Permit is accomplished by completing a construction site risk assessment to determine appropriate coverage level; preparing a Stormwater Pollution Prevention Plan (SWPPP), including site maps, a Construction Site Monitoring Program (CSMP), and sediment basin design calculations; for projects located outside of a Phase I or Phase II permit area, completing a post-construction water balance calculation for hydromodification controls; and completing a Notice of Intent. All of these documents must be electronically submitted to the SWRCB for General Permit coverage. The primary objective of the SWPPP is to identify and apply proper construction, implementation, and maintenance of BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction. The SWPPP also outlines the monitoring and sampling program required for the construction site to verify compliance with discharge Numeric Action Levels (NALs) set by the Construction General Permit.

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

The Los Angeles Regional Water Quality Control Board reissued a General NPDES Permit and General Waste Discharge Requirements (WDRs) (Order No. R4-2008-0032, NPDES No. CAG994004) which supersedes the former dewatering permit (Order No. R4 2003-011). This permit governs 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 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 the 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 the Project, 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 Newhall Ranch RMDP EIR/EIS (Impact Sciences, 2007) and the Mission Village EIR. As discussed in Section 4.4.2 below, this report does analyze the adverse impacts to natural drainage systems that may be caused by the Project's alteration of hydrologic conditions.

3.10 Lake or Streambed Alteration Agreement (LSAA)

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.

This report does not analyze the habitat and wildlife impacts associated with physical alterations to waters of the United States proposed in conjunction with the Project, 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 Newhall Ranch RMDP EIR/EIS (Impact Sciences, 2007) and the Mission Village EIR. As discussed in Section 4.4.2 below, this report does analyze 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 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 proposed by the Project, 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 are 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. TMDLs have been developed and adopted into the Basin Plan for nitrogen compounds in the Santa Clara River, 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 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 ground water contamination. High metal concentrations can lead to bioaccumulation in fish and shellfish and affect 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 2.7 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 compose 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 EPA, aluminum is not considered a contaminant of potential concern (COPC) to fish or aquatic organisms when surrounding soil pH is greater than 5.5 or when in solution of a pH above 5.5 (EPA, 2003) because aluminum solubility and resultant toxicity has been linked to pH values below this standard. In general, Project 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 Project 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 fecal indicator bacteria (FIB), such as fecal coliform,

have been used to indicate the presence of pathogens due to the difficulty of monitoring for pathogens directly. More recently, the scientific community has questioned the use of certain indicator organisms, as there are various confounding factors that affect the reliability of some FIB as pathogen indicators in stormwater runoff. Santa Clara River Reaches 5, 6, and 7 and the Santa Clara River Estuary area identified as impaired by high fecal coliform counts from point and nonpoint sources. An Indicator Bacteria TMDL was approved by the LARWQCB for the Santa Clara River Estuary and Reaches 3, 5, 6, and 7 on July 8, 2010.

***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 organophosphorous 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, including chlorinated pesticides. Santa Clara River Reaches 3, 1 and the estuary are proposed for or are also listed for toxicity, which can be a byproduct of pesticides. Toxic organophosphorous pesticides include diazinon and chlorpyrifos whose uses also are being banned of restricted by EPA. The current pesticides of concern for water quality are pyrethrums; parathyroid's (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, and permethrin); carbaryl; malathion; and imidacloprid.

***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 have caused listings for impairment. Irrigation of salt sensitive crops such as avocados and strawberries with water containing elevated levels of chloride potentially results 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 uncontrolled 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 affects insects and can affect 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). The most common forms are hydrogen cyanide (HCN) and the sodium and potassium salts (NaCN and KCN) (ANL, 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 Project.

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 algae growth. Nutrients in fertilizers and food wastes in trash are examples of likely oxygen demanding compounds to be present on the Project 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 2.5.1 above), chemical constituents are not a pollutant of concern for the Project.

Iron. Iron was included in the 2008 Los Angeles Region Integrated Report Clean Water Act Section 305(b) and proposed Section 303(d) List for Santa Clara River Reach 5. The listing referenced exceedances from Saugus and Valencia Water Reclamation Plant receiving water quality monitoring, based on EPA National Recommended Water Quality Criteria (1976) iron criterion of 1.0 mg/L for freshwater aquatic life. The EPA criterion is based on three studies that were conducted between 1948 and 1967 which observed fish toxicity effects at iron levels of 1 – 2 mg/L at low and unknown pH levels.

The presence of iron in the Santa Clara River is due to the fact that it is an abundant element in the earth's crust (the fourth most abundant element by weight); iron silicate minerals are a component of most rocks, including basalt. Iron is an important component in soil adhesion, and is additionally important biologically. Vertebrate animals utilize iron's oxidation-reduction mechanisms to transport oxygen in the bloodstream. Iron pollution sources include industrial wastewater, mine leachate, and groundwaters with high iron content. At low pH levels (below 5.5), iron from these sources complexes with hydroxide, and forms precipitates which can coat gills of fish and cement streambeds, making them unsuitable for spawning.

The Basin Plan and the CTR do not include a water quality criterion for iron. Instream monitoring data in Santa Clara River from 2002-2009 show concentrations of iron ranging from 400 to 44,400 μg/L, with no resultant toxicity. As iron concentrations from developed condition land uses typically range from 1,000 to 3,000 μg/L (LACDPW, 2000), runoff from the Project is unlikely to affect concentrations in the Santa Clara River. Additionally, wet weather water quality monitoring data in the Santa Clara River gathered by LA County from 2002-2009 (station S29, see section 2.7) show no correlation between toxicity and iron. Toxicity tests in two storm events from 2008-2009 showed no exceedances even with measured instream total iron levels as high as 31,000 μg/L and 39,600 μg/L, respectively. Therefore, iron is not anticipated to be a pollutant of concern for the Project.

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 Project include warm freshwater habitat to support warm water ecosystems, temperatures of stormwater runoff in the Project 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 Project.

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 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. Project land uses will not include industrial land uses. Therefore, color-, taste-, or odor-producing substances are not pollutants of concern for the Project.

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 potential for non-native plan species to impact natural drainages is analyzed in the "Mission Village Biota Report, Los Angeles County, California" prepared by Impact Sciences, Inc. (Impact Sciences, 2006) and in the Newhall Ranch RMDP EIR/EIS (Impact Sciences, 2007).

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 4-2). Therefore, these constituents are not considered pollutants of concern for the Project.

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 Project.

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 Project area did not historically include PCB-producing land uses. Therefore, PCBs are not a pollutant of concern for the Project.

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 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.

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 Groundwater Pollutants of Concern

The Project 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) 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 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 Project that exhibit these characteristics. Identification of the pollutants of concern for the Project considered proposed land uses as well as pollutants that have the potential to impair beneficial uses of the groundwaters below the Project. 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 Project 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 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 Project.

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). Therefore, these constituents are not considered pollutants of concern for the Project. As required by the CWA, the NRSP WRP discharge permit will include effluent limitations 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 surface and groundwater objectives, CTR criteria, and applicable TMDL waste load allocations. Therefore, these constituents are not considered pollutants of concern for the NRSP projects.

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	<150
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, 2006.

4.3 Hydrologic Conditions of Concern (Hydromodification)

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 increased 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 Significance Criteria and Thresholds for Significance

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 threshold 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 Project area, which last seven 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 (EPA, 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. In addition, satisfaction of the LID requirements of the County of Los Angeles' LID Ordinance and Manual are assessed as a benchmark for regulatory compliance. The LID criteria are considered benchmarks, as the Project is exempt from the requirements of the LID Ordinance and Manual.

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 (MEP). MS4 requirements are met when new development complies with the SUSMP requirements set forth in the MS4 Permit. Under the SUSMP requirements, the essential requirements for compliance are: (1) maximizing the percentage of pervious surfaces to allow percolation of stormwater into the ground; (2) minimizing the quantity of stormwater directed to impervious surfaces and the MS4; and (3) minimizing pollution emanating from parking lots through the use of appropriate treatment control BMPs and good housekeeping practices. 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 Manual. If the Project PDFs meet MS4 requirements, including sizing for treatment controls and other source control and low impact/site design BMPs consistent with the SUSMP requirements, it indicates that no significant impacts will occur as the result of MS4 Permit compliance.

Construction General Permit and General Dewatering Permit. The Construction General Permit requires the development and implementation of a Stormwater 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 Project Design Features (PDFs). The analysis will also consider whether the Project, including PDFs, and future projects 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 and the General Dewatering Permit) 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 Project 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, violate 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 Project 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 low impact/site design, source control, treatment control, and hydromodification control BMPs that will be incorporated into the Project and are considered a part of the Project 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. Low impact/site design and source control BMPs are practices designed to minimize 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 low impact/site design, source control, treatment control, and hydromodification control PDFs for the Project.

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 Project.

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

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
• 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.[3] • 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 five 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 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.	• Hydromodification source controls include minimizing impervious surfaces through clustering development and using bioretention, extended detention (see Figure 5-1), and other vegetated treatment control BMPs to disconnect impervious surfaces and reduce runoff volumes through evapotranspiration and infiltration. • 50-year capital storm peak flow rate analysis is contained in the "Mission Village Tentative Tract Map 6110561105 Drainage Concept", prepared by Psomas (Psomas, 2009), and analysis of flood impacts on the Santa Clara River is contained in the "Flood Technical Report" prepared by Pacific Advanced Civil Engineering, Inc. for the Mission Village Project (PACE, 2007).
• 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, including Mission Village. Approximately 70% (8,335 acres) of the NRSP subregion will remain undeveloped. • Approximately 627 acres of the 1,262 acre Mission Village Project area will remain as natural river corridor, open space, or parks. • 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, but not limited to, bioretention (placed in common area landscaping in commercial and multi-family residential areas, roadway median strips, and parking lot islands (where applicable) and dry extended detention basins.

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

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
		• Riparian buffers will be preserved along the Santa Clara River corridor and Lion Canyon by clustering development upland and away from the River and tributary canyon. • Lion Canyon will be stabilized and restored by the Project. The restoration will utilize boulder step-pool structures, biotechnical stabilization, soil cement, turf reinforcement mat (TRM) 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.
• 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 Figure 5-1 and Section 5.2). These treatment BMPs for the Project include detention basins, bioretention, vegetated swales, and catch basin media filtration units. These BMPs are designed to minimize introduction of pollutants to the Maximum Extent Practicable (MEP). • The Project 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 commercial areas and multi-family residential areas, use of native and/or non-invasive, climate appropriate 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 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

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
		cleaning up after pets and not feeding pigeons, seagulls, ducks, and geese. • Vegetated treatment control BMPs will allow for infiltration of treated stormwater.
• 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.	• Natural slopes and native vegetation on slopes adjacent to the SCR and Lion Canyon will be preserved and/or restored and enhanced. Native vegetation will be used in all plant palettes placed on restored slopes. • Project PDFs, including 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 RDMP. 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. For a detailed description of the proposed bank stabilization see the Flood Section of the Mission Village DEIR and the Flood Technical Report (PACE, 2007). • All outlet points to the Santa Clara River will include energy dissipaters per the Newhall Ranch RDMP. • In-stream stabilization techniques will be employed in Lion Canyon to protect habitat-related beneficial uses, per the Newhall Ranch RDMP. See Appendix F for further detail on the Lion Canyon channel restoration.

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
• 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 Los Angeles County Department of Public Works (LACDPW) and/or Home Owners Associations will maintain stencils and signs.
• 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.
• 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.
• 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.	• 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 Mission Village PDFs
• 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 Project 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 bioretention, dry extended detention basins (see Figure 5-1), vegetated swales, catch basin media filtration units, 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 Mission Village 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.
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	• Retail gasoline outlets will comply with design requirements.

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
	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.	
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..	• Automotive repair shop loading/unloading dock areas will comply with design requirements.
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.

SUSMP Requirement	Criteria/ Description	Corresponding Mission Village PDFs
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 (groundwater >10 ft from grade) 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 site design/low impact development (LID) BMPs is, to the extent feasible, to mimic the pre-developed hydrologic regime. The primary goals of site design/LID BMPs are to maintain a landscape functionally equivalent to predevelopment hydrologic conditions, and to minimize the generation of pollutants of concern.

Site design/LID 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 pre-development hydrologic regime. This may be accomplished by clustering development within portions of the site to conserve as much natural open space as possible, 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). For example, restricting the use of architectural copper on the outside of buildings and reducing the use of galvanized materials will reduce the impact of copper and zinc to stormwater runoff.

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

Implementation of these measures is required by the LA County LID Manual. Project Design Features (PDFs) which meet the requirements in the LID Manual are listed in Table 5-2. Volume reductions provided by the PDFs meet LID Manual volume reduction requirements, as explained in section 6.2 and 7.4.

5.2.1 Consideration of Spatial Scale

Low impact/site design implementation for the Project occurs at 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 – the Mission Village project;
- Land use scale – single family residential, multi-family residential, commercial, education, parks, and roadways within the Mission Village project, and
- Lot or parcel scale – individual lots or parcels within the Mission Village project.

5.2.2 Mission Village Low Impact/Site Design BMPs

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

Table 5-2: Mission Village Low Impact/Site Design BMPs

LA County LID Guidance	Corresponding Newhall Ranch LID Practice
<u>Conserve natural areas, soils, and vegetation</u> Site planning, design, and execution, where appropriate, should: • Conform to local watershed, conservation, and open space plans • Preserve sensitive environmental areas • Preserve historically undisturbed vegetated areas • Build upon the least porous soils or limit construction to areas with previously disturbed soils • Preserve the maximum surface area of undisturbed grades • Preserve native trees and restrict disturbance of soils beneath tree canopies • Avoid disturbing vegetation and soil on slopes and near surface waters • Leave an undisturbed buffer along both sides of natural streams • Avoid adding materials to the soil that decrease cation exchange capacity (CEC), such as sand, except where required for special water treatment needs.	*Ranch Scale* • The Newhall Ranch Specific Plan (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 and the Special Management Areas (SMAs), which include the Santa Clara Riverbed, as well as the Santa Susanna mountain high country. The Open Areas are designed to protect significant landforms and natural resources, and to provide an opportunity to protect natural resources from the proposed development. • The NRSP Land Use Plan designates a total of 5,161 acres for the 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 would assume responsibility for management of this area. • The largest land use designation of the Specific Plan Land Use Plan is the 4,185-acre High Country SMA. The High Country SMA is located in the southern portion of the subregion 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 SMA is to be dedicated in fee to a joint powers authority, consisting of representatives from the County of Los Angeles, the city of Santa Clarita, and the Santa Monica Mountains Conservancy. • To minimize potential biological impacts to lands in Ventura County as a result of the Project, 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 High Country SMA, discussed above. • Two conservation easements totaling approximately 62 acres have been granted to CDFG for the purpose of conserving populations of spineflower that occur on the NRSP sub-region. *Mission Village Scale* • Natural slopes and native vegetation on slopes adjacent to the SCR will be preserved and/or restored and enhanced. • The 20.3 acre spineflower conservation easement within Mission Village will be included in the 65.7 acre spineflower preserve (see Figure 2-2) increasing the natural open space by 45.4 acres.

LA County LID Guidance	Corresponding Newhall Ranch LID Practice
	Land Use Scale • Native and/or nonnative/noninvasive vegetation that requires less watering and chemical application would be utilized within the common area landscaping in commercial areas and multi-family residential areas.
<u>Minimize disturbances to natural drainage patterns</u> Site planning, design, and execution, where appropriate, should: • Maintain surface flow patterns of undeveloped sites • Maintain existing water body alignments, sizes, and shapes • Protect seasonal flooding patterns of wetlands • Restore streams and drainage corridors to achieve the same characteristics of timing, flow, and habitat as the original drainage courses in the event that preservation of natural drainage patterns cannot be maintained	*Village Scale* • Riparian buffers would be provided along the Santa Clara River Corridor and major tributaries by clustering development upland and away from the River and tributary drainages. • In order to stabilize and restore the Lion Canyon drainage, a geomorphic channel design is proposed (see Appendix F for further detail). This design will utilize boulder step-pool structures, biotechnical stabilization, soil cement, turf reinforcement mat (TRM) 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. *Land Use Scale* • Landscape watering in common areas, commercial areas, multi-family residential areas, and in parks would use efficient recycled water irrigation technologies with centralized irrigation controls.

LA County LID Guidance	Corresponding Newhall Ranch LID Practice
<u>Minimize and disconnect impervious surfaces</u> Site planning, design, and execution, where appropriate, should: • Reduce overall impervious areas by maximizing landscaping and using pervious pavements • Reduce the amount of impervious areas that are hydraulically connected to impervious conveyances, such as driveways, walkways, culverts, swales, streets, or storm drains.	*Ranch Scale* • A system of Open Areas would weave through the central portion of the Specific Plan 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. *Village Scale* • Impervious areas will be minimized by incorporating landscaped areas into each village, including Mission Village. Approximately 627 acres of the 1,262 acre Mission Village Project area will be natural river corridor, open space, or parks. • Project PDFs, including bioretention areas and water quality basins (hydrologic source controls), will disconnect impervious areas and reduce flows to natural channels through infiltration and evapotranspiration. *Land Use Scale* • 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 Open Areas will incorporate open-jointed paving materials, granular materials, or other pervious materials. • Impervious surfaces will be minimized in common area landscape design for commercial areas and multi-family residential areas. *Lot Scale* • Runoff from most sidewalks, walkways, trails, and patios will be directed into adjacent landscaping or to vegetated swales. • Landscape areas will be integrated into each site.

LA County LID Guidance	Corresponding Newhall Ranch LID Practice
<u>Minimize soil compaction</u> Site planning, design, and execution, where appropriate, should: • Restrict grading and compaction to those areas that will support structures • Protect soils, especially porous soils, against compaction and rutting in areas where traffic is unavoidable • Minimize the size of construction easements and material storage areas • Site stockpiles within the development envelope during the construction phase of a project • Prohibit working on wet soils with heavy equipment • Restore compacted open space areas with tilling and soil amendments	*Village Scale* • In areas not subject to mass grading, the smallest site disturbance area possible will be delineated and flagged; temporary storage of construction equipment will be restricted in these areas to minimize soil compaction on site. Site clearing and grading will be limited to the footprint necessary to allow development, access, and provide fire protection. *Mission Village Scale* • Natural slopes and native vegetation on slopes adjacent to the SCR will be preserved and/or restored and enhanced
<u>Direct runoff from impervious areas to infiltration areas</u> Site planning, design, and execution, where appropriate, should: • Grade surfaces to drain toward open space, swales, or bioretention cells with infiltration capability • Grade surfaces to drain through suitable pretreatment trains toward porous pavements with infiltration capability • Use grassed or vegetated swales with infiltration capability to convey runoff rather than using conduit and lined conveyances	*Village Scale* • The Mission Village stormwater treatment system will provide treatment control for approximately 96 percent of the Project area via the use of vegetated treatment BMPs that provide for volume reduction through infiltration and evapotranspiration, including one or more of the following volume reduction BMPs: bioretention, vegetated swales, and dry extended detention basins. • The Village-level stormwater treatment system would include the use of vegetated treatment BMPs, including bioretention, vegetated swales, and/or extended detention basins. *Lot Scale* • Bioretention areas or vegetated swales will collect and treat runoff from some of the commercial and multi-family residential areas. These bioretention areas will be located in parking lot islands and other on-site landscaped areas. Runoff from most sidewalks, walkways, trails, and patios would be directed into adjacent landscaping or to vegetated swales. • Home builders would be encouraged to direct rooftop runoff through landscaped areas. • Porous pavement will be used in some parking and low traffic areas.

5.3 <u>Treatment BMPs</u>

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 Project include:

- Sediments (TSS and Turbidity)
- Nutrients (Total Phosphorus, Nitrate-N + Nitrite-N, and Ammonia-N)
- 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

Treatment BMPs to be used for the Project are listed in Table 5-3 below, along with the pollutants of concern addressed by each.

Table 5-3: Treatment Control BMP Selection Matrix

Pollutant of Concern[1]	Treatment Control BMP Categories		
	Extended Detention Basins	Bioretention	Media Filtration[3]
Sediment	M	H	M
Nutrients	L	M	L
Trash	H	H	H
Trace Metals	M	H	M
Bacteria	M	H	L
Organics[2]	M	H	M

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.
[3]Treatment effectiveness for this category is estimated based on best professional judgment, as effectiveness results are not reported for proprietary treatment technologies in the CASQA BMP Handbook.

Stormwater runoff from all urban areas within the Project boundary and some off-site project components will be routed to bioretention areas, media filtration, and/or dry extended detention basin treatment control PDFs (Figure 5-1 and Tables 5-4 and 5-5 below). Catch basin inserts will also be used in high use parking lots to address trash and debris and petroleum hydrocarbons. The utility corridor maintenance access road and potential future trail, as well as the Edison substation, will drain to biofiltration (either a vegetated swale or bioretention) treatment. The off-site section of Westridge Parkway and water tank will drain to one of the Project's dry extended detention basins. Runoff from the easterly extension of Magic Mountain Parkway to the Old Road, the Commerce Center Drive Bridge, and a section of Commerce Center Drive will be treated with media filtration or an equivalent treatment method. Collectively, the water quality treatment control PDFs will treat the pollutants of concern in runoff from the Project's developed area and off-site project components. The media filtration units will be designed to operate off-line, receiving dry weather flows, small storm flows, and the initial portion of large storm flows from low-flow diversion structures located in the storm drain system. The proposed treatment control PDFs are described below. These treatment BMPs, when combined with the site design and source control BMPs described above, will address all of the pollutants of concern.

Bioretention: Bioretention areas will collect and treat a portion of the commercial and multi-family land use areas of the Project. As these areas will also drain to the water quality basins described below, runoff from these areas will be effectively treated using a treatment train approach. Bioretention (or swales) will used to treat runoff from the utility corridor maintenance access road and potential future trail, as well as the Edison substation. 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 stormwater through the vegetation and soils. In bioretention areas, 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 5-2, and photographs of existing bioretention areas are provided in Figure 5-3.

Vegetated Swales: Vegetated swales (or bioretention areas) will collect and treat runoff from the utility corridor and the Edison substation. Vegetated swales are engineered, vegetation-lined channels that provide water quality treatment in addition to conveying stormwater runoff. Swales provide pollutant removal through settling and filtration in the vegetation (often grasses) lining the channels and also provide the opportunity for volume reduction 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 5-4 and photographs of existing swales are provided in Figure 5-5. Check dams can be

incorporated into a vegetated swale design to promote enhanced settling and infiltration through velocity reduction and ponding.

Media Filtration: For roadway catchments where it is not possible to direct runoff to the vegetated treatment control BMPs due to proposed project grading (Figure 5-1), media filtration (or equivalent) will be used. A proprietary media filter, such as the Contech StormFilter®[4], is an example of this type of treatment. The StormFilter is a passive, flow-through stormwater media filtration system (Figure 5-6). 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 surface scum and floating 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. System sizing will be based on the manufacturers' recommendations for optimal cartridge performance (for instance, 15 gpm/cartridge for the StormFilter™) and the flow-based BMP design criteria established for the Project pursuant to the MS4 Permit.

Extended Detention Basins: Extended detention basins (EDBs) store runoff for sufficient periods of time to promote the removal of pollutants primarily through settling and 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. The water quality basin will also incorporate wetland vegetation in the basin forebay for the treatment and infiltration of dry weather flows and small storm events. Wetland vegetation provides one of the most effective methods for pollutant removal. As runoff flows through the wetland vegetation, pollutant removal is achieved through settling and biological uptake of nutrients and dissolved pollutants within the wetland. These basins are not designed or anticipated to contain standing water for periods in excess of 48 hours. A conceptual illustration of an extended detention basin is shown in Figure 5-7 and photographs of existing basins are provided in Figure 5-8.

Extended detention basins for the Project include four "Village" basins (Basins A, B, C and E) that will provide treatment for developed areas within the tract map portion of the Project and off-site areas tributary to the developed areas. The Project also includes one "Regional" basin (Basin D), which will provide treatment for portions of the Mission Village, Legacy Village, and Entrada Projects, as well as limited areas of the existing Westridge residential neighborhood and Westridge High School.

[4] This does not constitute a product endorsement.

Table 5-4: Project Drainage Areas and Treatment Control BMPs

Project Drainage Area	Area (acres)	Selected Treatment BMPs and Location[1]
A	171	Extended Detention Basin A, some Bioretention, and catch basin inserts (in Commercial and/or Multi-Family Residential Areas)
B	145	Extended Detention Basin B, some Bioretention, and catch basin inserts (in Commercial and/or Multi-Family Residential Areas)
C[1]	303	Extended Detention Basin C, some Bioretention, and catch basin inserts (in Commercial and/or Multi-Family Residential Areas)
D[1]	164	Extended Detention Basin D, some Bioretention, and catch basin inserts (in Commercial and/or Multi-Family Residential Areas)
E	40	Extended Detention Basin E, some Bioretention and catch basin inserts (in Commercial Areas)
Commerce Center Drive and Bridge	6	Cartridge Media Filtration (treatment BMP for the bridge would be provided by the SR126 interchange project)
Total Treated Area	829	

[1] Does not include off-site natural areas that are tributary to the water quality basins. Includes all open space within the project bounds that drain to the water quality basins.

Table 5-5: Treatment BMPs for Off-Site Project Components

Off-Site Project Component	Area (acres)	Treatment BMPs
Magic Mountain Parkway extension to The Old Road	19	Media Filtration
Water Tank plus access road	2.1	Dry Extended Detention Basin C
Utility Corridor	110	Vegetated Swale or Bioretention
Edison Substation	3.0	Vegetated Swale or Bioretention
Basin D and Associated Drainage Improvements	6.1	Dry Extended Detention Basin D
Total	140.2	

In addition, a planned extension of Magic Mountain Parkway from the western Project boundary was included in the water quality model as it would be tributary to Extended Detention Basin A, although it is not an off-site Project component as it would be constructed as part of another NRSP project.

The extended detention basins for the Project are listed in Table 5-6 below along with the tributary area, SUSMP minimum required volume and NRSP Sub-Regional Stormwater Mitigation Plan required volume, which is the volume of the basin that will be provided.

Table 5-6: Catchment Parameters and Basin Sizing

BMP ID	Tributary Area[1] (acres)	Catchment % Imperviousness[2]	Minimum SUSMP Volume (0.75 inches) (ac-ft) [3]	NRSP Sub-Regional SWMP Basin Volume, (ac-ft)[4]
Basin A	178	44	5.0	8.6
Basin B	145	34	3.4	7.6
Basin C	371	53	12.1	23.1
Basin D[5]	735	43	20.5	41.0
Basin E	40	84	2.0	3.4

[1] Includes off-site areas that drain to basins
[2] Imperviousness based on area weighted average of land use-based values from LA County Hydrology Manual; calculated for purposes of water quality analysis.
[3] Basin sizing for the volume of runoff produced from a 0.75 inch storm event and SUSMP Manual Appendix A runoff calculations. Volumes taken from *Drainage Concept/SUSMP for: Mission Village VTTM 61105* (Psomas, 2007).
[4] Basins sized to capture and treat 80% of annual average runoff volume. Basin volumes include 5 percent allowance for sediment storage.
[5] Basin sizing includes off-site areas outside of Mission Village Impact Boundary.

5.4 Hydromodification Control PDFs

Post-development flows will be directed to the Santa Clara River after treatment, no flows will be directed to the onsite restored tributary Lion Canyon. A series of progressive hydromodification control measures will be used in the Project to prevent and control hydromodification impacts to the Santa Clara River:

- 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.

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 Project 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 stormwater runoff to vegetated areas and/or vegetated BMPs; 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, bioretention areas, and extended detention basins can provide volume reduction on the order of 20 to 30 percent through infiltration and evaporation. 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.

5.4.2 Geomorphically-Referenced Channel Design

The hydromodification management approach for the Santa Clara River will incorporate "geomorphically-referenced" channel design as described in SCCWRP Technical Report 450 (SCCWRP, 2005a). The goal of this approach is to preserve the appearance and function of the natural stream channel to the maximum extent practicable while limiting instability in stream channel morphology. This approach will also be used to restore Lion Canyon to enhance habitat-related beneficial uses (see Appendix F for further detail). Further, by design, Lion Canyon will not receive stormwater runoff from the developed areas of the Project.

The Project's 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 include energy dissipation and bank stabilization, pursuant the Newhall Ranch RMDP.

- *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.

- *Bank Stabilization*. The Project will include bank stabilization along the Santa Clara River adjacent to and downstream of the Project site. In total, approximately 2,900 linear feet (LF) of bank stabilization would be constructed as part of the Project. This would include approximately 1,700 LF on the south bank fronting the Project site, and 1,200 LF downstream of the Project on the north bank, east of the WRP (PACE, 2007). The majority of the Project frontage on the south bank of the Santa Clara River does not require river bank stabilization. The bank stabilization along portions of the southerly side of the Santa Clara River would be designed and constructed to retain the river's significant riparian vegetation and habitat, to allow the river to continue to function as a

regional wildlife corridor, and to provide flood protection pursuant to Los Angeles County standards.

Most of the proposed bank protection would consist of buried soil cement to provide scour and freeboard flood control protection. Soil cement is a modern flood control technique used to protect against erosion while maintaining natural vegetation and soft banks. Soil cement will be buried below the existing banks of the Santa Clara River. Disturbed areas will then re-vegetated with native plant species, maintaining the natural habitat presently found along the River.

Turf Reinforcement Mat (TRM) or similar bank stability protection would be provided by installing approximately 16,000 LF of TRMs along the southern edge of the utility corridor. TRMs are designed to reinforce vegetation at the root and stem allowing vegetation to be used as erosion control in areas where flow conditions exceed the ability of natural vegetation to remain rooted. This includes applications with high slopes or stream banks where grouted rip-rap and concrete channels are aesthetically undesirable.

5.5 Operation and Maintenance

Depending on the type and location of the BMP, 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.

Table 5-7 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.

Table 5-7: 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 years for basins not preceded by HSS unit, every 20 years for basins preceded by HSS unit.	
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

Treatment Control BMP	Operation & Maintenance Category	Activities	Frequency	Maintenance Responsibility
	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)	
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)	

Treatment Control BMP	Operation & Maintenance Category	Activities	Frequency	Maintenance Responsibility
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	

6 ANALYSIS METHODOLOGY

6.1 Water Quality Model Description

A water quality model was used to estimate pollutant loads and concentrations in Project stormwater runoff for certain pollutants of concern for pre-development conditions and post-development conditions with PDFs for the tentative map portion of the Project. 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 40 years (1969 - 2008) of hourly rainfall data measured at the National Climatic Data Center (NCDC) Newhall rain gauge 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 (LACDPW, 2000). 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 modeling only considers the structural treatment PDFs (biofiltration, media filters, and dry extended detention basins) and does not take into account 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 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 (Strecker *et al.*, 2004). Based on this analysis, a conservative estimate of 20 percent of the inflow to the vegetated swales, bioretention with underdrains, and 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).

- *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 are measured prior to discharge into a receiving water body. Currently, such data are available from stormwater programs in Los Angeles 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 Los Angeles County database. Such data is often referred to as "end-of-pipe" data to distinguish it from data obtained in urban streams, for example.

- *Infiltration*: Existing conditions infiltration parameters were assumed based on soil hydrologic group, soil texture class, and the NRCS Soil Survey of the Project area. The majority of the development area will be impacted by cut/fill operations; therefore, post-development soil compaction impacts were modeled for post-development open and landscaped areas assuming a 25 percent reduction in saturated hydraulic conductivity, or infiltration rate, from the pre-developed to post-developed condition. Impervious surfaces were modeled assuming no infiltration.

6.1.1 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, and Ammonia
- Total Aluminum
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- 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 required 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).

6.1.2 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. Because maximum allowable 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 indicator 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 (LACDPW, 2000).

Trash and debris, MBAS, and cyanide are not typically included in routine urban stormwater monitoring programs. 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), dry weather runoff water quality impacts (Section 7.6), and groundwater quality impacts (Section 7.8).

6.2 LID Equivalency Analysis

Los Angeles County's LID Standards Manual outlines stormwater runoff quantity and quality control development principles, technologies, and design standards for achieving the LID Standards of the Los Angeles County LID Ordinance, as described in Section 3.6.3. An analysis was performed to demonstrate that the LID and treatment control PDFs that would provide equivalent or greater volume reductions to that which would be achieved by BMPs designed per the specific requirements of the Los Angeles County LID Manual.

As described in section 3.6.3, infiltration may not be possible if the following criteria apply:

- Locations where seasonal high groundwater is within 10 feet of the surface.
- Within 100 feet of a groundwater well used for drinking water.
- Brownfield development sites or other locations where pollutant mobilization is a documented concern.
- Locations with potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations with natural, undisturbed soil infiltration rates of less than 0.5 inches per hour that do not support infiltration-based BMPs.
- Locations where infiltration could cause adverse impacts to biological resources.
- Development projects in which the use of infiltration BMPs would conflict with local, State or Federal ordinances or building codes.
- Locations where infiltration would cause health and safety concerns.

The Project is required to use reclaimed water for irrigation of landscaping. Therefore, storage and reuse are considered infeasible for the Project.

To demonstrate equivalency, a two tiered analysis was conducted. The first tier of analysis divided the Project area into analysis regions using spatial data processing of the proposed developed condition and the infiltration infeasibility criteria listed above. The second tier calculated the LID Manual volumetric mitigation requirements for these areas (i.e., the volumetric capture efficiency and volume reduction that would be achieved by well designed BMPs per the specific requirements of the LID Manual), calculating the volumetric performance of Project BMPs, and comparing these values. A brief description of the analysis steps and inputs are included below.

6.2.1 Tier One Analysis Methodology

The tier one analysis utilizes spatial datasets and Geographic Information System (GIS) processing to divide the Project into analysis regions based on infiltration infeasibility criteria. Inputs into the tier one analysis included:

- *Proposed Condition Land Use:* Undeveloped areas do not require LID BMPs.
- *Spatial datasets representing feasibility of infiltration:* Spatial datasets representing areas where infiltration is limited by one of the identified screening factors were merged and dissolved. Negative spaces in this merge represent areas where infiltration is potentially feasible within the Project area.

The intersection of proposed land use conditions and areas potentially feasible for infiltration was used to divide the Project into three categories: 1) Open Space, 2) Developed Areas Potential Feasible for Infiltration, and 3) Developed Areas Potentially Infeasible for Infiltration.

6.2.2 Tier Two Analysis Methodology

The Tier Two analysis established a performance standard for the Project based on LID Manual requirements, and compared the predicted performance of the Project PDFs to this performance standard. The LID Manual performance standard was established based on the estimated long term performance of LID BMPs designed per the LID Manual requirements, considering the feasibility criteria contained in the manual. The performance of Project PDFs is estimated based on the water quality modeling. Key components of the Tier Two analysis include:

- *ΔV Calculation:* The volumetric sizing criteria associated with the LID Ordinance is the excess volume (ΔV). The ΔV was calculated in a manner approximately equivalent to the Los Angeles County Hydrology Manual T_c Calculator method by computing the difference in runoff volume in the existing and proposed conditions of the Project for the water quality design storm depth (0.75 inches). Calculations were completed separately for areas where infiltration is potentially feasible and areas where infiltration is potentially infeasible. Calculation methods are described in greater detail in Appendix B.
- *Unit performance of BMPs designed per LID Manual Requirements:* An estimation of the volumetric performance of BMPs designed per LID Manual requirements was made as an element of the LID performance standard. Volumetric performance is a function of:
    1) The average annual capture efficiency of the BMP (i.e., the fraction of average annual runoff that is captured and not immediately bypassed by the BMP), and
    2) The average annual fraction of the captured volume that is retained (or lost) in the BMP due to infiltration, evapotranspiration or direct use.

  Capture efficiency was calculated based on a performance analysis of a hypothetical BMP designed to LID Manual requirements (i.e., sized to capture the ΔV, explained above) for a hypothetical catchment using over 40 years of historic hourly precipitation

records. The resulting capture efficiency was estimated to be approximately 48 percent. For infiltration BMPs, captured water is expected to be fully retained up to the design storm event, therefore the total average annual reduction of runoff volume will be equal to the capture efficiency (48 percent).

In areas where infiltration is infeasible, vegetated treatment BMPs may still achieve incidental volume reductions through soil soaking and drying processes (i.e., evapotranspiration) and slower infiltration (unless facilities have an impermeable liner). An analysis of the International BMP Database (Strecker et al., 2004) found that detention basins and biofilters (swale and filter strips) achieved average volume reductions of 30 to 38 percent of captured volume, respectively. This analysis likely included studies of BMPs underlain by highly infiltrative soils and/or specifically designed for infiltration. For areas of the Project where infiltration is not feasible, it is likely that incidental volume reduction achieved by vegetated BMPs would be significantly less than indicated by the Strecker et al. (2004) study. Therefore, for areas of the Project where infiltration is not feasible it was assumed that 20 percent of the volume captured in vegetated BMPs in areas would be retained. The remaining 80 percent of captured volume was assumed to be treated and released.

- *Applying Unit Volumetric Performance to Spatial Screening to Compute LID Manual Requirements:* Average annual runoff volumes from developed land uses were calculated based on methods approximately equivalent to the Los Angeles County Hydrology Manual T_c Calculator. These volumes were calculated separately for areas where infiltration is potentially feasible and areas where infiltration is potentially infeasible. For areas where infiltration is potentially feasible, the performance standard for volume reduction is equal to 48 percent of the computed average annual runoff volume. For areas where infiltration is potentially infeasible, the performance standard for volume reduction is equal to 9.6 percent (20 percent of 48 percent) of the computed average annual runoff volume. The sum of these two volume reductions forms the LID performance standard for volume reduction. In addition, the LID performance standard includes capture and treatment in a vegetated BMP (including retention) of at least 48 percent of the average annual runoff volume.
- *Performance of PDFs:* Using the water quality modeling approach described in section 6.1 and Appendix B, total Project runoff volumes were estimated for the developed condition with PDFs and without PDFs. The difference between the runoff volume generated from the developed condition without PDFs and the volume generated from the developed condition with PDFs represents the volume reduction achieved by the Project. This volume reduction is compared to the LID Manual performance standard to determine LID equivalency.

LID equivalency analysis results are summarized in section 7.4.

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. , Compliance with NPDES Permit requirements, construction-related impacts, and analyses of dry weather impacts are discussed in Sections 7.3, 7.5 and 7.7, respectively. 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, as applicable; and (3) evaluation in light of receiving water benchmarks. Pursuant to the third criterion, predicted runoff pollutant concentrations in the post-development with PDFs condition are compared with benchmark receiving water quality criteria as provided in the Basin Plan and the CTR and TMDL wasteload allocations. The water quality criteria and wasteload allocations are considered benchmarks for comparison purposes only, since they do not apply directly to runoff from the Project, 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 one 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 Project design features (PDFs).

Note that the modeling results account for pollutant reductions in the extended detention basins and media filtration only and do not account for the pollutant reductions that will occur due to source control PDFs. Because not all BMPs are modeled, the model results predict greater water quality impacts than are likely to occur from the Project.

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

existing receiving water conditions with the modeled developed condition with PDFs runoff quality.

The area of the Project included in the model includes all drainage areas within the Project boundary that will be treated by Project PDFs and does not include natural open space areas that directly discharge to the Santa Clara River or areas in the Santa Clara River channel. Therefore, the Project area (1,261.8 acres) exceeds the on-site modeled area (829 acres). Of the off-site project components, the easterly and westerly extensions of Magic Mountain Parkway, a portion of Commerce Center Drive, the water tank and access road and dry extended detention Basin D were included in the modeled area; the utility corridor and the Edison Substation were not included in the model, but are analyzed qualitatively.

7.1.1 Stormwater Runoff Volume

Table 7-1shows the predicted changes in stormwater runoff mean annual volumes[5]. Mean annual runoff volumes are expected to increase with development. The increase can be explained by the increase in percent imperviousness associated with development of the site, as well as by the decrease in infiltration capacity of existing site soils associated with the compaction of site soils during construction.

For modeling purposes, existing site land uses were assumed to have an imperviousness of one percent for the open space areas, an imperviousness of 10 percent for oil and gas extraction areas, and an imperviousness of two percent for agriculture areas, accounting for compaction by machinery and soil saturation due to irrigation. In contrast, single family residential land use is assumed to have an average imperviousness of 42 percent and multi-family residential land use is assumed to have an average imperviousness of 74 percent.

Project PDFs include low impact/site design, source control, and treatment control BMPs in compliance with the SUSMP requirements. Most of the low impact/site design PDFs, especially the minimization of impervious area and the conservation of approximately 598 acres of open space areas within the Project, reduce the impacts of the proposed development on increases in stormwater runoff volume. In addition to water quality improvements, the treatment control BMPs will also provide runoff volume reduction. Volume reduction in Project BMPs was

[5] Volume reduction estimates for Project water quality basins used in the calculation of runoff volumes and pollutant loads reported in this section are conservative as they are based on a relatively simple model representation that does not account for all volume reduction processes. This simple representation was used for the sake of conservatism when estimating pollutant loads. In contrast, volume reduction estimates reported in Section **Error! Reference source not found.** (LID Equivalency Analysis) are based on a more detailed representation of Project water quality basins that attempts to account for additional volume reduction processes including soil soaking and drying and the potential installation of gravel drainage layers and amended soil layers in the bottoms of water quality basins. Therefore, the volume reduction estimates reported in this section are not directly comparable to the volume reduction estimates reported in Section **Error! Reference source not found.**.

assumed based on monitoring data in the International Stormwater BMP Database and continuous simulation of project BMPs.

Table 7-1: Predicted Average Annual Stormwater Runoff Volumes

Site Conditions	Average Annual Stormwater Runoff Volume (acre-ft)
Existing	154
Developed with PDFs	634
Change	480

Runoff volumes from the impervious access road within the utility corridor and the power substation pad are likely to increase compared to the existing condition. The use of bioretention and/or vegetated swales for treatment control will minimize the increase in post-development runoff volumes, as 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 bioretention and vegetated swales (ASCE/EPA, 2004).

7.1.2 TSS

Comparison of Pre- and Post-Project Conditions: Table 7-2shows the predicted average annual TSS concentration and loads. TSS concentration is predicted to decrease as a result of the Project. This decrease can be attributed to higher EMCs observed in monitoring data from agricultural and open space land uses (the existing condition for the site) compared with urban land uses (representative of post-development conditions). TSS load is also predicted to decrease with development despite increased runoff volumes.

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

Site Conditions	Average Annual TSS Concentration (mg/L)	Average Annual TSS Load (tons/yr)
Existing	233	49
Developed with PDFs	34	32
Change (Dev. with PDFs vs. Existing)	-198	-18

Comparison with Water Quality Criteria: The predicted average annual TSS concentration in stormwater runoff is compared with receiving water objectives and the range of observed concentrations in the Santa Clara River in Table 7-3. The predicted TSS concentration declines with development and is at the lower end of the range of observed concentrations in Santa Clara River Reach 5.

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)
34	Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses	NA	32 – 51,200

[1] Range of concentrations observed in the Santa Clara River during wet weather (see Section 2.7.1).
NA – not applicable

TSS concentrations in runoff from the access road within the utility corridor and the power substation pad are likely to decrease compared to the existing condition, similar to the modeled project area. The use of bioretention and/or vegetated swales for treatment control in these off-site areas will further reduce the post-development runoff TSS concentrations and loads. The average TSS concentration in runoff treated in biofilters (bioretention and vegetated swales) reported in the International Stormwater BMP database is 57.5 mg/L, which is within the lower end of the range of observed concentrations in Santa Clara River Reach 5.

Based on the comprehensive low impact/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 from the Project will not cause a nuisance or adversely affect beneficial uses in the receiving waters.

7.1.3 Total Phosphorus

Comparison of Pre- and Post-Project Conditions: Table 7-4shows the predicted average total phosphorus (TP) concentrations and annual loads. TP concentrations are predicted to decrease as a result of the Project. This decrease can be attributed to higher EMCs observed in monitoring data from agricultural and open space land uses (the existing condition for the site) compared with urban land uses (representative of post-development conditions). TP loads, however, are predicted to increase as a result of the Project. This can be attributed to the significant increase in runoff volume predicted for the post-development scenario.

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

Site Conditions	Average Annual TP Concentration (mg/L)	Average Annual TP Load (lbs/yr)
Existing	0.47	198
Developed with PDFs	0.18	316
Change	-0.29	118

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 are not expected to promote (i.e., increase) algal 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)
0.18	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 – 1.8

[1] Range of concentrations observed in the Santa Clara River during wet weather (see Section 2.7.1).
NA – not applicable

Total phosphorus loads and concentrations in post-development runoff from the utility corridor and the power substation are likely to increase in comparison to open space runoff and to decrease in comparison to runoff from agricultural areas. The use of bioretention and/or vegetated swales for treatment control will minimize any potential increase in post-development runoff total phosphorus concentrations and loads. The average total phosphorus concentration in runoff treated in biofilters reported in the International Stormwater BMP database is 0.40 mg/L, which is within the range of observed concentrations in Santa Clara River Reach 5.

Based on the comprehensive low impact/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- plus nitrite-nitrogen and ammonia concentrations and annual loads are summarized in Table 7-6and Table 7-7, respectively. Nitrate plus nitrite concentrations are predicted to decrease as a result of the Project. This decrease can be attributed to higher EMCs observed in monitoring data from agricultural and open space land uses (the existing condition for the site) compared with urban

land uses (representative of post-development conditions). Ammonia concentrations are predicted to decrease as a result of the Project. This decrease may be attributed to higher EMCs observed in monitoring data from some existing land uses compared to developed land uses and low observed ammonia concentrations in effluent from extended detention basins. Nitrate plus nitrite and ammonia loads are predicted to increase as a result of the Project. This can be attributed to the significant increase in runoff volume predicted for the post-development scenario.

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

Site Conditions	Average Annual NO3-N+NO2-N Concentration (mg/L)	Average Annual NO3-N+NO2-N Load (lbs/yr)
Existing	1.5	647
Developed with PDFs	1.0	1,730
Change	-0.5	1,083

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

Site Conditions	Average Annual NH3 Concentration (mg/L)	Average Annual NH3 Load (lbs/yr)
Existing	0.46	179
Developed with PDFs	0.30	535
Change	-0.16	357

Comparison with Water Quality Criteria: Predicted nitrogen compound concentrations are compared to Basin Plan objectives and observed concentrations in Table 7-8. The average annual stormwater concentration of ammonia is predicted to be considerably less than the concentration-based wasteload allocation for Santa Clara River Reach 5 and the Basin Plan objective, and within the low end of the range of observed concentrations. Likewise, the average annual stormwater concentration of nitrate plus nitrite is predicted to be considerably less than the TMDL wasteload allocation and the Basin Plan water quality objective and within the range of observed concentrations for this reach of the Santa Clara River.

Table 7-8: 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)	TMDL/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	1.0	5	6.8[3]	0.2 – 4.0
Ammonia-N	0.30	2.0[4]	1.75[4]	0.02 – 1.4

[1] There are no CTR criteria for nitrogen compounds.
[2] Range of concentrations observed in the Santa Clara River during wet weather (see Section 2.7.1).
[3] 30-day average.
[4] 30-day average in Reach 5 below Valencia.

Nitrate plus nitrite and ammonia-nitrogen concentrations in post-development runoff from the utility corridor and the power substation are likely to decrease or remain the same compared to open space and agricultural runoff concentrations, although loads are likely to increase due to the increase in runoff volume. The use of bioretention and/or vegetated swales for treatment control will minimize any potential increases in post-development runoff nitrate plus nitrite or ammonia-nitrogen loads. The average nitrate plus nitrite concentration in runoff treated in biofilters reported in the International Stormwater BMP database is 0.92 mg/L and the average ammonia-nitrogen concentration is 0.06 mg/L, which are considerably less than the TMDL wasteload allocations and Basin Plan water quality objectives, and are within the range of observed concentrations for Santa Clara River Reach 5.

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

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 Table 7-9through Table 7-12. 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 (LACDPW, 2000).

Post-development trace metal loads are predicted to increase compared to pre-development conditions; concentrations of dissolved copper are predicted to increase slightly, and total aluminum, total lead, and dissolved zinc concentrations are predicted to decrease. These results can be explained by the difference in EMC values observed in representative monitoring data from the pre-developed agriculture, oil and gas extraction, and open space condition and the post-developed urban condition (see Appendix B, Table B-12). Runoff volumes will increase with development while land use changes will decrease metals concentrations in runoff for most proposed land uses.

Project PDFs include low impact/site design, source control, and treatment control BMPs in compliance with the SUSMP requirements. Specific low impact/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 7-9: 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	10	4
Developed with PDFs	11	19
Change	1	15

Table 7-10: 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	5
Developed with PDFs	5	10
Change	-7	5

Table 7-11: 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	282	105
Developed with PDFs	82	141
Change	-200	37

Table 7-12: **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	1,427	568
Developed with PDFs	647	1,122
Change	-780	555

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 (EPA, 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 7-13, along with the range of observed concentrations in Santa Clara River Reach 5. Although the trace metal loadings are predicted to increase (except for dissolved zinc), 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. While dissolved zinc concentrations are predicted to be higher than the concentration observed in the Santa Clara River, dissolved copper, total lead, and aluminum concentrations are

predicted to be within the range of observed values. Despite the predicted dissolved zinc concentrations being greater than the range of observed concentrations, Project runoff is not expected to affect the concentration of dissolved zinc in the Santa Clara River, as the Project area represents a very small portion of the overall watershed.

Table 7-13: 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	11	32	3.3 – 22.6
Total Lead	5	260	1.1 – 95
Dissolved Zinc	82	250	3.0 – 37
Total Aluminum	647	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 (see Section 2.7.1).

Trace metals (aluminum, copper, lead, and zinc) concentrations in post-development runoff from the utility corridor and the power substation are likely to decrease in comparison to concentrations in runoff from agricultural areas and to increase in comparison to concentrations in runoff from open space. Trace metal loads are likely to increase due to the increase in runoff volume. The use of bioretention and/or vegetated swales for treatment control will minimize any potential increases in post-development runoff trace metal loads. The average trace metals concentrations in runoff treated in biofilters reported in the International Stormwater BMP database are: 13.5 µg/L (dissolved copper), 14.8 µg/L (total lead), and 27.4 µg/L (dissolved zinc). No performance data is available in the International Stormwater BMP database for treatment of aluminum in biofilters. Trace metal concentrations in runoff from the utility corridor and power substation are expected to be below all benchmark water quality criteria.

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

7.1.6 Chloride

Comparison of Pre- and Post-Project Conditions: Table 7-14 shows the predicted average annual chloride concentrations and loads. The annual average chloride concentration is predicted to slightly increase when compared to the existing conditions. Average annual chloride load is expected to increase as a result of the significant increase in total annual runoff volume predicted for the Project.

Table 7-14: Predicted Average Annual Chloride Concentration and Load

Site Conditions	Average Annual Chloride Concentration (mg/L)	Average Annual Chloride Load (tons/yr)
Existing	12	2
Developed with PDFs	21	17
Change	8	15

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 7-15. The predicted average annual chloride concentration in stormwater runoff from the Project area 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 site specific objective for Santa Clara River Reach 5 (150 mg/L).

Table 7-15: 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	21	100	2.6 - 290[3]	150 mg/L when chloride load reductions and/or chloride export projects are in operation; otherwise: 100 mg/L

[1] There are no CTR criteria for chloride.
[2] Range of concentrations observed in the Santa Clara River during wet weather (see Section 2.7.1).
[3] This value was observed in 1965.

Chloride concentrations in post-development runoff from the utility corridor and the power substation are likely to decrease or remain the same in comparison to runoff from open space and agricultural areas, although chloride loads are likely to increase due to increased runoff volumes. Similarly to the modeled areas, the average annual chloride concentration in stormwater runoff from the utility corridor and power substation are likely to be at the low end of the range of observed concentrations for chloride and well below the Santa Clara River Reach 5 Basin Plan water quality objective and the TMDL wasteload allocation for Santa Clara River Reach 5.

Based on the comprehensive low impact/site design, source control, and treatment control strategy, and comparison with benchmark receiving water criteria and instream monitoring data, the Project is not expected to have significant water quality impacts resulting from chloride.

7.2 Post Development 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 7.8 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 Project during storm events, and will therefore decrease turbidity in the runoff (see also hydromodification impacts discussed in section 7.8 below). Project PDFs, including source controls (such as common area landscape

[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.

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 Project 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 Project on turbidity are considered less than significant.

7.2.2 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 some of these pesticides in the Santa Clara River estuary, approximately 40 miles downstream of the Project 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. Site development involves remedial grading which will stabilize soils and prevent their transport from the Project site, 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 Los Angeles 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 (LACDPW, 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 proposed Project, which does incorporate treatment control PDFs.

Diazinon and chlorpyrifos are two pesticides of concern due to their potential toxicity in receiving waters. The EPA has banned all indoor uses of diazinon in 2002 and stopped all sales for all outdoor non-agricultural use in 2003 (EPA, June, 2002)[7]. With no agricultural uses

[7] Changes to the use of chlorpyrifos include reductions in the residue tolerances for agricultural use, phase out of nearly all indoor and outdoor residential uses, and disallowal of non-residential uses where children may be exposed. Retail sales of chlorpyrifos were stopped by December 31, 2001, and structural (e.g. construction) uses were phased out by December 31, 2005. Some continued uses will be allowed, for example public health use for fire ant eradication and mosquito control is permitted by professionals.

Permissible uses of diazinon are also 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 EPA ban will eliminate most of the use of diazinon within the

planned for the proposed Project, diazinon would not be used at the proposed Project site. The EPA is has also phased out most indoor and outdoor residential uses of chlorpyrifos and has stopped all non-residential uses where children may be exposed. Use of chlorpyrifos in the proposed Project area 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 landscape pesticide management program.

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 breakdown rate or degradable rate, 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

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Project area. The use of diazinon for many agricultural crops has been eliminated (EPA 2001), while some use of this chemical will continue to be permitted for some agricultural activities.

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, media filtration, and extended detention basins 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 on the Project site. 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 low impact/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.

7.2.3 Pathogens

Pathogens are viruses, bacteria, and protozoa that can cause gastrointestinal and other illnesses in humans through body contact exposure. Identifying pathogens in water is difficult as the number of pathogens is fairly small, requiring sampling and filtering large volumes of water to obtain a reliable result. Traditionally, regulators have used fecal indicator bacteria (FIB), such as total and fecal coliform, enterococci, and *E. coli*, as indirect measures of the presence of pathogens, and by association, human illness risk. Early epidemiological studies (i.e., studies that investigate human illness occurrence versus environmental factors such as water quality) that linked swimming-associated gastrointestinal symptoms to *E. coli* or enterococci in swimming waters for sewage-dominated receiving waters led to the development of the current recreational water quality criteria (EPA, 1986). In contrast to receiving waters subject to sanitary discharges, only a few epidemiological studies have evaluated the health effects of exposure to water bodies subject to discharges from storm drains and these studies focused on the effects of dry weather urban flows on recreational exposure (e.g., Haile et al, 1999 and Colford et al, 2005).

Santa Clara River Bacteria TMDL

The LARWQCB approved a Basin Plan amendment on July 8, 2010, to incorporate a TMDL for Indicator Bacteria for the Santa Clara River Estuary and Reaches 3, 5, 6 and 7 of the Santa Clara River (Resolution #R10-006). The TMDL provides allowable exceedance day-based WLAs for MS4 dischargers for *E. coli* in Reaches 3, 5, 6 and 7, and for Fecal coliform, Enterococcus, and Total Coliform in the Santa Clara River Estuary. These WLAs are anticipated to be incorporated into the Los Angeles County MS4 Permit once the interim and final WLAs become effective, at which point they will become an enforceable permit provision.

The TMDL WLAs applicable to Reach 5 of the Santa Clara River are listed in Table 3-3. The Indicator Bacteria TMDL MS4 WLAs are applied in the form of allowable exceedance days. The TMDL implementation schedule deadlines applicable to Reach 5 are summarized in Table 7-16.

The Regional Board indicated in the TMDL implementation schedule that the Regional Board will reconsider the TMDL if, prior to four years after the effective date of the TMDL, one of the following occurs:

1) Monitoring or any voluntary local reference system studies justify a revision, or

2) US EPA publishes revised recommended bacteria criteria (expected in December 2012), or

3) The Regional Board adopts a separate Basin Plan amendment, suspending recreational uses in the Santa Clara River during high flows.

Table 7-16: Indicator Bacteria TMDL Implementation Schedule and Tasks

Deadline	Task
1 year after effective date of TMDL	Jurisdictions and agencies responsible for the MS4 WLAs must submit an in-stream bacteria water quality monitoring plan for the SCR watershed. The monitoring plan must be approved by the Executive Officer.
6 months after monitoring plan approval by Executive Officer	Monitoring of SCR Watershed must begin.
3 years after effective date of TMDL	Jurisdictions and agencies must submit a draft Implementation Plan outlining how to achieve compliance with the WLAs.
4 years after effective date of TMDL	Interim MS4 WLAs apply.
6 months after receipt of Regional Board comments on draft Implementation Plan	Jurisdictions and agencies must submit a final Implementation Plan and begin additional outfall monitoring.
11 years after effective date of TMDL	SCR Reaches 3, 5, 6 and 7 must achieve compliance with final WLAs for geometric mean objectives and allowable exceedance days for single sample objectives for dry weather.
17 years after effective date of TMDL	SCR Reaches 3, 5, 6 and 7 must achieve compliance with final WLAs for geometric mean objectives and allowable exceedance days for single sample objectives for wet weather.

Factors That Affect FIB Concentrations

There are various confounding factors that affect the reliability of FIB as pathogen indicators. One primary factor is that there are numerous natural or non-anthropogenic (or "zoonotic") sources of FIB in developed watersheds and their receiving water bodies, including birds and other wildlife, soils, and plant matter. Anthropogenic sources may include domesticated animals and pets, poorly functioning septic systems, sewer system overflows or spills, cross-connections between sewer and storm drains, and the utilization of outdoor areas or storm drains for human waste disposal by people without access to indoor sanitary facilities. All of these sources can contribute to the concentrations of FIB, but not all the sources may pose a comparable human health risk (EPA, 2009).

A second confounding factor is that FIB can multiply in the field if the substrate, temperature, moisture, and nutrient conditions are suitable (MEC, 2004). This is one potential reason that FIB concentrations do not always correlate with pathogens. For example, in a field study conducted by Schroeder *et al.* (2002), pathogens (in the form of viruses, bacteria, or protozoa) were found to occur in 12 of 97 soil samples, but the samples that contained pathogens did not correlate with

the samples containing concentrations of FIB. Numerous other researchers have reported that bacteria presence and even regrowth was observed in various substrates such as beach sands, wrack line (accumulation of kelp in the inter-tidal area of beaches), inter/sub-tidal sediments, and material deposited in storm drains (MEC, 2004). FIB monitoring in the Santa Ana River indicate that the ubiquity of sources and potential regrowth far exceed the human sources of fecal bacteria generated by the entire population in the watershed (Surbeck et al, 2008). Regrowth of bacteria downstream of a package treatment plant utilizing ultraviolet (UV) radiation to disinfect dry weather flows in Aliso Creek was considered a prime factor in the rapid rebound of FIB concentrations downstream of the plant (Andersen, 2005). Recent research also implicates storm drain biofilms as another urban source of FIB to receiving waters (Roberts and Kolb, 2009; Skinner et al, 2010)

A third confounding factor is that the persistence of FIB may differ from those of various pathogenic viruses, bacteria, and protozoa. Viruses, for instance, are small, low in number, and difficult to inactivate, while protozoa may form protective cysts that are resistant to destruction and render them dormant but capable of reactivating in the future. Therefore, while some indicator bacteria may die off in the water column due to ultraviolet disinfection or other unfavorable environmental conditions (including predation and antagonism), pathogens occasionally may persist longer (Haile et. al., 1999). So while the previously two described factors may result in indicator bacteria resulting in false positive indications of public health risk, there may also be instances when indicator bacteria result in false negative indications.

Current Research Efforts to Improve Recreational Water Quality Criteria

Given the concern about the adequacy of the current recreational water quality criteria, the USEPA is undergoing a comprehensive evaluation and revision of their current FIB-based recreational water quality criteria, with completion scheduled for December 2012. To help initiate this effort, EPA gathered 43 experts to identify research priorities needed to refine the existing criteria and transition to new methods (EPA, 2007b). The experts identified seven topics for research, including “scientifically defensible for applications in a wide variety of geographical locations and water types” and “protective of individuals exposed to recreational waters impacted by all sorts of pathogen sources including animal feces, stormwater, and sewage” (Boehm et al, 2009). In a similar effort focused on inland waters, the Water Environment Research Federation (WERF) convened an expert panel to recommend a research program that would also support EPA’s intended revision of the water quality criteria (WERF, 2009). These various research efforts are ongoing and the U.S. EPA will consider all submitted data as part of their recreational water quality criteria revision process.

Epidemiological Studies

Until recently, few epidemiological studies have tested the health effects of exposure to the receiving waters of direct and recent stormwater runoff, and these studies have found it difficult to link illness with stormwater sources. For instance, the Mission Bay epidemiological study (Colford *et al.*, 2005) found that “only skin rash and diarrhea were consistently elevated in swimmers versus non swimmers, the risk of illness was uncorrelated with levels of traditional

water quality indicators, and State water quality thresholds were not predictive of swimming-related illnesses." Various other researchers, as part of EPA's pathogen research program, are now conducting epidemiological studies nationwide at fresh and salt water beaches that receive wastewater and/or stormwater discharges. In southern California, the Southern California Coastal Water Research Project (SCCWRP) has been conducting a multi-year study of public health risks at marine beaches, with a final report that is scheduled for late 2011. Until these various studies are completed, however, there is no reliable documentation of the health effects caused by exposure to stormwater based on epidemiological studies.

Effects of Land Use and Runoff on FIB Concentrations

Dry weather, non-storm stream flows from undeveloped watersheds tend to have lower concentrations of FIB than dry weather urban flows, although water quality standard exceedances still occur. For instance, a recent study by SCCWRP which monitored 15 unimpaired natural southern California streams weekly during dry weather for a year showed that about 18% of the samples exceeded daily and monthly bacterial indicator thresholds, although concentrations from these unimpaired streams were one to two orders of magnitude lower than levels found in developed watersheds (Tiefenthaler, *et al.*, 2009). The study reported an average of the geometric means for *E. coli* in dry weather flows in each stream of 41 MPN/100 mL. In comparison, the Santa Clara River Bacteria TMDL numeric target is 235 MPN/100 mL for any single sample and 126 MPN/100 mL for the geometric mean *E. coli* density. The Santa Clara River bacteria TMDL WLAs are based on this and other SCCWRP reference stream and reference beach datasets, in acknowledgement of natural sources.

During wet weather, stormwater runoff can mobilize indicator bacteria from a number of watershed and instream sources, and, therefore, indicator bacteria concentrations tend to increase. For example, median stormwater runoff monitoring results for the open space land use category, as summarized by Stein et. al. (2007), include *E. Coli* concentrations of about 5,400 MPN/100 mL from the 2001-2005 Los Angeles River Watershed Wet Weather Study, and 7,200 MPN/100 mL from the National Stormwater Quality Database (Pitt *et al.*, 2003). Similarly, median open space land use stormwater runoff monitoring results include *E. coli* concentrations of 5,400 MPN/100 mL from the Stein *et al.* (2007) study based on two flow-weighted average results, and 500 MPN/100 mL for fecal coliform from a 1994-2000 Los Angeles County (2000) study based on 21 grab samples. The Santa Clara River Bacteria TMDL has incorporated allowable exceedance days to account for the fact that recreational criteria, strictly applied, are frequently exceeded even at natural, undeveloped streams and beaches. The interim and final allowable exceedance days for Reach 5 of the Santa Clara River for wet and dry weather are listed in Table 3-3.

Land use type and condition also affect runoff concentrations, and most studies show higher FIB concentrations in urban runoff than in open space runoff. Runoff from residential land uses from the Los Angeles River Watershed Wet Weather Study had a median *E. coli* concentration of about 6,300 MPN/100 mL and about 8,300 from the National Stormwater Quality Database

(Table 5-2, Stein et. al, 2007). The median value of four flow-weighted average results from the Stein et. al. (2007) study was about 6,100 MPN/100mL for *E. coli* for the low density residential land use site. 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 Project.

Runoff from agricultural watersheds involving horticulture and row cropping is known to similarly contain relatively high concentrations of FIB. Data from a stormwater drain serving an agricultural watershed with predominantly row crops in Ventura County showed median fecal coliform levels (approximately 7,000 MPN/100 mL) similar 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 FIB.

Project Design Features that Address Pathogen Indicators

The primary sources of pathogen indicators from the Project 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 Project would be reduced by source controls and treatment controls. The most effective means of controlling specific bacteria sources, such as pet and other animal wastes, is through source control, specifically education of pet owners, education regarding feeding (and therefore attracting) of waterfowl near waterbodies, and providing products and disposal containers that encourage and facilitate cleaning up after pets. These BMPs are specified as project source controls in Table 5-1.

Although there are limited data on the effectiveness of different types of stormwater treatment to manage pathogen indicators, treatment processes that help reduce pathogen indicators include sunlight (ultraviolet light) degradation, sedimentation, and filtration.

Bioretention, a stormwater treatment BMP which provides filtration through amended soils, is an example of an effective BMP for addressing FIB. 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.

Similarly, where soil conditions are conducive to infiltration, LID practices and stormwater treatment facilities that allow for infiltration can reduce runoff volume and treat FIB by infiltration, which in turn reduces FIB loads. In a literature summary, EPA reported typical pathogen removal for infiltration facilities as 65 to 100 percent (EPA, 1993). These types of BMPs are specified for incorporation into the Project where feasible to meet the LID design standards specified in Section 5 of this report, which are based on achieving equivalent pollutant control and hydrologic control as specified the LID Ordinance and Manual and in the MS4 Permit/ SUSMP Manual requirements for treatment of volume or flow of stormwater.

In summary, stormwater discharges from the Project could potentially exceed the Basin Plan standard for FIB and therefore impacts from FIB may be significant prior to mitigation. However, the FIB concentrations in runoff from the Project would be reduced through the implementation of source and treatment control PDFs. The Project will incorporate a number of source controls specific to managing FIB, including education of pet owners, education regarding feeding (and therefore attracting) of waterfowl near waterbodies, and providing products and disposal containers that encourage and facilitate cleaning up after pets. The Project will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. The Project development, consistent with the MS4 permit requirements, includes a comprehensive set of source, low impact/site design, and treatment control PDFs, including treatment BMPs (i.e., infiltration facilities and bioretention), selected to manage pollutants of concern, including pathogen indicators. Furthermore, the Project will comply with all future MS4 Permit provisions incorporating the TMDL wasteload allocations and implementation plan. With these PDFs, the Project would not result in substantial changes in pathogen or FIB concentrations in receiving waters causing a violation of the water quality standards or waste discharge requirements or otherwise substantially degrade water quality in the receiving waters. Water quality impacts related to pathogens would be reduced to less-than-significant.

7.2.4 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 site. 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. Additionally, the parking lot low impact/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 Marsalek 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 (LACDPW, 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 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 Project on petroleum hydrocarbon levels in the receiving waters post-development is considered less than significant.

During the construction phase of the Project, 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 impacts related to hydrocarbons on water quality are considered 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. Trash and debris can impose 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 high use 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 Project.

During the construction phase, there is potential for an increase 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 Project.

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 (EPA, 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 (EPA, 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 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 (EPA, 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 Project, and the forgoing discussion suggests that concentrations in stormwater runoff from the Project 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 runoff 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 Project 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 Project.

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

Project Design Features (PDFs) include low impact/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 Project. Sizing criteria contained in the MS4 Permit and the SUSMP requirements will be met for all treatment control BMPs.

In summary, the proposed low impact/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 Low Impact Development Equivalency Analysis

The results of the LID equivalency analysis demonstrate that the Project exceeds the LID Manual volume reduction requirements (Table 7-17). Figures 7-1 and Figure 7-2 illustrate the results of the Tier One infiltration screening using information provided by the Project geotechnical engineers R.T. Frankian and Associates (RTF&A, 2010; see Appendix G).

Volume reduction estimates reported for the purpose of LID equivalency analysis are based on a detailed representation of Project water quality basins that attempts to account for additional volume reduction processes including soil soaking and drying and the potential installation of gravel drainage layers and amended soil layers in the bottoms of water quality basins.

Based on the comparison of volumetric requirements associated with the LID Manual and volumetric performance achieved by Project Design Features, the Project achieves volume reductions exceeding the intent of the Los Angeles County LID Manual. Because treatment control BMPs are designed to capture and treat 80 percent of average annual runoff, the requirement to capture and treat at least 48 percent of average annual runoff volume is also met.

Table 7-17: LID Equivalency Calculations

Feasibility Category	Open Space[1]	Infiltration Feasible	Infiltration Infeasible[2]	Total
Total Area, ac	622	67	606	1,295[3]
Composite Imperviousness[4]	1%	66%	67%	
Average Annual Runoff Volume[5], ac-ft		64	575	
Average Annual Capture Efficiency of BMPs Designed per LID Manual[6]		48%	48%	
Average Annual Volume Reduction of Captured Water in Vegetated BMPs[7]		100%	20%	
LID Manual Performance Standard Volume Reduction, ac-ft/yr		31	55	**86**
Achieved Average Annual Volume Reduction[8], ac-ft/yr		-	-	**97**
Surplus Average Annual Volume Reduction[9], ac-ft/yr				**11**

[1] Includes water quality basins along with other open space (does not include parks)
[2] Per infeasibility criteria in Section 6.2
[3] Total Area represents on and off-site areas within the Project Impact boundary (i.e. 1262 ac on-site, 33 off-site; see Table 2-1)
[4] Composite imperviousness based on distribution of developed land uses within each analysis area.
[5] Calculated per rational method using the average annual rainfall at the Project site.
[6] Capture efficiency estimated through continuous simulation modeling of 40 years of precipitation, runoff and routing for a hypothetical volume-based BMP sized per the LID manual (see section 6.2.2 and Appendix B).
[7] Volume reduction in vegetated treat and release BMPs based on Strecker et al., 2004.
[8] Achieved Volume Reduction determined from WQ Model outputs, see section 6.
[9] Positive Surplus Volume Reduction indicates exceedance of LID Manual-based performance standard.

7.5 Construction-Related Impacts

The potential impacts of construction activities, construction materials, and non-stormwater runoff on water quality during the construction phase are primarily due to sediment (TSS and turbidity) and certain non-sediment related pollutants. Construction-related activities that are primarily responsible for sediment releases are related to exposing previously stabilized 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 will be minimized through compliance with the Construction General Permit. This permit requires the discharger to perform a risk assessment for the proposed development (with differing requirements based upon the determined level) and to prepare and implement a Storm Water Pollution Prevention Plan (SWPPP), which must include erosion and sediment control BMPs that will meet or exceed measures required by the determined risk level of the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants. A Construction Site Monitoring Program that identifies monitoring and sampling requirements during construction is a required component of the SWPPP. Preliminary analysis indicates that the Project will most likely be categorized as a Risk Level 2. BMPs required by the Construction General Permit will be incorporated assuming this level of risk; if final design analysis indicates that the Project will fall under Risk Level 3, the additional Level 3 permit requirements will be implemented as necessary.

7.5.1 Erosion and Sediment Control BMPs to be Implemented during Construction

Erosion control BMPs are designed to prevent erosion, whereas sediment controls are designed to trap or filter sediment once it has been mobilized. A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and the City of Santa Clarita Standard Conditions. The General Permit requires the SWPPP to include BMPs to be selected and implemented based on the determine project risk level to effectively control erosion and sediment to the BAT/BCT. The following types of BMPs will be implemented as needed during construction:

Erosion Control

- Physical stabilization through hydraulic mulch, soil binders, straw mulch, bonded and stabilized fiber matrices, compost blankets, and erosion control blankets (i.e., rolled erosion control products).
- Limiting the area and duration (<14 days) 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.
- Vegetative stabilization through temporary seeding and mulching 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 sediment discharges (silt fences, fiber rolls, gravel bag berms, sand bag barriers, and compost socks).

- Storm drain inlet protection.
- Sediment capture and drainage control through sediment traps and sediment basins.
- Velocity reduction through check dams, sediment basins, and outlet protection/velocity dissipation devices.
- Reduction in off-site sediment tracking through stabilized construction entrance/exit, construction road stabilization, and entrance /exit tire wash.
- Slope interruption at permit-prescribed intervals (fiber rolls, gravel bag berms, sand bag berms, compost socks, biofilter bags).

Waste and Materials Management

- Management of the following types of materials, products, and wastes: solid, liquid, sanitary, concrete, hazardous and equipment-related wastes. Management measures include covered storage and secondary containment for material storage areas, secondary containment for portable toilets, covered dumpsters, dedicated and lined concrete washout/waste areas, proper application of chemicals, and proper disposal of all manners of wastes.
- Protection of soil, landscaping and construction material stockpiles through covers, the application of water or soil binders, and perimeter control measures.
- A spill response and prevention program will be incorporated as part of the SWPPP and spill response materials will be available and conspicuously located at all times on-site.

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, and street sweeping. All such measures will be recorded and maintained as part of the project SWPPP.
- If construction dewatering or discharges from other specific construction activities such as water line testing, and sprinkler system testing are required, comply with the requirements of the Los Angeles RWQCB's General Waste Discharge Requirements (WDRs) under Order No. R4-2008-0032 (NPDES No. CAG994004) governing construction-related dewatering discharges.

Training and Education

- Inclusion of General Permit defined "Qualified SWPPP Developers" (QSD) and "Qualified SWPPP Practitioners" (QSP). QSDs and QSPs shall have required certifications and shall attend State Board sponsored training.
- Training of individuals responsible for SWPPP implementation and permit compliance, including contractors and subcontractors.

- Signage (bilingual, if appropriate) to address SWPPP-related issues (such as site cleanup policies, BMP protection, washout locations, etc).

Inspections, Maintenance, Monitoring, and Sampling

- Performing routine site inspections and inspections before, during (for storm events > 0.5 inches), and after storm events.
- Preparing and implementing Rain Event Action Plans (REAPs) prior to any storm event with 50% probability of producing 0.5 inches of rainfall, including performing required preparatory procedures and site inspections.
- Implementing maintenance and repairs of BMPs as indicated by routine, storm-event, and REAP inspections.
- Implementation of the Construction Site Monitoring Plan for non-visible pollutants, if a leak or spill is detected.
- Sampling of discharge points for turbidity and pH, at minimum, three times per qualifying storm event and recording and retention of results.

7.5.2 Construction BMP Implementation

During Project construction, BMPs will be implemented in compliance with the Construction General Permit and the general waste discharge requirements in the Dewatering General WDRs. The Project 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. All discharges from qualifying storm events will be sampled for turbidity and pH and results will be compared to Numeric Action Levels (250 NTU and 6.5-8.5, respectively) to ensure that BMPs are functioning as intended. If discharge sample results fall outside of these action levels, a review of causative agents and the existing site BMPs will be undertaken, and maintenance and repair on existing BMPs will be performed and/or additional BMPs will be provided to ensure that future discharges meet these criteria.

The construction-phase BMPs will assure effective control of not only sediment discharge, but also of pollutants associated with sediments, such as 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.

7.5.3 Compliance with Construction Permit and Construction Impacts

Prior to the issuance of preliminary or precise grading permits, the landowner or subsequent project applicant will provide the City Engineer with evidence that a Notice of Intent (NOI) has been filed with the State Water Resources Control Board. Such evidence will consist of a copy of the NOI stamped by the State Water Resources Control Board or Regional Water Quality Control Board, or a letter from either agency stating that the NOI has been filed and a copy of the site's applicable Waste Discharge identification (WDID) number.

Construction on the Project site may require dewatering. For example, dewatering may be needed if water has been standing on site and needs to be removed for construction, vector control, or other reasons. Further, dewatering may be necessary 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 III.C 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.

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. R4-2008-0032 (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.

7.6 <u>Pollutant Bioaccumulation</u>

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 potential for bioaccumulation impacts from the proposed bioretention and vegetated swale facilities will be minimal. Since the site is largely impervious, very little coarse solids and associated pollutants are expected to be generated. The vegetation in the facilities will trap sediments and pollutants in the soils, which contain bacteria that metabolize and transform trace metals, therefore 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.

In the literature, the primary pollutants that are of concern with regard to bioaccumulation are mercury and selenium. However, selenium and mercury are not naturally present at levels of concern in this watershed and will not be introduced by the projects. Therefore, bioaccumulation of selenium and mercury is not expected.

Bioaccumulation of pollutants in the Santa Clara River is not of concern due to the low concentrations of pollutants, below the benchmark Basin Plan objectives and CTR criteria, predicted 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.

7.7 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 swales and bioretention basins will not be designed to have open pools of standing water.

The treatment control PDFs 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. 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.

7.8 Summary of Surface Water Quality Impacts

7.8.1 Direct Impacts

Runoff volumes and pollutant loads for most modeled constituents (with the exception of TSS loads) are predicted to increase for the post-development condition, primarily as a result of increased imperviousness and reduced soil infiltration capacity (a result of construction-related compaction). Concentrations of chloride, ammonia, and dissolved copper are predicted to increase, while concentrations of all other modeled constituents are predicted to decrease under proposed conditions when compared to existing conditions. Furthermore, modeled pollutant

concentrations in runoff from developed areas with PDFs are predicted to be below all benchmark water quality objectives and criteria and TMDL wasteload allocations for the Santa Clara River and are addressed by a comprehensive low impact/site design, source control, and treatment control strategy, and compliance with MS4 Permit, 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. None of the qualitatively assessed constituents are expected to significantly impact receiving waters due to the implementation of a comprehensive low impact/site design, source control, and treatment control strategy in compliance with the MS4 Permit, Construction General Permit, and General De-Watering Permit requirements. Therefore potential impacts from the Project on receiving water quality are not expected to be significant.

7.8.2 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 Project 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 the Santa Clara River (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 1,764 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 four 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 low impact/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 7-18 and 7-19 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 7-18, 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 7-19). 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 7-20).

Table 7-18: 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	1,245	3,968	2,723
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

Modeled Parameter	Units	Development Condition		Change
		Existing	Developed w/ PDFs	
Total Aluminum	lbs	4,030	7,396	3,366
Dissolved Aluminum	lbs	732	1,508	776
Dissolved Copper	lbs	39	99	60
Total Lead	lbs	37	77	40
Dissolved Zinc	lbs	477	670	193
Chloride	tons	44	93	49

7-19: 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	1,191	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 7-20: 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	35	Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses	NA	NA	32 – 51,200
Nitrate-N + Nitrite-N	mg/L	0.18	5	NA	6.8[3]	0.2 – 4.0

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 Ammonia	mg/L	1.0	2.0[4]	NA	1.75[4]	0.02 – 1.4
Total Nitrogen	mg/L	0.30	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	0.6 – 10.4
Total Phosphorus	mg/L	2.9		NA	NA	0.18 – 1.8
Dissolved Copper	µg/L	11	NA	32	NA	3.3 – 22.6
Total Lead	µg/L	5	NA	260	NA	1.1 – 95
Dissolved Zinc	µg/L	81	NA	250	NA	3.0 – 37
Total Aluminum	µg/L	663	NA	750	NA	131 – 19,650
Chloride	mg/L	21	100	NA	100	2.6 - 290[5]

[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 2.7.1).
[3] 30-day average.
[4] 30-day average in Reach 5 below Valencia.
[5] This value was observed in 1965.
NA – not applicable

As discussed above, the anticipated quality of effluent expected from the Mission Village Project's 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 Project's receiving waters. Therefore, the Project's incremental effects on surface water quality are not expected to be significant.

The Mission Village Project's 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 requirements; 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 Water Quality Technical Report, 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 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 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.

7.9 Groundwater Impacts

7.9.1 Direct Groundwater Quality Impacts

Discharge from the Project's 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 PDFs after treatment, and (3) infiltration of urban runoff, after treatment in the Project 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 implementation of the Project's low impact/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.

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 0.7 mg/L, which is well below the groundwater quality objective.

As required by the CWA, the NRSP WRP discharge permit will include effluent limitations 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 the surface water quality objective for nitrate-nitrogen plus nitrite-nitrogen is 5 mg/L and the WRP discharge permit will be conditioned to meet this criteria, the NRSP WRP irrigation water supply that will serve the project will be well below the groundwater quality objective of 10 mg/L.

On this basis, the potential for adversely affecting groundwater quality is considered less than significant.

7.9.2 Cumulative Groundwater Quality Impacts

As discussed above, the anticipated quality of stormwater runoff discharges from the Project's 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 Project's incremental effects on groundwater quality when considered together with the effects of other projects in the area are not expected to be significant.

The Project's 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 requirements; 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.

7.9.3 Groundwater Recharge Impacts

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 D) 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 48 percent of the Project site, which will reduce recharge. In addition, development of agricultural lands will eliminate 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 Project will result in a significant change in groundwater recharge in the project vicinity. Based on the above discussion, the Project's impact on groundwater recharge is considered less than significant.

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.

7.10 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.

All flows from those areas of the Project that will be developed with impervious surface with potential for altering drainage patterns will be discharged directly to the Santa Clara River. There will be no post-development stormwater flows delivered to Lion Canyon from the Project. Therefore, this analysis addresses the potential for hydromodification impacts to the Santa Clara River as a result of the proposed Project.

The physical alteration of natural drainages, such as bank protection, energy dissipaters, and bridge abutments, are not impacts created by changes in runoff 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 types of effects are analyzed in the RMDP and related EIR/EIS, as well as the Mission Village Draft EIR and more specifically the biological and floodplain modification chapters of the EIR for this Project.

7.10.1 Wet Weather Flows

Direct Impacts to the Santa Clara River

The Project proposes development that would create impervious surface within approximately 50 percent (635 acres) of the 1,261.8 acre total project area with an average imperviousness of approximately 69 percent. The size of the Project in comparison to both the 1,618 square mile total 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, that the proposed Project will comprise 1.1 percent of the total impervious area in the watershed encompassing the Project location at ultimate planned build-out for the watershed. See Section 4.4.3 above for information regarding adopted plans and projection used to derive build-out assumptions for the watershed.

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

- 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 low impact/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.

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 Project that will limit impervious area and disconnect imperviousness:

Low impact/site design. Low impact/site design PDFs will help to reduce the increase in runoff volume, including the clustering of development into village areas, including the Mission Village, the preservation of 70 percent of the NRSP area in open space, and 627 acres (50 percent) of the Project in natural river channel, open space, and parks; 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 the low impact/site design BMPs were not quantified in the runoff modeling, so these BMPs will reduce the predicted increase in runoff volumes discussed below. These measures will help to protect the stability of the Santa Clara River and to avoid and minimize direct impacts to those drainages.

Treatment Controls. The Project's treatment control BMPs will also serve as hydromodification source control BMPs. Vegetated swales, bioretention areas, and extended detention basins can provide volume reduction on the order of 20 to 30 percent through infiltration and evaporation. 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 project area is predicted to increase the average annual stormwater runoff volume from the project area by approximately 444 acre-feet per year, after accounting for the estimated volume reductions using the method described in Section 7.4 to model proposed treatment control PDFs. The treatment control PDFs are estimated to reduce

the increase in average annual stormwater runoff volume by approximately 97acre-feet per year[8], which is a 14 percent reduction of the predicted average post-development stormwater runoff volume without the treatment control PDFs. In addition, these facilities will also receive and eliminate dry weather flows.

Geomorphically-Referenced Channel Design

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

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.

Bank Stabilization. The Project will include buried soil cement along the Santa Clara River adjacent to and downstream of the Project site. In total, approximately 2,900 linear feet (LF) of bank stabilization would be constructed as part of the Project. This would include approximately 1,700 LF on the south bank fronting the Project site and 1,200 LF downstream of the Project on the north bank, east of the WRP (PACE, 2007). The alignment was selected so that bank protection along the river would generally be excavated from 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.

Turf Reinforcement Mat (TRM) or similar bank stability protection would be provided by installing approximately 16,000 LF of TRMs along the southern edge of the utility corridor downstream or west of the tract map site. TRMs are designed to reinforce vegetation at the root and stem allowing vegetation to be used as erosion control in areas where flow conditions exceed the ability of natural vegetation to remain rooted. This includes applications with high slopes or stream banks where grouted rip-rap and concrete channels are aesthetically undesirable.

[8] Volume increases and BMP volume reduction estimates reported here are based on a detailed representation of Project water quality basins as described in Section **Error! Reference source not found.** (LID Equivalency Analysis).

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. The Project's low impact/site design and treatment controls PDFs will minimize increases in runoff volume from the development area, the preferred method for controlling hydromodification impacts from new development (SCCWRP, 2005a).

Potential instream impacts of increased volumes, rates, and flow durations will be managed and mitigated with energy dissipaters at the discharge points to the Santa Clara River and the River banks will be protected 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).

For these reasons, the hydromodification impacts of the Project with PDFs on the Santa Clara River are considered less than significant.

Cumulative Impacts

As identified in the MS4 Permit, the increased volume, increased 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 size of the 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 Reach 5 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 et al. (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 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, is about 625 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 and 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 of 1980s levee construction is 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 (aggredation) 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, consistent with Balance Hydrologics' conclusions (Appendix F).

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, existing and proposed 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 in 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 Project 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 NRSP, Legacy, and Entrada Sub-regions will implement hydromodification controls consistent with the NRSP Sub-regional Stormwater Mitigation Plan. Further, other future projects within the watershed reflected in adopted plans and projections 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 "reset" 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. These conclusions are confirmed by the PACE Fluvial Study with respect to development of the NRSP.

Based upon the above discussion, that the Project includes hydromodification controls as Project Design Features, 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 Project's contribution to cumulative

hydromodification impacts to the Santa Clara River will be less than significant and consistent with the requirements of the MS4 permit.

7.10.2 Dry Weather Runoff

Direct Impacts

In order to quantitatively address dry weather impacts, a dry weather water balance was performed (Table 7-21). 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 x 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 x 10^{-5} to 1.8 x 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 x 10^{-4} cfs per urbanized acre was used in this report.

A monthly dry weather flow balance was performed on the water quality PDFs (which also serve a hydrologic source control function) for the proposed Project. Water quality basins were conservatively assumed to infiltrate at only 0.15 in/hr, representing half of the long-term infiltration rate estimated in water quality basins for wet-weather hydrologic modeling. Evapotranspiration rates were conservatively assumed to be 75% of reference rates from CIMIS Zone 14, in which the Project is located. It was assumed that natural open space in the Project area would result in no dry weather runoff. The only impact areas that are not served by detention basins, vegetated swales, and/or bioretention areas are miscellaneous roadway areas that will be served by catch basin media filtration units; however, these areas either will not produce dry weather discharges, or will include design elements to fully infiltrate dry weather flows.

Table 7-21: Predicted Dry Weather Water Balance

Month	Dry Weather Flow (af)[1]	ETo (af)[2]	Infiltration (af)[3]	Outflow (af)
January	18.4	0.8	17.6	0.0
February	16.6	1.2	15.5	0.0
March	18.4	1.9	16.5	0.0
April	17.8	2.7	15.2	0.0
May	18.4	3.6	14.9	0.0
June	17.8	4.1	13.8	0.0
July	18.4	4.5	13.9	0.0
August	18.4	4.0	14.4	0.0
September	17.8	3.0	14.9	0.0
October	18.4	2.1	16.3	0.0
November	17.8	1.1	16.7	0.0

Month	Dry Weather Flow (af)[1]	ETo (af)[2]	Infiltration (af)[3]	Outflow (af)
December	18.4	0.8	17.6	0.0

[1] Based on dry weather flow of 0.0003 cfs/acre from a range of researched values.
[2] 60% of Reference ETo from CIMIS Zone 14.
[3] Equal to dry weather runoff up to maximum of 0.15 in/hr for water quality basins.

It is predicted that all dry weather flows will be infiltrated or removed by evapotranspiration in the Project area water quality PDFs, which also provide hydrologic source control. The Project will include numerous source controls that will reduce dry weather flow generation at the source, such as education programs, use of native and/or non-invasive, climate appropriate vegetation, and smart irrigation systems in multi-family residential areas. In addition, low impact/site design BMPs that will be implemented by the Project at the lot scale will help to eliminate the discharge of dry weather runoff.

Based on comprehensive site planning, source control, and treatment control strategy and the above water balance analysis, the potential for dry weather flows to result in hydromodification or associated habitat or water quality impacts is considered less than significant.

8 CONCLUSIONS

This section summarizes the potential effects, if any, of the proposed Mission Village Project 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. Model results referenced here are anticipated to be conservative as the model does not include the effects of source control on concentration and loads:

- ***Sediments*:** MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address sediment in both the construction phase and post-development. Mean total suspended solids concentration and loads are predicted to be less in the post-development condition than in the existing conditions. 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 Project on sediments is considered less than significant.
- ***Nutrients (Phosphorus and Nitrogen (Nitrate+Nitrite-N and Ammonia-N))***: MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address nutrients in both the construction phase and post-development. Average annual loads for total phosphorus, nitrate plus

nitrite, and ammonia are predicted to increase from the Project due to increased average annual runoff volumes. Average concentrations are predicted to decrease for total phosphorus nitrate-N plus nitrite-N, and ammonia concentrations. Average concentrations are predicted to be within the range of observed wet weather values for Santa Clara River Reach 5. Average nitrate-N plus nitrite-N and ammonia-N concentrations are predicted to be well below LA Basin Plan objectives and TMDL wasteload allocations. The predicted nutrient concentrations are not expected to cause increased algae growth. On this basis, the impact of the Project 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 Project to address trace metals in both the construction phase and post-development. Aside from dissolved copper concentrations which are predicted to increase, the average annual trace metal concentrations are predicted to decrease with Project development. Average annual trace metal loads are predicted to increase due to the increase in average annual runoff volume. Predicted average annual concentrations of dissolved copper, total lead, dissolved zinc, and total aluminum are below benchmark Basin Plan objectives, CTR criteria, and NAWQC criteria. Cadmium is not expected to be present at significant levels in runoff discharges from the Project. On this basis, the impact of the Project 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 Project to address chloride loads (via volume reduction) in both the construction phase and post-development. The mean predicted concentration and load of chloride is predicted to increase with development, although the predicted concentration is well below the LA Basin Plan objective and is near the low end of the range of observed values in the Santa Clara River Reach 5. On this basis, the impact of the Project 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 Project, 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 Project 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. A reduction in

agriculture and open space within the Project area will reduce the bacteria produced by wildlife. The Project 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 Project. On this basis, the Projects impact on pathogen and pathogen indicators is considered less than significant.

- ***Hydrocarbons*:** Hydrocarbon concentrations will likely increase 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 and bioretention areas. 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 Project, 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 Project 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 Project 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 commercial area parking lots and in the treatment control PDFs. During the construction phase of the Project, 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 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 Project, 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 proposed Project.

- ***Cyanide:*** In addition to the expected relatively low level of cyanide in untreated stormwater, cyanide in runoff from the Project 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 Project.
- ***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 the Project area, 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 Project PDFs or in the Santa Clara River and 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 (PAHs, metals). A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and County of Los Angeles 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 Project on water quality is considered less than significant.
- ***Regulatory Requirements:*** The proposed Project satisfies MS4 Permit requirements for new development, including SUSMP requirements and SQMP requirements, and satisfies construction-related requirements of the Construction General Permit and General Dewatering Permit, and therefore complies with water quality regulatory requirements applicable to stormwater runoff.

8.2 Groundwater Impacts

- ***Groundwater Quality Impacts (Nitrate+Nitrite-N)***: MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project 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 Project 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 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 Project. On this basis, the Project's 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 the Project's 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:
  - Project low impact/site design and on-site treatment PDFs, especially open space retention, efficient irrigation, and treatment 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 the Santa Clara River banks will be protected by geomorphically referenced engineering techniques, 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).

  For these reasons, direct hydromodification impacts of the Project on the Santa Clara River are considered less than significant.

- ***Cumulative Hydromodification Impacts:*** The Project contributes only 1.1 percent of the total potential impervious surface at build out within the watershed, the Project includes hydromodification controls as Project Design Features, future development projects within the watershed will control flow in compliance with the sub-regional program, and large-scale changes naturally occur in the Santa Clara River in response to major episodic events, therefore, the Project's 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, the impact of the Project on dry weather water quality and seasonality of flow in the Santa Clara River is considered less than significant.

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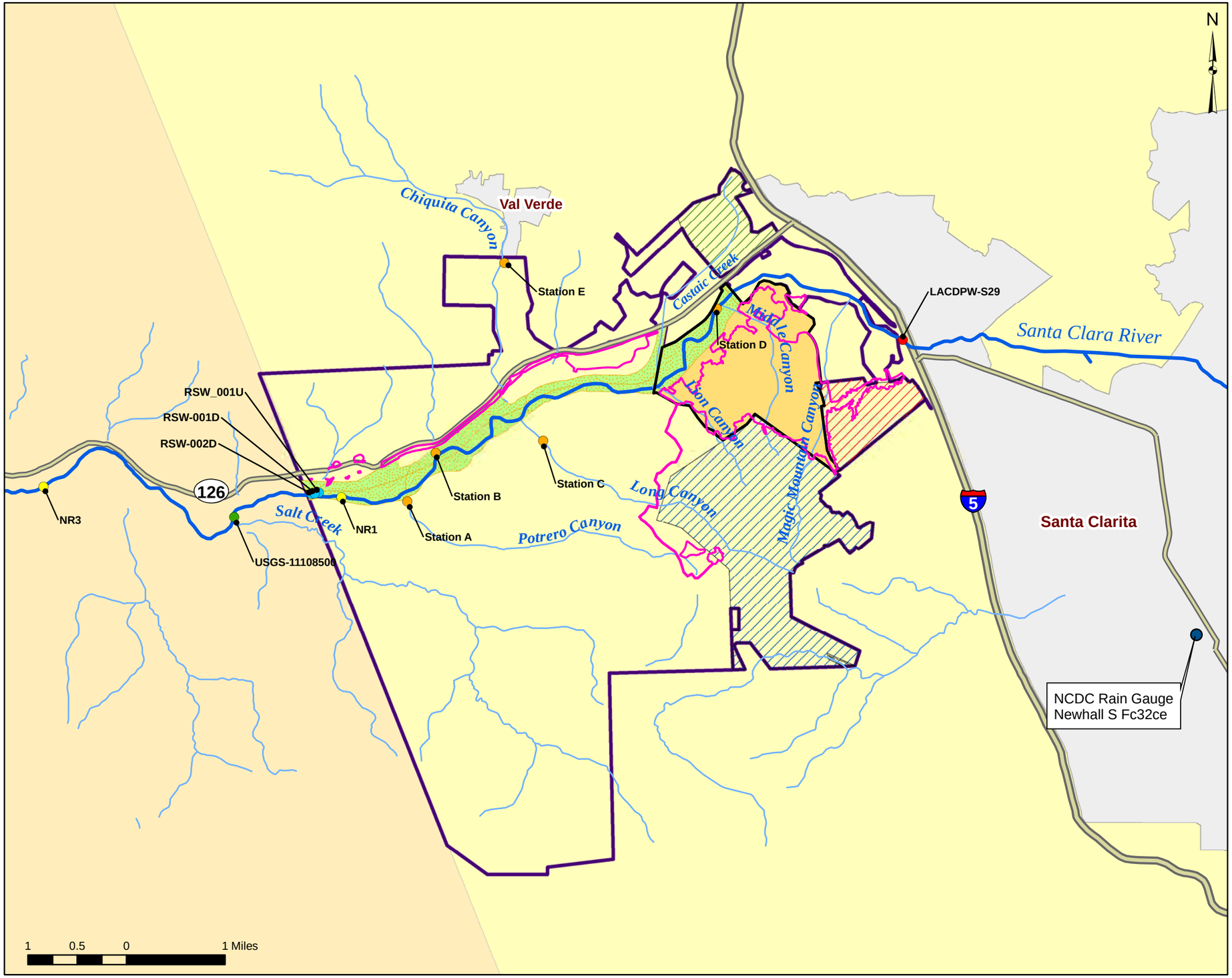

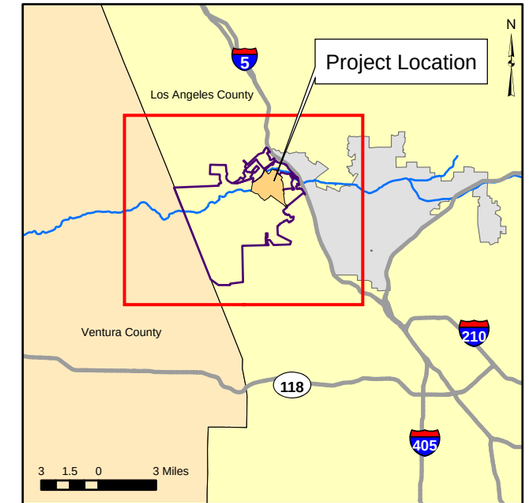

Legend

- MV Project Boundary
- Impact Boundary
- NRSP Sub-Regional SWMP Boundary
- Entrada Boundary
- VCC Boundary
- Legacy Boundary
- River Corridor
- Santa Clara River
- Major Tributaries
- Los Angeles County
- Ventura County
- City Boundaries

Water Quality Monitoring Stations

- LACDPW
- Newhall Ranch Stormwater Monitoring
- Newhall WRP Pre-Startup Monitoring
- Newhall WRP NPDES Monitoring
- USGS

Figure 2-1
Project Vicinity

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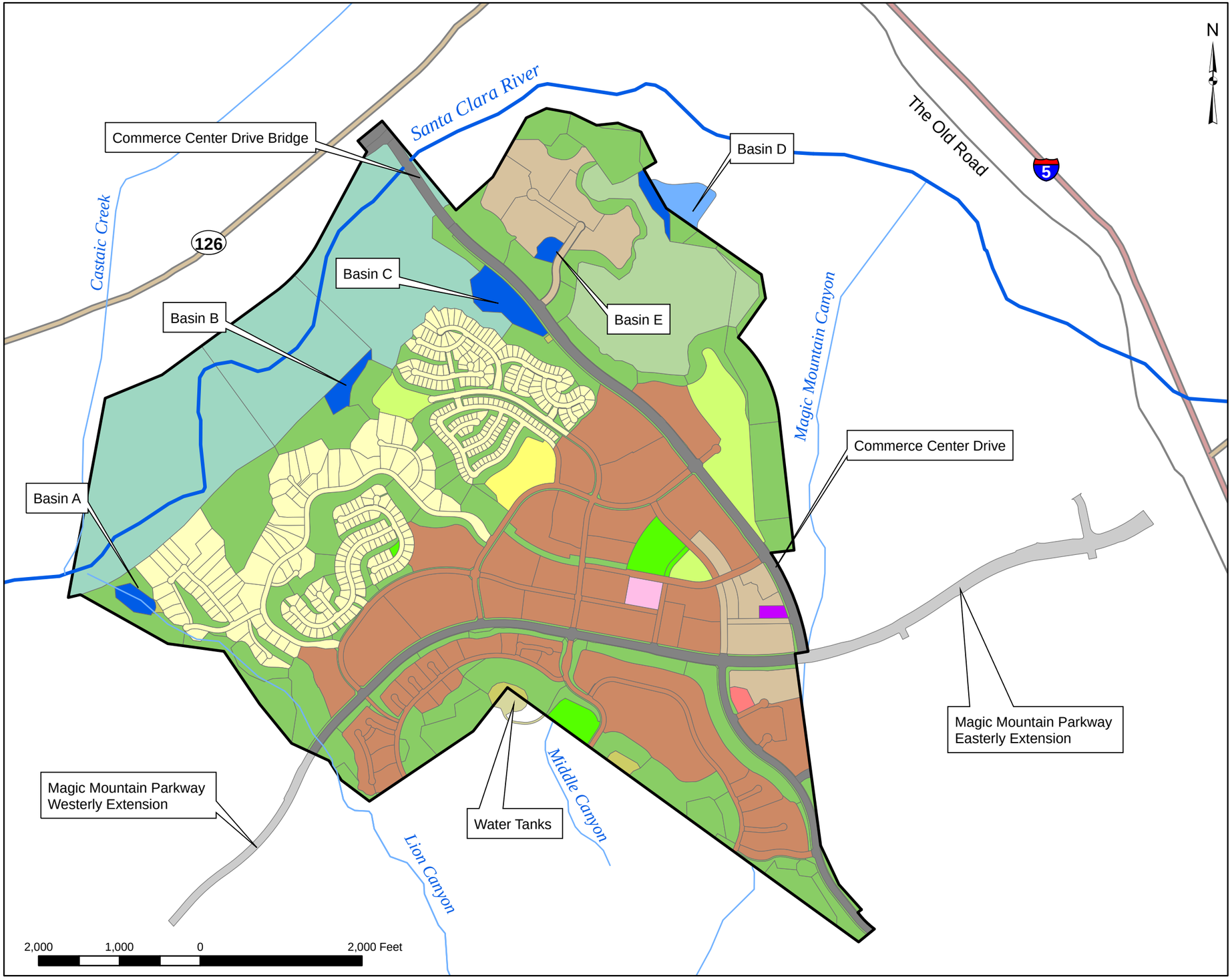

Legend

- MV Project Boundary

Land Use

- Single-Family Residential
- Multi-Family Residential
- Mixed Use/ Commercial
- Transit
- Library
- Fire Station
- School
- Recreation
- Open Space
- Spineflower Preserve
- Park
- River Corridor
- Utilities
- Roads
- Water Quality Basin
- Off-site Water Tank
- Off-site Road
- Off-site Water Quality Basin

Figure 2-2: Land Use

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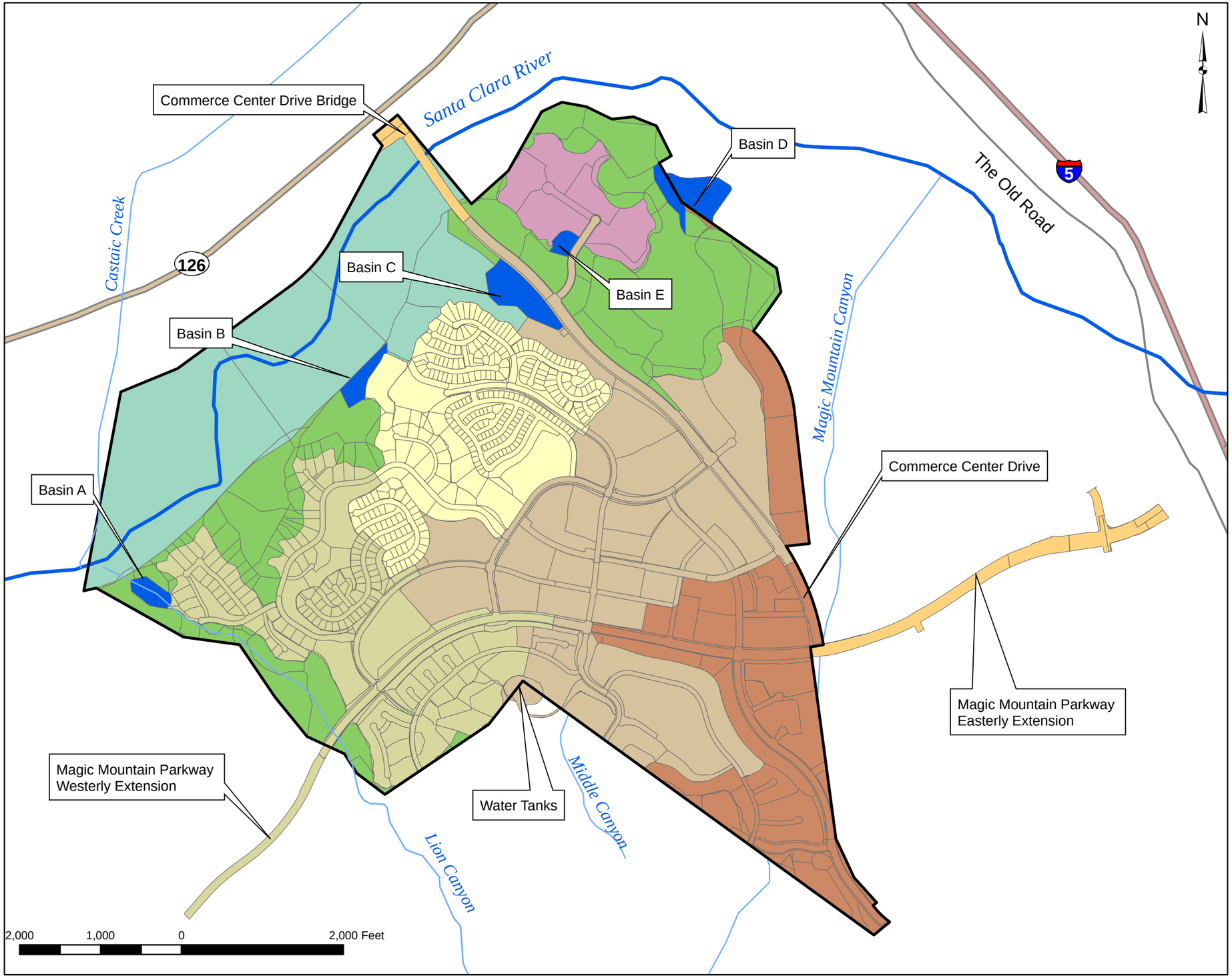

Legend

- Mission Village Boundary
- Water Quality Basins

Drains to:

- Basin A
- Basin B
- Basin C
- Basin D
- Basin E
- Media Filter
- Natural/Off-site
- River Corridor

Figure 5-1
Treatment Areas

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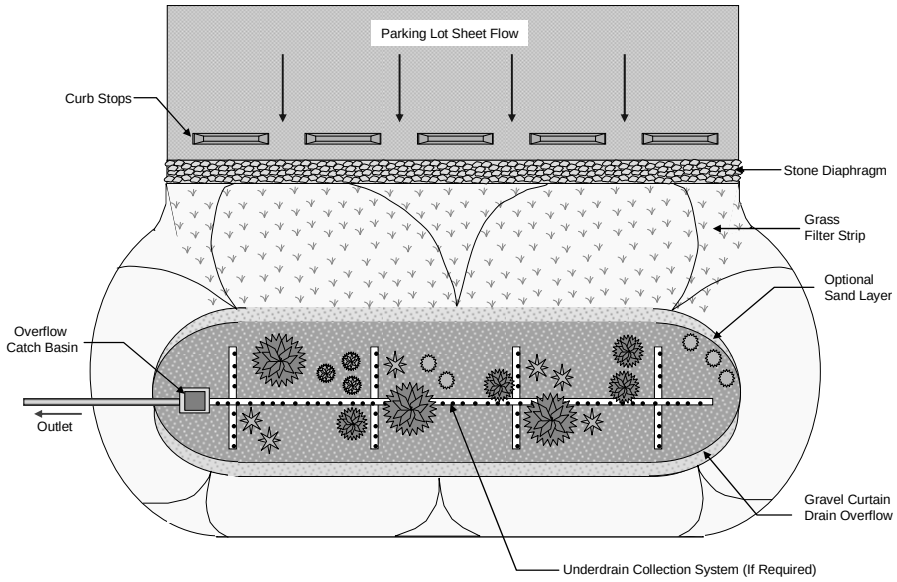
Plan View



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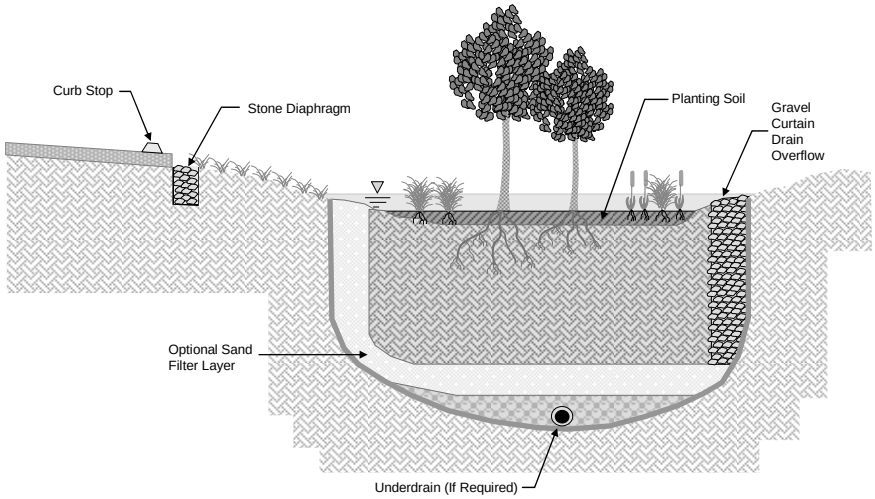
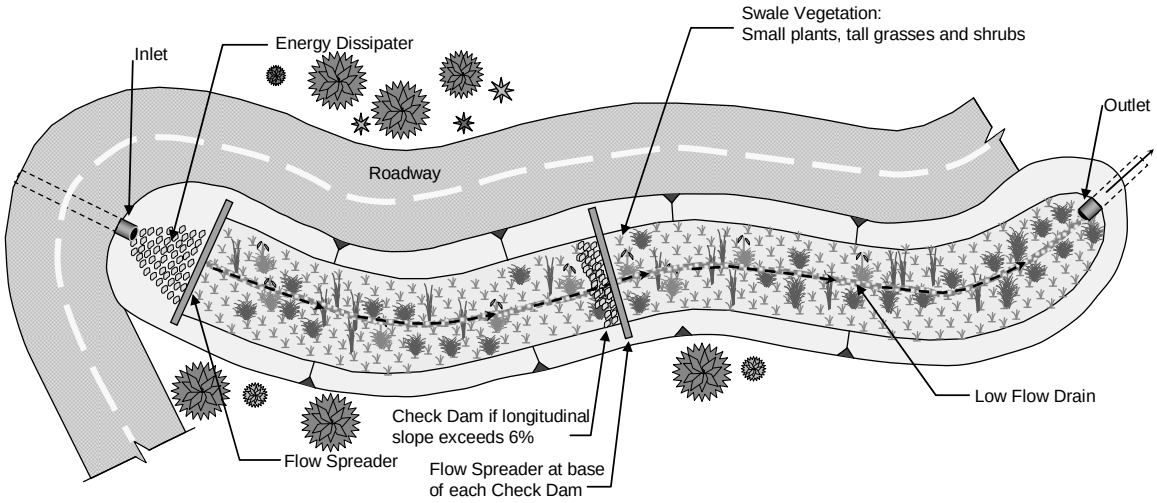


Figure 5-2
Conceptual Illustration of a Bioretention Facility

Figure 5-3
Examples of Bioretention Areas

Plan View



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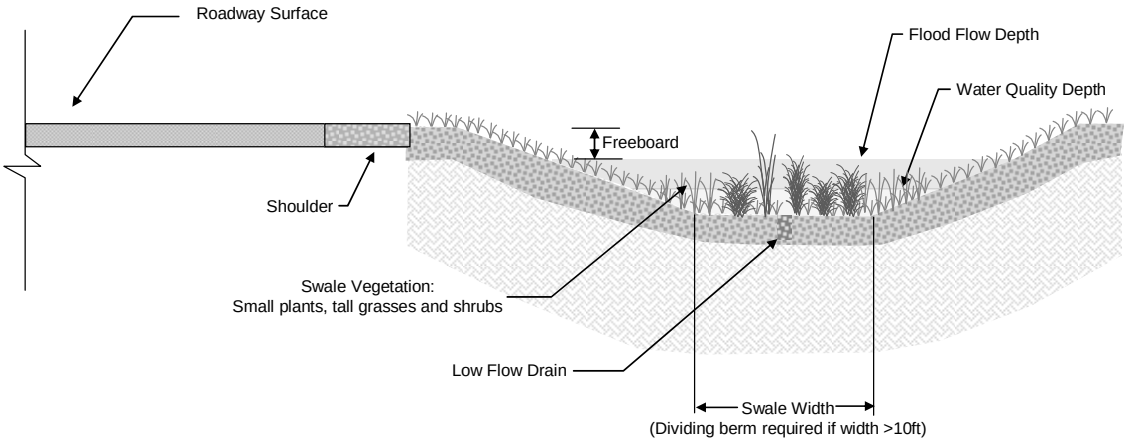
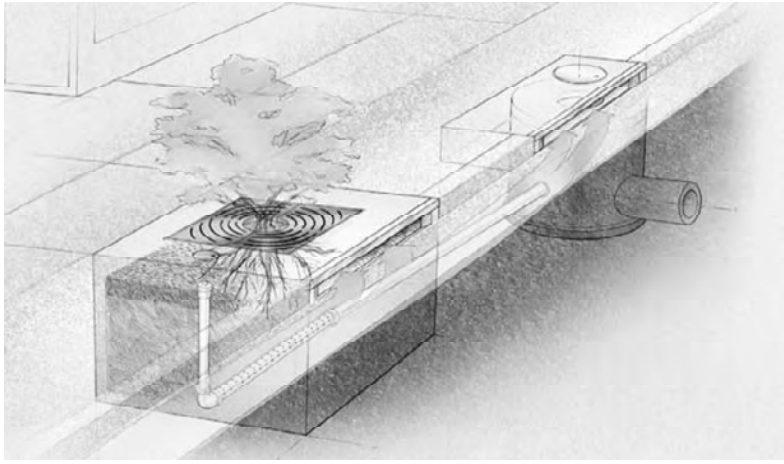
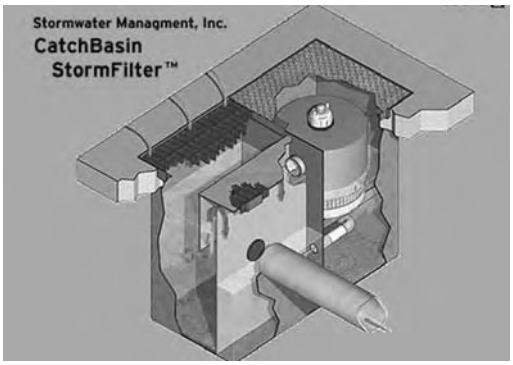


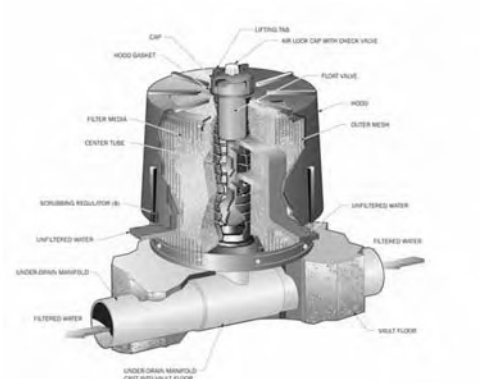
Figure 5-4
Conceptual Illustration of a Vegetated Swale

Figure 5-5
Examples of Vegetated Swales



Filterra® Bioretention Filtration System





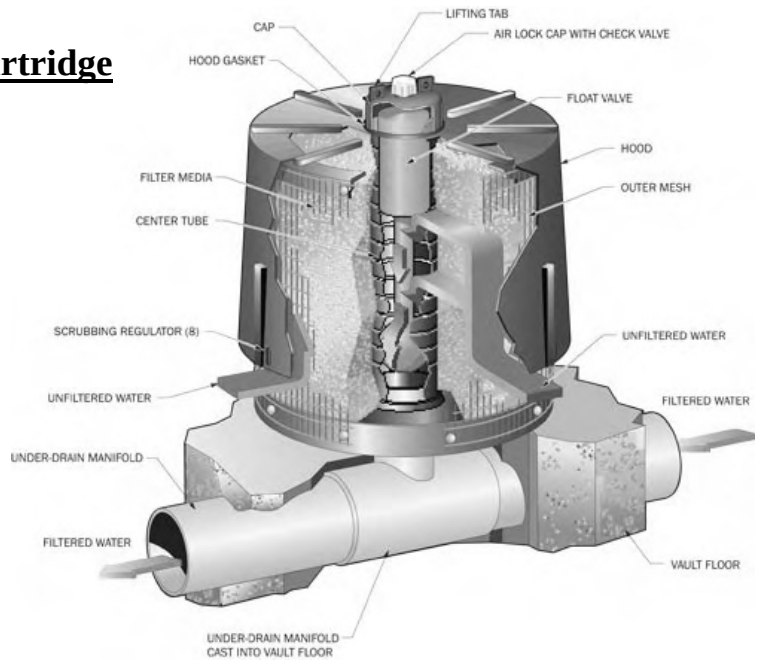
Contech StormFilter®

Modular Wetlands MWS-Linear®

Figure is for illustration purposes only. Does not constitute product endorsement of BMPs shown above.

Figure 5-6
Conceptual Illustration of Selected Proprietary Treatment BMPs

StormFilter Media Cartridge



Example configuration of Catch Basin Storm Filter

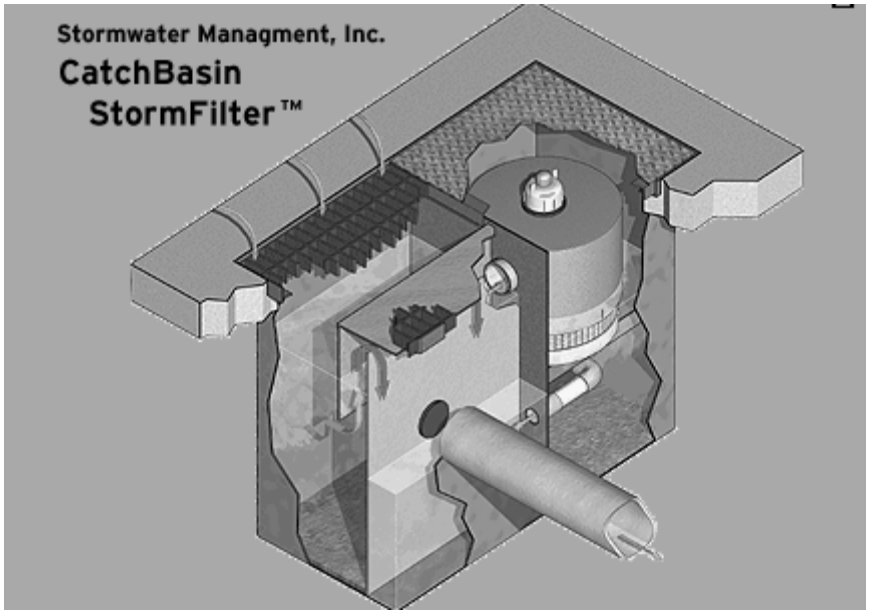
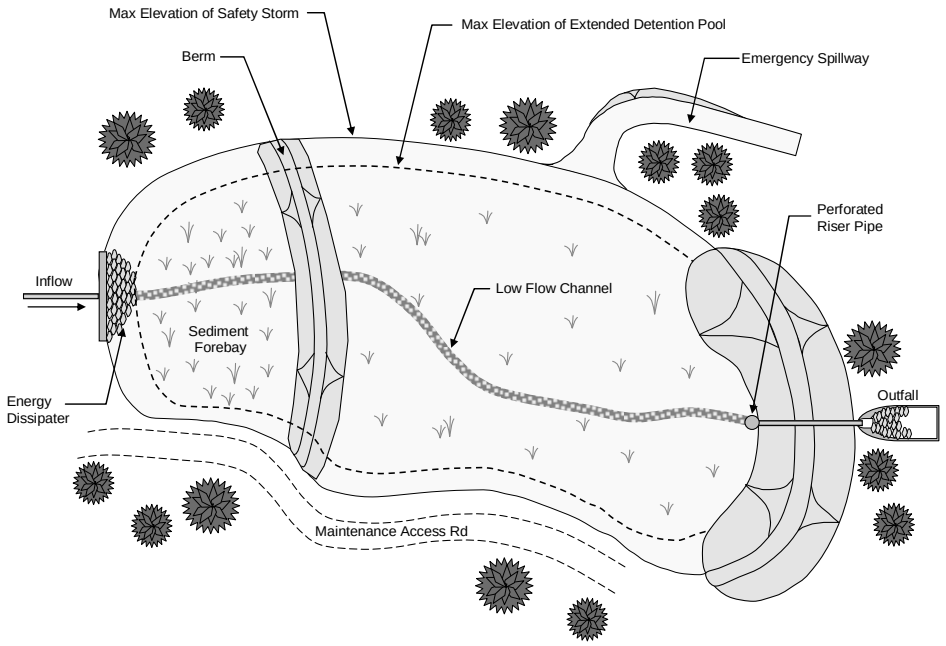


Figure 5-6
Conceptual Illustration of a Storm Filter™ Media Filter

Plan View



Profile

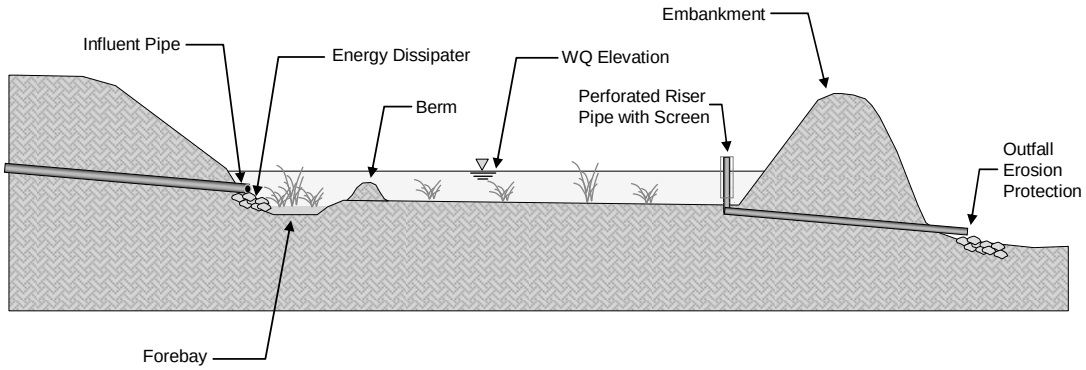
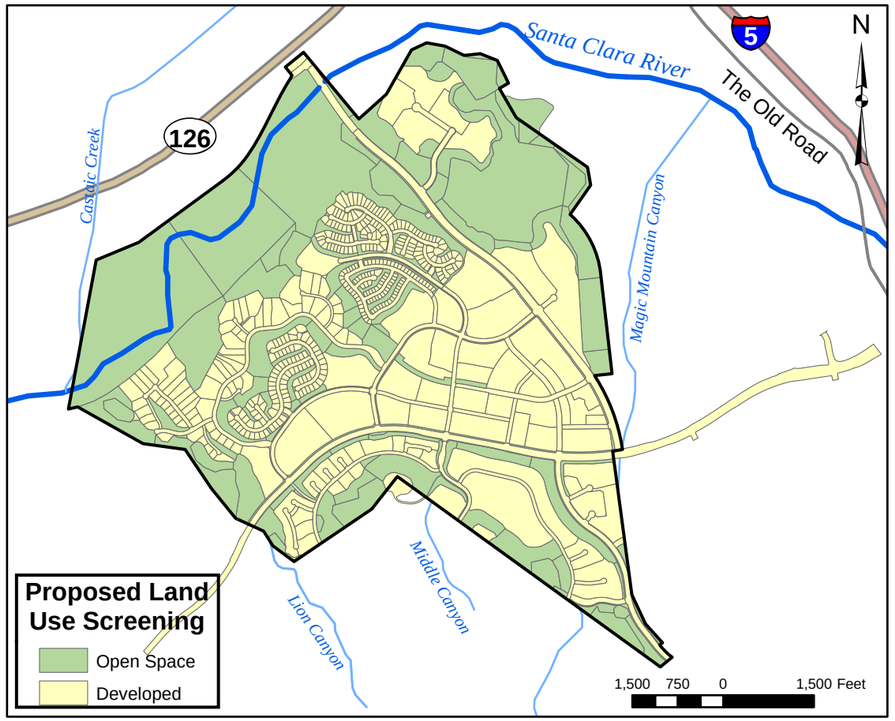
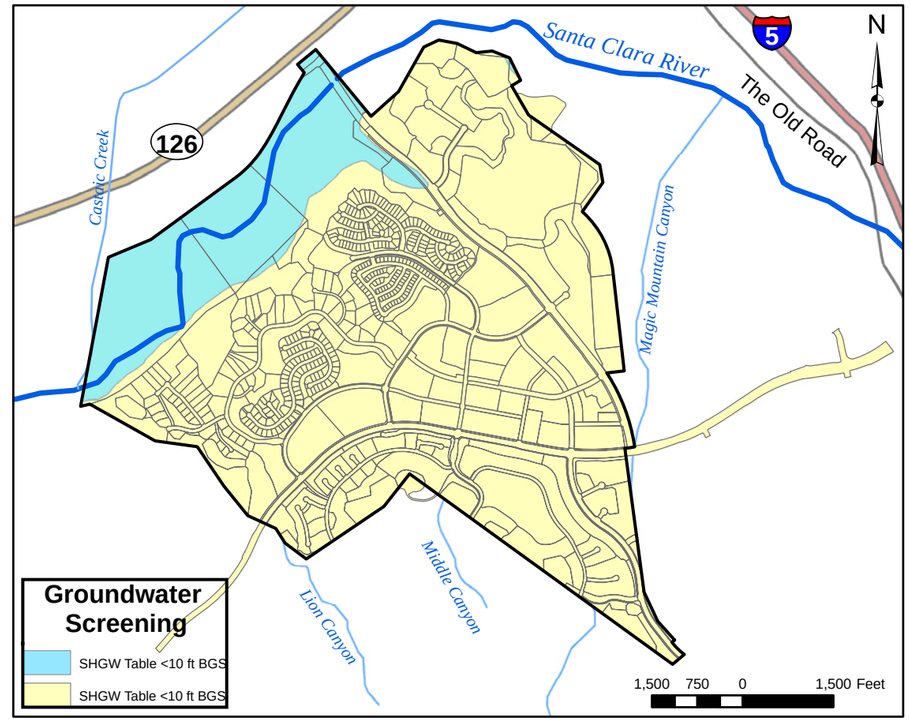
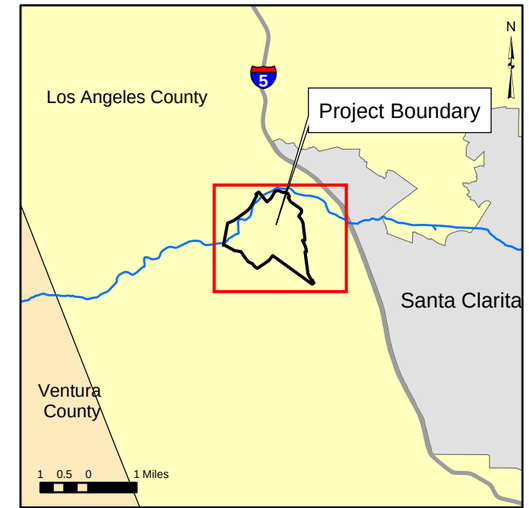


Figure 5-7
Conceptual Illustration of an Extended Detention Basin

Figure 5-8
Examples of Extended Detention Basins

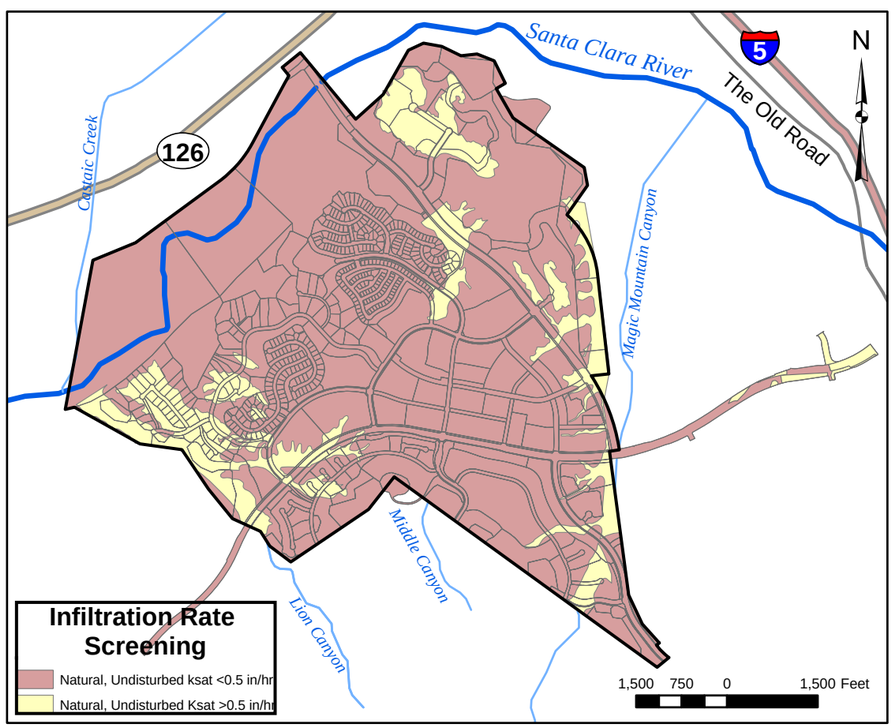


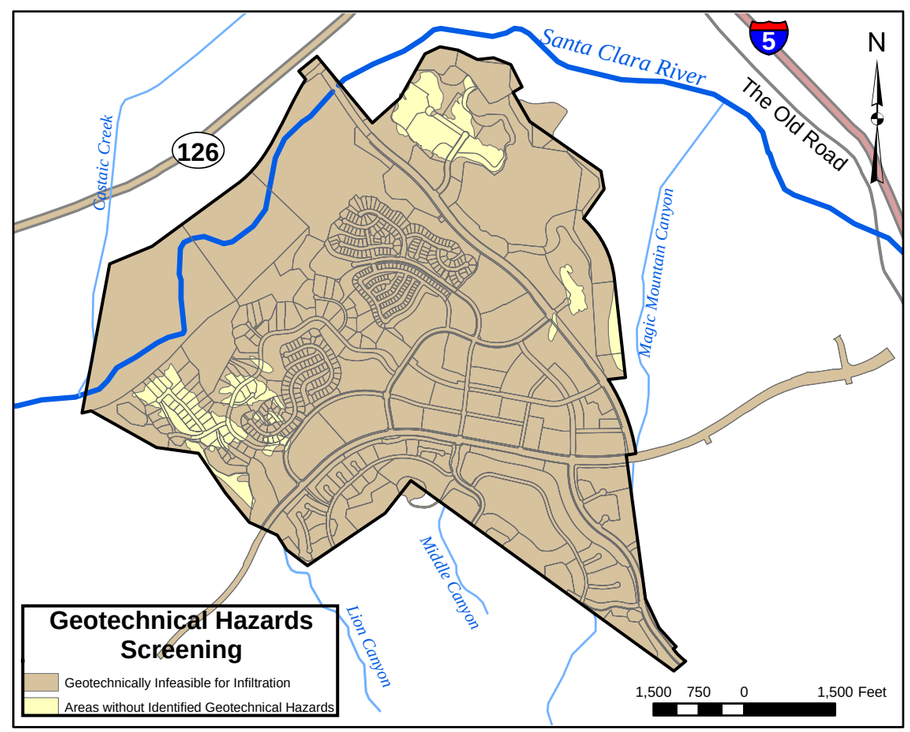




Legend

- Mission Village Project Boundary
- Santa Clara River
- Major Tributaries





Notes:
1. Yellow color indicates areas where the LID performance standard would potentially apply based on that particular screening factor.
2. The intersection of these feasiblity areas demonstrate the composite area to which the LID performance would potentially apply based on all four screening factors and is shown in Figure 5-2.
3. The Geotechnical Hazards Screening was conducted primarily for areas where other screening factors do not apply.

Figure 7-1
LID Equivalency Screening Factors

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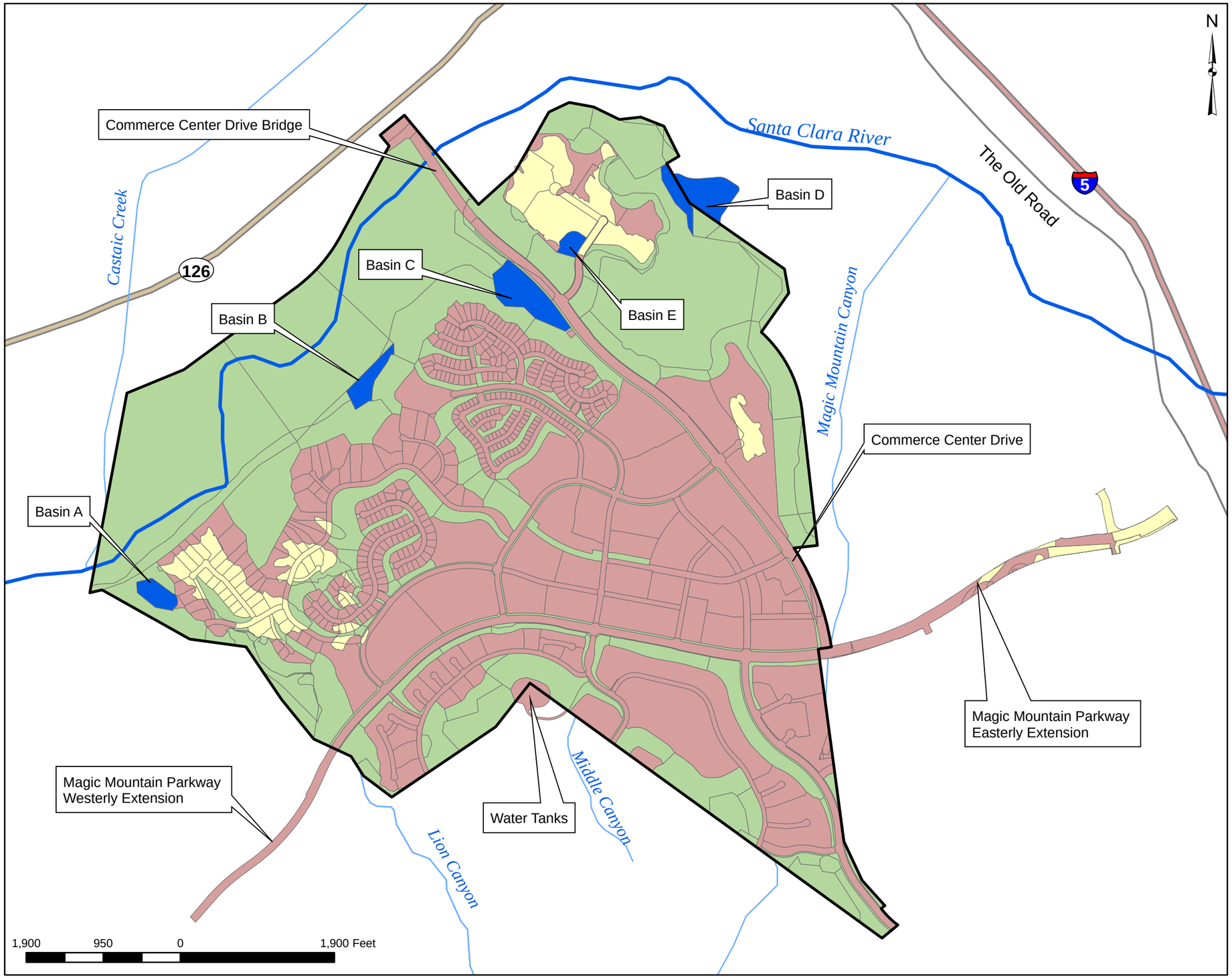

Legend

- Mission Village Project Boundary
- Santa Clara River
- Major Tributaries
- Water Quality Basins

Infiltration Screening Results

- Infiltration Potentially Feasible
- Infiltration Potentially Infeasible
- Open Space

* Based on screening factors shown in Figure 7-1.

Figure 7-2
Composite LID Equivalency Screening

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Mission Village Water Quality Technical Report
Appendices

(A) Pollutants of Concern

(B) Modeling Parameters & Methodology

(C) Newhall Ranch Stormwater Monitoring Data

(D) "Effect of Urbanization on Groundwater Recharge in the Santa Clarita Valley"

(E) "Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California"

(F) "Basis of Design: Lion Canyon"

(G) "Geotechnical Evaluation of Infiltration, Vesting Tentative Tract Map Number 61105, Mission Village, Newhall Ranch, Los Angeles County, California."

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)	1. Narrative objective in the LA Basin Plan: "Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses." 2. LA 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: Natural Turbidity — Max Increase 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."
Nutrients: Ammonia, Nitrite, Nitrate, Total Nitrogen, and Total Phosphorus	1. "Nutrients including nitrogen and phosphorous 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). 2. Nutrients are a biostimulatory substance.	1. LA 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 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. LA Basin Plan standards for nitrogen: "Waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N + NO_2-N), 45

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
		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 Reach 5 of the Santa Clara River Reach 5 with a water quality objective of 5 mg/L nitrate-N + nitrite-N. 3. Reaches 5 and 7 (EPA Reaches 7 and 9) of the Santa Clara River is listed as having ground water recharge as a beneficial use in the LA Basin Plan. LA Basin Plan 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 water quality objectives (TMDLs) for Reach 5 (EPA Reach 7) of the Santa Clara River of 2.0 mg/L ammonia-N (1.2 mg/L at County line) and 4.5 mg/L as NO_3-N + NO_2-N. 5. Narrative objective for biostimulatory substances in the LA 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: Copper, Lead, Zinc, Arsenic, Cadmium, Chromium, Mercury, and Nickel	1. "Metals including lead, zinc, cadmium, copper, chromium, and nickel 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	1. Narrative objective in the LA 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

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
	sediments. Metals are of concern because they are 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." (CSQA, 2003) 2. LA Basin Plan requires that discharges into receiving waters shall not cause or contribute to toxicity. 3. Urban development can increase potential sources of these metals due to sources from vehicles and building materials.	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. 3. CTR criteria are expressed for dissolved metal concentrations and are determined on the basis of hardness in the receiving water. In application of criteria to the Project, local hardness data will be used to determine most appropriate criteria.
Chloride	1. Resolution 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 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) 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 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) 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." 2. Resolution R03-003 was revised in December 2008 by Resolution No. R4-2008-012, which sets site-specific objectives (SSOs) for Santa Clara River Reaches, which apply and supersede existing water quality objectives of 100 mg/L only when chloride load reductions and/or	1. LA Basin Plan contains mineral objectives for individual inland surface waters. Reach 5 of the Santa Clara River has a chloride objective of 100 mg/L. 2. Resolution R03-008 states "The numeric target for this TMDL pertains to Reaches 5 and 6 of the Santa Clara River and is based on achieving the existing water quality objective of 100 mg/L, measured instantaneously, throughout the impaired reaches." 3. Resolution R4-2008-012 includes a SSO for Reach 5 of the Santa Clara River of 150 mg/L, which applies when chloride load reductions and/or chloride export projects are in operation by the SCVSD.

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
	chloride export projects are in operation by the SCVSD according to the implementation section in Table 7-6.1.	
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 coliform is a frequently monitored indicator organism of human pathogens. 3. Human related activities can increase fecal coliform concentrations. 4. Concentrations of fecal coliform in stormwater can be elevated, often due in part to the presence of coliform bacteria from natural sources.	1. LA Basin Plan objectives are based on the designated uses of the water body. The Santa Clara River Reach 5 is listed with a REC1 beneficial use. Resolution # 01-018 (LARWQCB, 2001) amended the LA Basin Plan standards 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
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 LA 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 …." The LA Basin Plan 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 substances are now banned from most urban uses.

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
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. Petroleum hydrocarbons are ubiquitous, and used in a wide variety of applications. Potential sources are generally expected to increase with urban development. 3. A source of PAHs is automobile exhaust. Therefore, development would generally be expected to increase levels of PAHs.	1. Narrative objective in the LA 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 the protection of aquatic health.
Bioaccumulation & Toxicity	1. Some Pollutant 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. 2. Certain pollutants in stormwater runoff have the potential to be highly toxic to aquatic organisms resulting in effects such as impaired reproduction or mortality.	1. Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health. 2. LA Basin Plan objectives for toxicity: "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."
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	1. LA 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."

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
	dissolved oxygen levels in streams, lakes, and estuaries sometimes causing fish kills." (CASQA, 2003)	
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. LA 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. LA Basin Plan objective for BOD: "Waters shall be free of substances that result in increases in the BOD which adversely affect beneficial uses."
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. LA 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. LA 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	1. LA Basin Plan objectives for temperature: "For waters designated WARM, water temperature shall not be altered by more than 5º F above the natural temperature. At no time shall these WARM-designated waters be raised above 80 º F as a result of waste discharges".

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
	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.	
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. LA 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 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	1. LA Basin Plan objective for color: "Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses". 2. LA 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**
	concern for the project.	
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. LA 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. LA Basin Plan objectives for minerals: Reach 5 / Reach 7 TDS (mg/L) 1000 / 800 Sulfate (mg/L) 400 / 150 Boron (mg/L) 1.5 / 1.0 SAR (mg/L) 10 / 5.0
MBAS (Methylene blue activated substances)	1. MBAS are related to presence of detergents in runoff, may be incidentally associated with new urban development, but more commonly with point sources such as treatment plants. The project will have no planned illicit sewer connections or septic tanks, eliminating domestic sources. Further, the project will employ source controls such as educational materials for homeowners regarding elimination of discharges from car washing to the storm drain system, control of construction vehicle wash water, control of construction, street, and pavement washing activities to control wash water. LADPW stormwater monitoring found MBAS	1. LA Basin Plan objective for MBAS: "Waters shall not have MBAS concentrations greater than 0.5 mg/L in water designated (MUN)."

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
	concentrations below the water quality criteria for all urban land use except transportation; therefore this Pollutant is not anticipated to be a pollutant of concern for the project.	
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. LA 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."
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. LA 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. LA 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. Pollutants of concern are those pollutants that are anticipated or potentially could be generated by development that have been identified by regulatory agencies as potentially impairing beneficial uses in the receiving water bodies or that could adversely affect receiving water quality.

A.2. References

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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.

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.

B. WATER QUALITY MODEL METHODOLOGY

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B.1. Model Overview

B.1.1. Model Overview

The model used to assess stormwater quality impacts associated with the proposed Newhall Ranch Mission Village sub-division (Project) 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:

- Pre-development
- 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 from, and are strongly dependent on the land-use type. The flow chart in Figure B-1 provides an overview of the modeling methodology.

The model does not incorporate the hydraulics or detailed hydrology of the site, which would be more appropriate for subsequent 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.

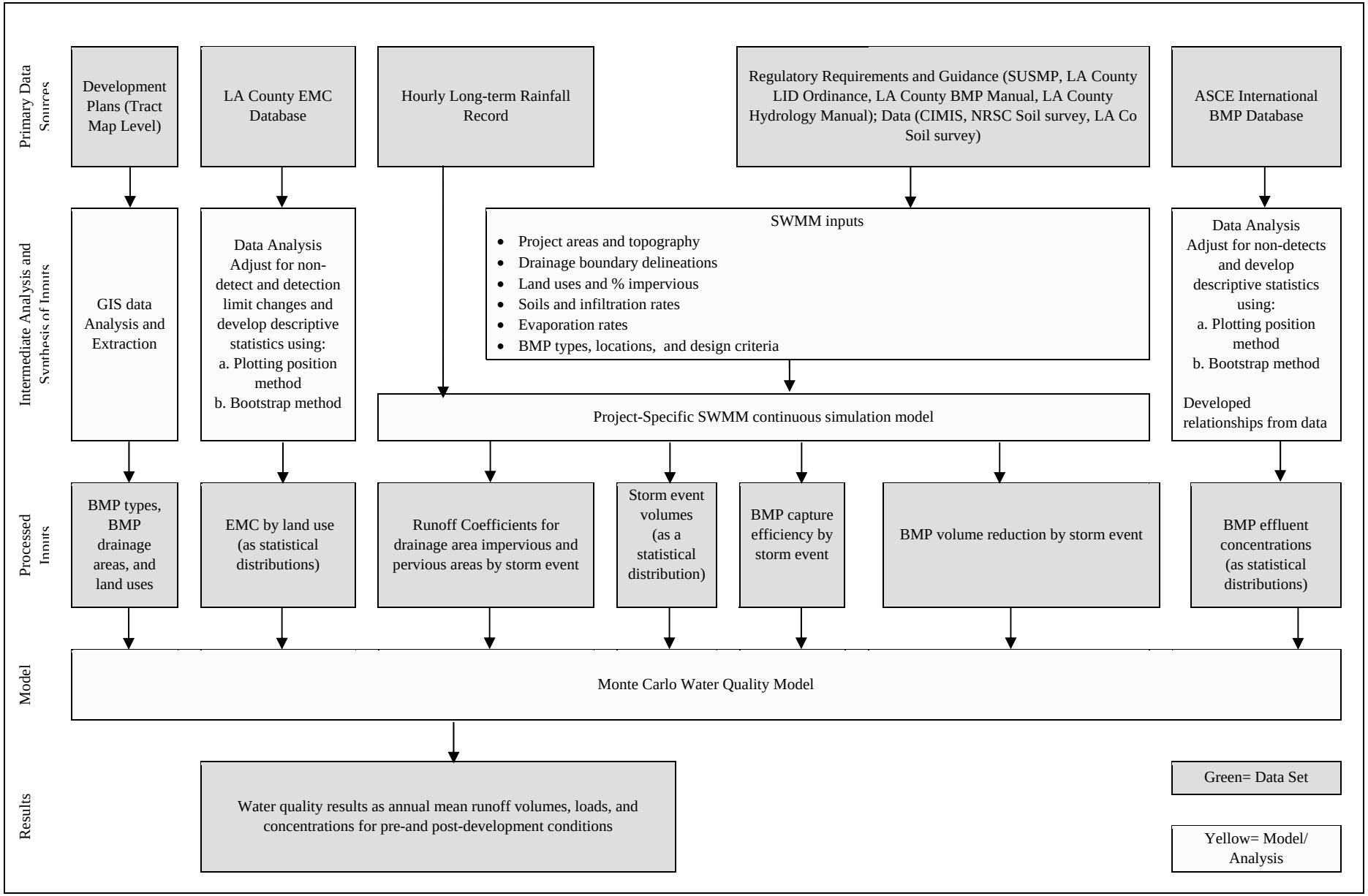

Figure B-1: Overview of Water Quality Analysis Methodology

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.

B.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 B.2.7 discusses the assumptions that were made in specifying the model parameters and Section B.3.4 discusses the assumptions regarding the modeling approach. Section B.4 discusses model accuracy.

B.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.

B.2.1. Rainfall & Storm Characteristics

Rainfall analysis was conducted with hourly precipitation data from a 40 year period of record (water year (WY) 1969-2008) recorded at the National Climatic Data Center (NCDC) Newhall rain gauge (station number 046162), located in the town of Newhall, California. Figure B-2 shows the location of the Newhall gauge in relation to the Project area. This gauge is located approximately 4 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 1,000-1,200 ft AMSL.

While the period of record rainfall data collected at the Newhall rain gauge is quite long (40 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 6 miles away from the Newhall gauge, and 10 miles away from the Project (south and slightly east).

The Castaic Junction gauge monitored by LACDPW 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. Other gauges in the area report daily rainfall totals only. Hourly data are required to support water quality modeling efforts.

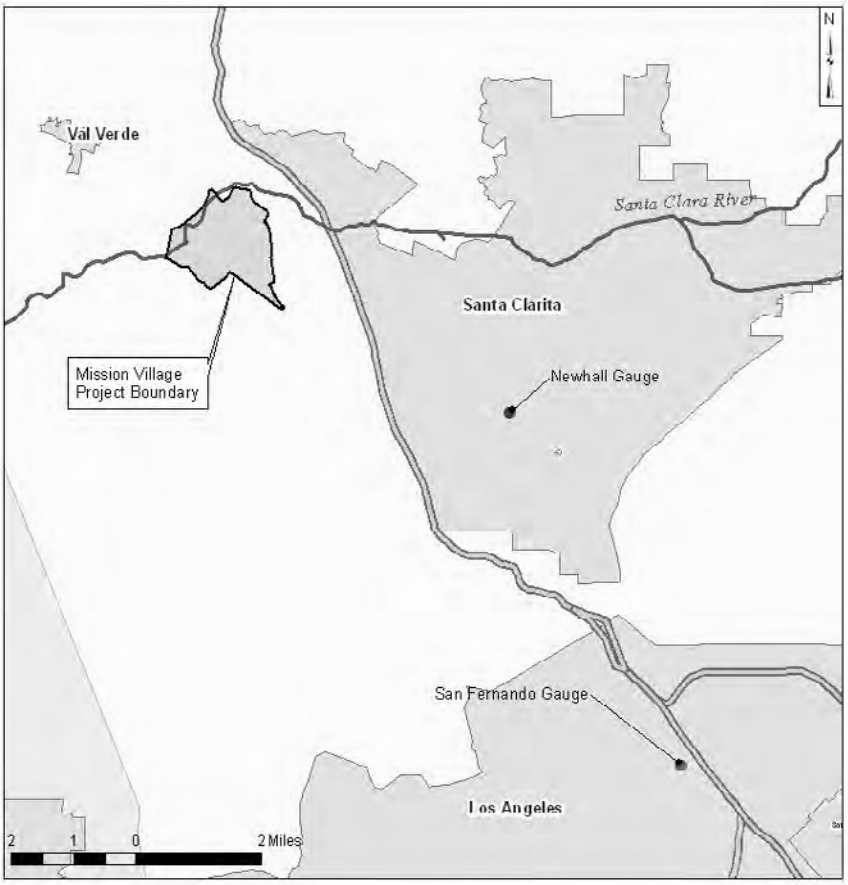

Figure B-2: Location of Newhall Rain Gauge in the Vicinity of the Project Area

San Fernando rainfall data was adjusted based on comparison between the two gauges over periods for which they both contained data. A comparison of hourly or daily rainfall totals is not expected to yield a strong correlation as spatial variability is exaggerated on short time scales (i.e. a single storm could result in appreciable rainfall at one gauge and little rainfall at the other). However, monthly correlations are expected to yield meaningful comparison between the gauges when taken over a long period of record. Data from the gauges from WY 1969 to 2008 were screened to keep only the months without missing data and with measured rainfall at both stations. Correlation of the monthly rainfall totals is shown in Figure B-3.

This monthly correlation indicated slightly higher rainfall amounts at the Newhall gauge compared to the San Fernando gauge.

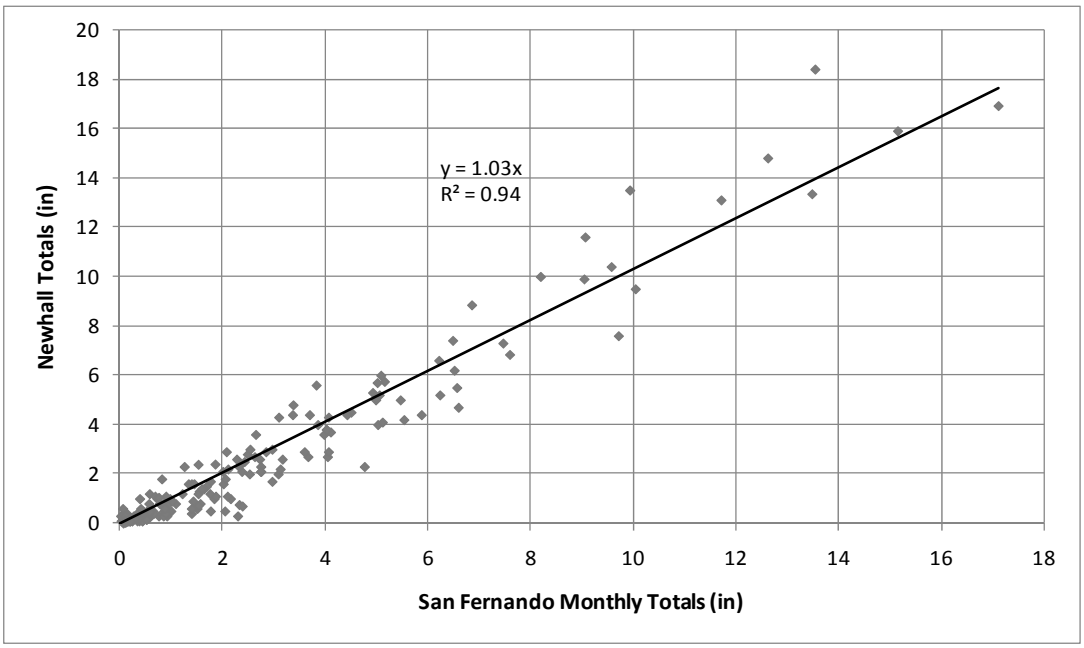

Figure B-3: Correlation of 24-hour Totals between Newhall & San Fernando Gauges

Based on the relationship developed through the monthly comparison, a multiplier of 1.03 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 two data groups: all storm events; and only the storms that were 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) facilitates resolving 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 an inter-event dry period, which in this case was set to a minimum of 6 hours. Small rainfall events, which resulted in rainfall of 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 609 storm events (>0.1 inches) were segregated from the continuous data from October 1, 1968 to September 30, 2008. Storm statistics for the full (all storms) and the trimmed (storms > 0.1 inch) data sets are shown in Table B-1

Table B-1: Analysis Results for the Actual and Filled Newhall Rainfall Data

Storms	Newhall Gauge WY 1969 – 2008	Patched Record
All Storms	Average annual rainfall (in):	18.4
	Total number of storms:	1011
	Average number of storms per year:	25.3
	Average storm volume (in):	0.73
	Average storm duration (hrs):	7.3
	Average storm intensity (in/hr):	0.097
Storms >0.1 inch	Average annual rainfall (in):	17.4
	Total number of storms:	609
	Average number of storms per year:	15.2
	Average storm volume (in):	1.14
	Average storm duration (hrs):	11.4
	Average storm intensity (in/hr):	0.102

1- Augmented record includes adjusted data from San Fernando gauge to fill gaps in Newhall gauge record.

B.2.2. Runoff Coefficients

The long term runoff coefficient (i.e. the fraction of precipitation that runs off as stormwater) is dependent on a number of factors. The long term runoff coefficient is most strongly dependent on catchment imperviousness. However, soil characteristics, watershed slope and roughness, rainfall patterns, evapotranspiration rates and a variety of other factors also influence runoff coefficient. Runoff coefficients are expected to vary from storm event to storm event as a function of antecedent conditions, storm intensity distribution, storm duration, and storm depth. The following describes how the runoff coefficients were estimated for use in the Water Quality model.

B.2.2.1. SWMM Runoff Coefficient Modeling Parameters

The water quality model uses an equation consistent with the Los Angeles County Hydrology Manual to estimate a runoff coefficient for sub-basins as a function of the percent impervious for a given storm event. The format of this equation is described as:

$$C = C_i * i + C_p * (1-i)$$

Where:

C = composite runoff coefficient
C_i = runoff coefficient from impervious areas
C_p = runoff coefficient from pervious areas
i = imperviousness fraction (ranges from 0 to 1)

Per the Los Angeles County Hydrology Manual, $C_i = 0.90$ and C_p is a function of Los Angeles County soil type and rainfall intensity. Los Angeles County soil types observed on the site

include 020, 097 and 098. While the C_p value characteristic of these soils is also dependent on rainfall intensity, which varies during each storm event, a value of 0.1 is typically assumed for small to moderate storms. Because small to moderate storms make up the majority of average annual rainfall volume, this value is appropriate for use as a long term average runoff coefficient consistent with the Hydrology Manual method. However, because the pervious and impervious runoff coefficients that make up the runoff coefficient equation are dependent on many site-specific parameters, the runoff coefficient equation used in modeling should be determined on a Project-specific basis. It is recognized that C_p for smaller storms may be zero, while for larger storms it may greatly exceed the long term average. Thus the water quality model should ideally estimate Project-specific pervious area runoff coefficients on a storm-by-storm basis, using a robust method that accounts for more detailed hydrologic processes and antecedent conditions. Such a method should consider the range of conditions that could occur and select appropriately conservative values to account for uncertainty.

Continuous simulation modeling, using the Storm Water Management Model (SWMM), was conducted for Project drainage areas to generate appropriate storm-by-storm pervious and impervious runoff coefficients to use in the runoff coefficient equation for each storm event. A modified version of SWMM 4.4h was used that segregates rainfall into storm events (using algorithms identical in performance to GeoSYNOP, described above), tracks the fate of rainfall to losses (i.e. infiltration, evapotranspiration) and runoff for each storm, and tabulates runoff coefficients by storm event. The majority of the SWMM modeling parameters assumed for this analysis are shown in Table B-3.

Table B-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
Pervious Manning's n		0.25
Drainage area modeled for C determination	acres	Actual drainage areas used, sub-divided by soil-group areas; see and accompanying description.
Shape		Rectangular, 500 ft flow path length for pervious areas, 250 ft flow path length for impervious area (represents typical overland flow path lengths, not a very sensitive parameter)
Slopes	ft/ft	0.05 (represents average of relatively flat landscaping, streets, and roofs)
Evaporation	in / month	60% of reference ET values contained in Table B-5.
Soil properties / infiltration		Green-Ampt soil parameters as shown in

SWMM Runoff Parameters	Units	Values
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)

Drainage basins were divided into sub-catchments based on hydrologic soil group (HSG). The HSGs were identified based on catchment-specific soils distributions obtained from the Natural Resources Conservation Service (NRCS) Soil Survey of the Antelope Valley Area (Survey CA675), and were divided as follows for modeling purposes: HSG A/B, HSG C, and HSG D/Other. Group A soils were grouped with B soils because of the extreme scarcity of soil group A on the Project site and the similarity in infiltration parameters between A and B soils. Soil units that are not assigned an HSG in the Soil Survey were grouped with D soils because they are somewhat scarce and, according to the Soil Survey, have similar infiltrative characteristics to D soils. Runoff results were then weighted by area and combined to obtain a composite pervious area runoff coefficient for each drainage basin for each storm event. The soils distributions assumed for this modeling effort are shown in Table B-4

Table B-3: SWMM Runoff Block Modeled Soils Distribution by Drainage Basin

	Basin A		Basin B		Basin C		Basin D		Basin E		Media Filtration	
Soil Group	**Acres**	**% Total**	**Acres**	**% Total**	**Acres**	**% Total**	**Acres**	**% Total**	**Acres**	**% Total**	**Acres**	**% Total**
HSG A/B	150.0	84.8%	6.9	4.7%	26.6	8.7%	39.5	23.3%	26.1	64.6%	14.1	59.0%
HSG C	25.7	14.5%	138.3	95.3%	277.2	90.7%	130.0	66.0%	9.0	22.3%	9.6	40.2%
HSG D/Other[1]	1.2	0.7%	-	-	1.9	0.6%	-	-	5.3	13.1%	0.2	0.8%
Total	*176.9*		*145.2*		*305.6*		*169.6*		*40.4*		*23.9*	

[1] Hydrologic soil group not assigned for soil unit TsF (Terrace Escarpments) in NRCS soil survey. Properties assumed to be similar to Group D soil.

[2] On and off-site impacts only displayed in this table. See Figure 2-2 for the impact boundary. Off-site areas draining to basins that are not within the impact boundary (this mainly applies to off-site areas draining to Basin D) are not included here.

Soils in the project area will exhibit a range of infiltrative capacity, depending on soil type and condition. Soil type or group can be used to estimate a typical range in soil parameters, such as the Green-Ampt parameters, while soil condition (pre- or post-development) may be used to select the most appropriate parameters within the range. Hydrologic soil groups (HSG) and soil texture classes provided in the Soil Survey were used to classify soils on the Project site into the 3 soil groups shown in Table B-4 above (A/B, C, and D/other) and assign typical ranges of soil parameters to these soil groups. Green-Ampt suction head and initial moisture deficit values for each HSG were based on the soil texture class reported by the NRCS soil survey for the dominant texture class within the respective HSGs (Table B-5). Green-Ampt saturated hydraulic

conductivities for each soil group were determined on an area weighted basis as the average of: 1) the low range of saturated hydraulic conductivity (K_{sat}) reported in the NRCS soil survey, 2) infiltration rates by HSG recommended by Musgrave (1955), and 3) characteristics infiltration rates for LACDPW soil classes interpreted from Appendix C of the LA County Hydrology Manual (Table B-6). Spatial analyses were used to composite these values by tributary area. It has been assumed that compaction during construction will reduce the hydraulic conductivity by 25% in the post-development condition in areas where construction is planned. While localized effects of incidental compaction may be greater, this assumption is believed to represent a reasonable estimate of drainage basin-wide reduction in long term infiltration rate considering that not all pervious areas will be subjected to incidental compaction and vegetation and other natural process tend to restore infiltration rates with time.

Table B-4: Green-Ampt Soil Parameters

Hydrologic Soil Group	Prevalent Soil Texture Class	Suction Head[2] (in)	IMD[2] (in/in)
A/B	Loam	8	0.32
C	Silty Clay Loam	8	0.29
D[1]	Terrace Escarpment	12	0.15

[1] Hydrologic soil group not assigned for soil unit TsF in NRCS soil survey. Properties assumed to be similar to Group D soil.
[2] Estimated based on texture class from Rawls, et al., (1983)

Table B-5: Infiltration Rates by Basin Tributary Area

Basin	Hydrologic Soil Group	Pre- Development Ks (in/hr)	Post- Development Ks (in/hr)
Water Quality Basin A	A/B	0.39	0.29
	C	0.21	0.16
	D[1]	0.13	0.10
Water Quality Basin B	A/B	0.39	0.29
	C	0.21	0.16
Water Quality Basin C	A/B	0.38	0.29
	C	0.21	0.16
	D[1]	0.12	0.09
Water Quality Basin D	A/B	0.38	0.28
	C	0.21	0.16

Basin	Hydrologic Soil Group	Pre- Development Ks (in/hr)	Post- Development Ks (in/hr)
Water Quality Basin E	A/B	0.37	0.28
	C	0.19	0.15
	D[1]	0.11	0.08
Media Filtration	A/B	0.37	0.28
	C	0.19	0.15
	D[1]	0.12	0.09

Reference ET values for estimating actual ET rates was taken from Figure B-4 produced by the California Department of Water Resources. The Mission Village Project site is located in zone 14. Reference ET values for zone 14 are reproduced in Table B-7.

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 which will generally be planted with predominantly drought-tolerant vegetation.

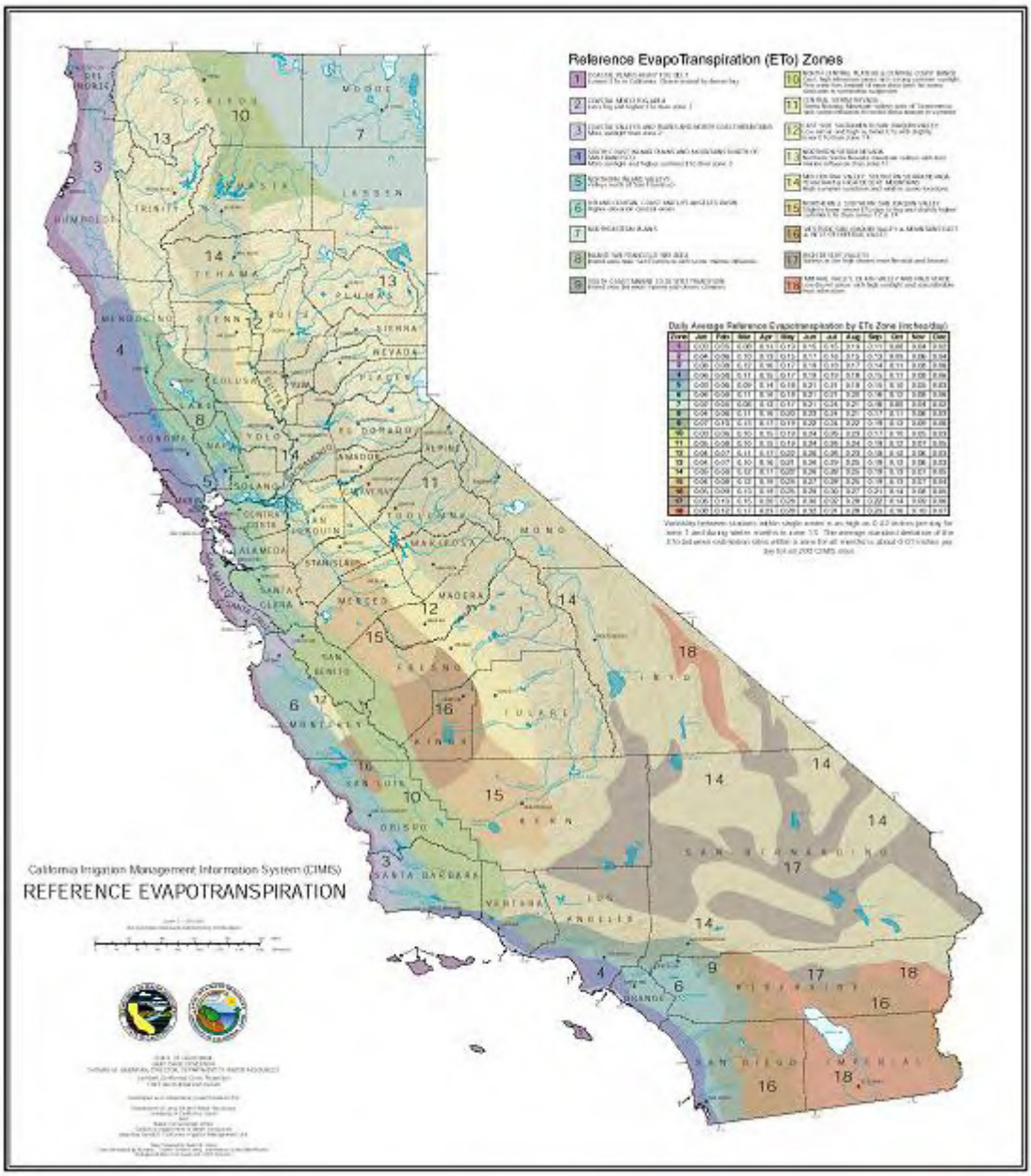

Figure B-4: Reference ET for CA Zones

Table B-6: 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 (year)		*365*	*57.04*	*34.22*

B.2.2.2. SWMM Runoff Coefficient Results

Using the SWMM Stormwater Modeling Methodology explained in Section B.2.3, the pervious and impervious runoff coefficients shown in (table) were obtained, and compared to the results using the LA County Hydrology Method. Runoff coefficients determined by SWMM modeling using the inputs as described above yielded the storm-weighted (weighted by storm over the entire period of record) runoff coefficients in Table B-2. These coefficients are compared to the runoff coefficients as calculated using the LA Hydrology manual method, assuming 100% imperviousness for the impervious runoff coefficient and 0% imperviousness for the undeveloped runoff coefficient.

Table B-7: SWMM Runoff Coefficients and Hydrology Manual Coefficients

Basin	Impervious Runoff Coefficient		Undeveloped Pervious Runoff Coefficient		Developed Pervious Runoff Coefficient	
	Model Methodology (used for WQ model)	LA County Hydrology Manual (for comparison purposes)	Model Methodology (used for WQ model)	LA County Hydrology Manual (for comparison purposes)	Model Methodology (used for WQ model)	LA County Hydrology Manual (for comparison purposes)
Water Quality Basin A	96.0	90	2.3	10	4.7	10
Water Quality Basin B	96.0	90	6.2	10	10.0	10
Water Quality Basin C	96.0	90	6.1	10	9.9	10
Water Quality Basin D	96.0	90	5.3	10	8.8	10
Water Quality Basin E	96.0	90	5.6	10	8.5	10
Media Filter	96.0	90	3.9	10	6.9	10

As is evident from Table B-2, the runoff coefficient for impervious areas calculated using the model method is higher, and thus more conservative, than the runoff coefficient calculated using the LA County Hydrology Manual method. This is because a higher runoff coefficient yields higher runoff volumes, thus more conservatively estimating the impacts of adding impervious area to the Project site. The pervious runoff calculations estimated using the model methodology yielded lower runoff coefficients than the LA County method, which is also more conservative as it estimates lower runoff volumes from the Project site in the existing condition.

B.2.3. Land Use & Treatment BMPs

The delineation of land uses and areas within Mission Village were determined from the Vesting Tentative Tract Map (VTTM #61105) and subsequent GIS analysis for the developed Project conditions. The existing condition land uses were determined from GIS analysis of the Los Angeles County Department of Public Works (LACDPW) existing land use coverage. 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 stormwater constituents. Existing and developed conditions of the Project and associated off-site areas are summarized in Table B-8 and Table B-9, respectively.

Table B-8: Modeled Existing Conditions for Project & Off-site Impact Areas

Land Use	Development Area (acres)	
	Project Site	Off-Site
Agriculture	35.8	7.3
Gas and Oil Extraction Areas	655.6	3.4
Vacant	137.7	22.6
Total	*829.1*	*33.3*

Table B-9: Modeled Developed Conditions Project & Off-site Areas

Land Use	Development Area (acres)[1]	
	Project Site	Off-Site
Single family	145.9	
Multi-family	300	
Commercial	72.6	2.1[2]
Schools	9.5	
Recreation	12.5	
Roads	49.7	25.1
Park	29.0	
Open Space	196.3	
Water Quality Basin	13.7	6.1
Total	*829.1*	*33.3*

[1] Land use acreages may not exactly match the final programmatic land use description. All differences, unless noted, are minor and are not significant in water quality analysis results.
[2] Water Tanks are modeled as a commercial land use.

Included in the water quality analysis are 33.3 acres of off-site project areas. The off-site impact areas include the section of Magic Mountain Parkway that is being extended adjacent to the Mission Village Project area to the east toward The Old Road (19 acres), another section of Magic Mountain Parkway that is being extended to the west through the proposed Homestead Project (6.1 ac), off-site water tanks and access road located in the proposed Legacy Village project (2.1 ac), and regional water Basin D (6.1 acres). Areas draining to project BMPs but not included in the water quality analysis consist of off-site open space areas in the proposed Legacy Village and Entrada Projects, existing single family dwellings along Westridge Parkway (27 ac) and the existing Stevenson Ranch High School (54 ac). The impacts of these areas are to be addressed in water quality analyses for other projects and in a cumulative analysis.

Table B-10 provides the modeled land uses and percent impervious values used to represent the existing and developed project and off-site conditions. The modeled land uses were based on the most representative land use within the available data sets (see Section B.2.5).

Table B-10: Modeled Land Uses and Percent Imperviousness

Land Use	**Modeled Percent Impervious[1]**	**Modeled Land Use**
Existing Land Uses		
Agriculture	2%	Agriculture
Oil and Gas Extraction[2]	10%	Light Industrial/Vacant[2]
Vacant	1%	Open Space
Proposed Land Uses		
Single family	42%	Single Family Residential
Multi-family	74%	Multi-family Residential
Commercial	91%	Commercial
Schools	82%	Education
Recreation	50%	Education
Roads	91%	Transportation
Park	10%	Open Space
Open Space	1%	Open Space
Water Quality	100%	Water[3]

[1] Percent impervious values are based on the LA County Hydrology Manual except for Recreation which was estimated by Psomas (personal communication) based on knowledge of likely development patterns.
[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] The 'Water' land use has no EMC land use associated with it as this is not a pollutant-generating source.

The majority of the Mission Village Project will be treated in extended detention basins. Five dry extended detention basins (DEDBs) will be used at the downstream ends of the developed catchments to provide treatment of runoff in the developed condition (see section 5.3 of the WQTR body for more information). Bioretention BMPs will be used as distributed BMPs to provide on-site treatment of a fraction of commercial and multi-family land use. These BMPs are not included in the water quality analysis because their extent and placement is not yet determined and they will only have beneficial impacts on overall results. Small portions of the project and the off-site areas will be treated with media filtration.

B.2.4. Stormwater Runoff Pollutant Concentrations

Stormwater monitoring data collected by the Los Angeles Department of Public Works (LACDPW) was used to derive estimates of pollutant concentrations in runoff from urban land uses. The existing conditions of the Mission Village Project site contain agricultural uses. Stormwater monitoring data collected by Ventura County was used to estimate stormwater pollutant concentrations for agricultural land use.

B.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 and the Mission Village sub-division 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-11with a brief description of the site and when the monitoring data were collected.

Table B-11: 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
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

Station Name	#	Modeled Land Use	Site Description[1]	Years Monitoring Conducted
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)

B.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 present. Data through 2008 were available at the time of preparation of this report. 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 the Ventura County Watershed Protection District.

B.2.4.3. Data Analysis for Derivation of Land Use EMCs

The Los Angeles County Department of Public Works (LACDPW) 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 half 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 LACDPW.

In an effort to provide more reliable and accurate estimates of land use EMCs for the Project 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).

The final land use EMC input parameters developed for the Monte Carlo water quality model include the log-normal mean and log-normal standard deviation. Analyses demonstrate that nearly all of the Los Angeles County land use data sets can be more closely represented by the log-normal distribution than the normal distribution[1], which is consistent with findings by Pitt et al. (2004) based on analyses of the NSQD. Table B-13 summarizes the number of data points and the percent non-detects for the pollutants and land uses of interest that have sufficient data available for modeling based on the Los Angeles County data set. While data may be available to develop descriptive statistics for other pollutants (e.g., organics, other metal constituents, trash), reliable land use EMCs statistics could not be computed due to statistically insufficient number of detected results or due to the use sampling techniques not amenable to estimating representative EMCs (e.g., catch basin clean-outs in the case of trash). Also, the availability of BMP effluent quality data similarly limits the number of pollutants that can be effectively modeled; i.e., other pollutants (e.g., organics, other metal constituents) may have land use EMC data available but not BMP effluent data.

[1] Statistical distribution test results reported by Los Angeles County also confirm this assessment, as summarized by Table 4-14 found at http://LACDPW.org/wmd/npdes/Int_report/Tables/Table_4-14.pdf.

B.2.4.4. Example Data Set

To illustrate the statistical methods used to obtain land use EMCs, the LACDPW 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 B-12 describes the data according to the number of censored and uncensored values in the example data set.

Table B-12: 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 B-5 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.

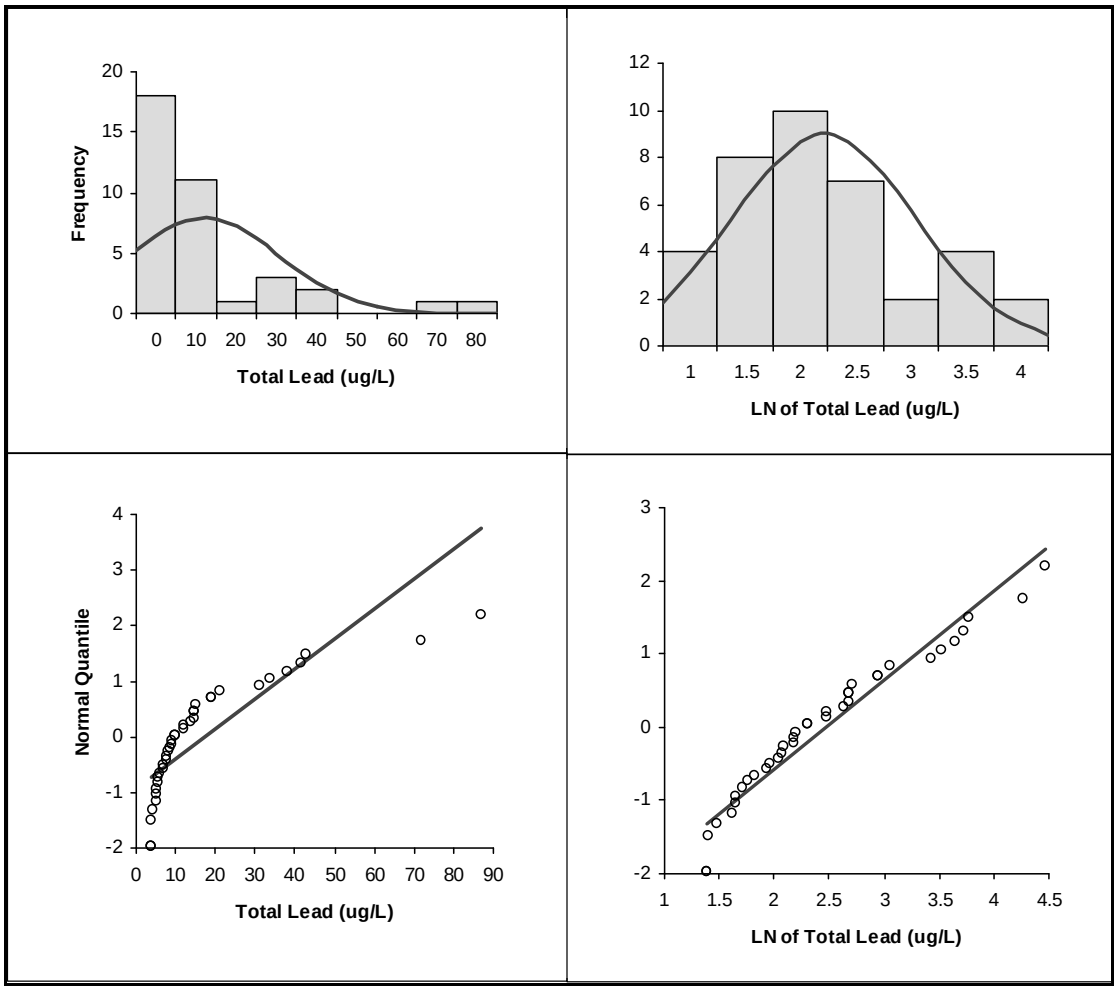

Figure B-5: Histograms and Probability Plots of Transportation Total Lead Data in Arithmetic and Lognormal Space

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 B-6 illustrates the results of the application of the plotting position method 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 ith 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 ith observation of the n_j censored values below the j detection limit.

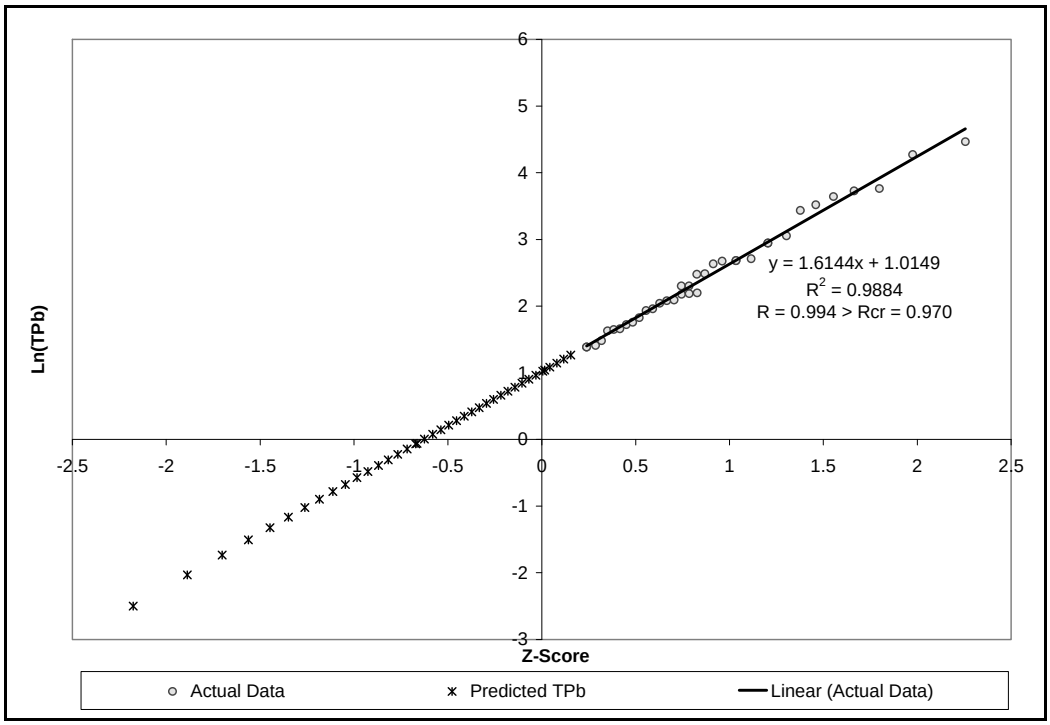

Figure B-6: Probability Plot of the Uncensored and Predicted (Censored) Total Lead Transportation EMCs

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 (20,000 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 B-7 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.

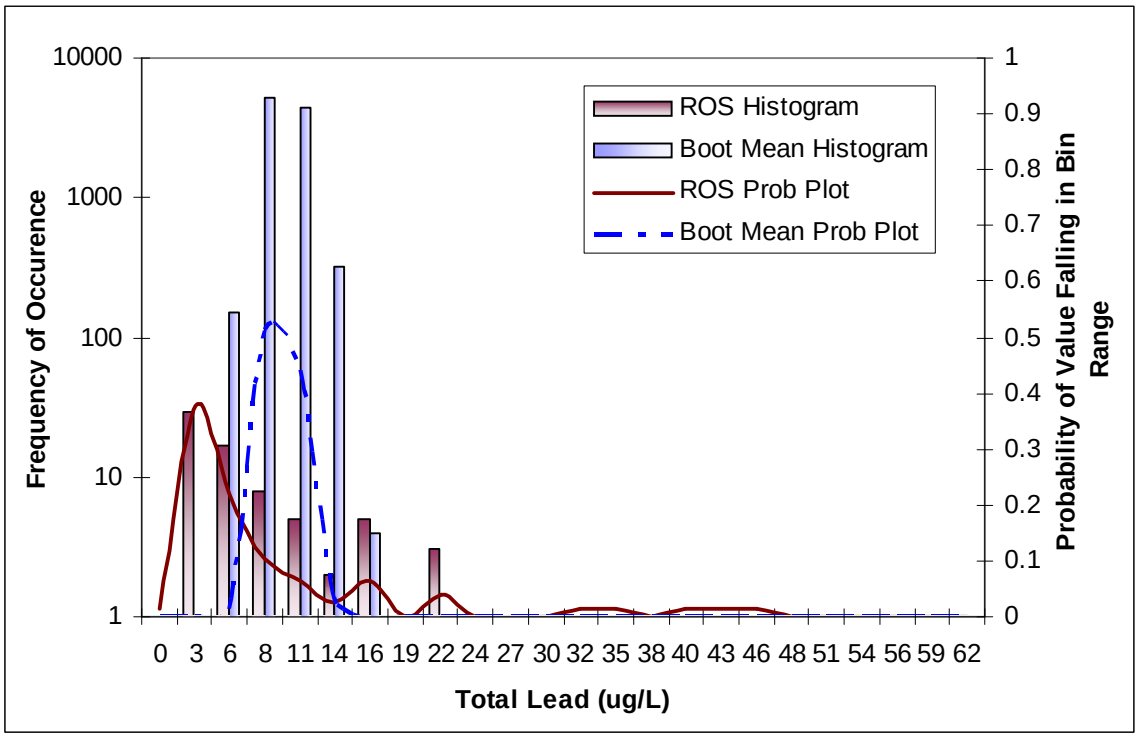

Figure B-7: Comparison of the Distribution of ROS Method Total Lead Data and the Bootstrap Means of the ROS Data.

The majority of the LACDPW 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. Table B-12 summarizes the lognormal descriptive statistics, and Table B-14summarizes the resulting arithmetic means. The latter data represent the land use specific pollutant EMCs in the Monte Carlo water quality model.

Table B-13: Summary of Number of Data Points and Percent Non Detects for Los Angeles County Land Use EMC Data

Land Use		TSS	TP	NH3-N	NO3-N	NO2-N	TKN	Diss Cu	TotPb	Diss Zn	TotAl	Cl
Commercial	Count	31	32	33	33	7	36	40	40	40	33	33
	% ND	0%	3%	21%	21%	0%	3%	15%	45%	10%	24%	0%
Industrial	Count	53	55	57	56	9	57	61	61	61	57	57
	% ND	0%	5%	19%	5%	16%	0%	15%	43%	7%	14%	0%
Transportation	Count	75	71	74	75	10	75	77	77	77	75	76
	% ND	0%	1%	27%	20%	0%	0%	1%	52%	6%	13%	4%
Education	Count	51	49	52	51	15	51	54	54	54	54	52
	% ND	0%	0%	35%	24%	0%	0%	19%	76%	39%	7%	4%
Multi-Family Residential	Count	45	38	46	46	11	50	54	54	54	54	46
	% ND	2%	3%	24%	26%	0%	0%	37%	72%	41%	20%	8%
Single Family Residential	Count	41	42	44	43	15	46	48	48	48	46	43
	% ND	0%	0%	16%	30%	0%	0%	40%	52%	81%	20%	2%
Vacant / Open Space	Count	48	46	48	50	35	50	52	57	52	49	50
	% ND	2%	41%	67%	2%	70%	0%	90%	88%	96%	37%	0%
Agriculture (Ventura County)	Count	24	6	25	23	7	21	25	25	25	6	16
	% ND	13%	0%	48%	9%	0%	10%	0%	0%	0%	0%	19%

Table B-14: Lognormal Statistics for Modeling Pollutant Concentrations from Land Uses

Land Use		TSS	TP	NH3	NO3	NO2	TKN	DisCu	TotPb	DisZn	TotAl	Cl
Commercial	Mean	4.00	-1.19	-1.08	-0.947	-2.63	0.698	2.25	1.45	4.87	5.66	3.44
	St. Dev	0.634	0.733	1.60	0.832	1.17	1.04	0.723	1.47	0.575	1.92	0.969
Industrial	Mean	5.07	-1.30	-1.14	-0.532	-2.67	0.803	2.39	1.68	5.57	6.25	2.27
	St. Dev	0.798	0.860	1.12	0.891	0.788	0.711	0.818	1.49	0.978	1.54	0.620
Transportation	Mean	3.97	-0.909	-1.71	-0.863	-2.69	0.373	3.24	1.60	5.10	5.85	1.58
	St. Dev	0.878	1.03	1.20	1.06	0.755	0.690	0.693	1.12	0.776	1.07	0.718
Education	Mean	4.14	-1.35	-1.92	-0.888	-3.05	0.359	2.20	0.770	4.13	6.30	2.06
	St. Dev	0.961	0.538	1.41	0.886	1.22	0.599	0.773	1.02	0.626	0.915	1.54
Multi-Family Residential	Mean	3.20	-1.75	-1.26	-0.401	-2.94	0.391	1.76	0.827	3.96	5.48	1.71
	St. Dev	0.988	0.777	1.07	1.28	1.20	0.624	0.687	1.17	0.882	0.891	1.69
Single Family Residential	Mean	4.24	-1.13	-1.20	-1.17	-3.14	0.776	1.91	1.85	2.49	5.48	1.49
	St. Dev	1.08	0.672	0.996	1.35	1.24	0.787	0.811	1.07	1.28	1.30	0.640
Vacant / Open Space	Mean	3.44	-3.20	-3.18	-0.031	-3.95	-0.354	-1.83	-0.375	3.24	5.07	1.87
	St. Dev	1.97	1.44	1.37	0.615	0.494	0.792	1.59	1.72	0.438	1.68	0.249
Agriculture (Ventura County)	Mean	6.56	0.930	-0.080	2.59	-1.17	1.58	2.64	2.65	3.06	7.92	3.93
	St. Dev	0.654	1.38	0.976	0.654	0.725	0.639	0.863	1.23	1.03	1.04	0.926

Table B-15: Resulting Arithmetic Means from Lognormal Statistics used for Modeling Pollutant Concentrations[1]

Land Use	TSS	TP	NH3	NO3	NO2	TKN	DisCu	TotPb	DisZn	TotAl	Cl
Commercial	67	0.40	1.2	0.55	0.14	3.4	12	12	153	1,810	50
Industrial	219	0.39	0.60	0.87	0.09	2.9	15	16	422	1,696	12
Transportation	78	0.68	0.37	0.74	0.09	1.8	32	9.2	222	611	6.3
Education	100	0.30	0.40	0.61	0.10	1.7	12	3.6	75	830	26
Multi-Family Residential	40	0.23	0.50	1.5	0.11	1.8	7.4	4.5	78	358	23
Single Family Residential	124	0.40	0.49	0.78	0.09	3.0	9.4	11	27	562	5.4
Vacant / Open Space	217	0.12	0.11	1.2	0.02	1.0	0.6	3.0	28	650	6.7
Agriculture (Ventura County)	877	6.59	1.5	17	0.40	6.0	20	30	36	4,718	78

1 – Calculated from values provided in Table B-14

B.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.

Capture efficiency calculations used to estimate results for the individual storms and volume reduction estimates are discussed in Section B.2.6.1. Pollutant removal estimates are described in Section B.2.6.2.

B.2.5.1. BMP Capture Efficiency and Volume Reduction

Volume Based BMP Capture Efficiency

Drainage basins were simulated in SWMM 4.4h using inputs described above in Table B-3. The continuous runoff hydrograph computed from the drainage basins was then routed through proposed water quality basins using standard SWMM storage routing algorithms. Water quality basins were represented using realistic stage-storage-discharge relationships and included simulation of incidental infiltration below the basins (as described below). Water overflowing the basins was considered to be bypassed.

Results from the SWMM simulations were then post-processed in a modified SWMM engine to yield capture efficiency and volume reduction for each storm. The modified SWMM engine tracks rainfall, runoff, and treatment system routing in the context of individual storm events. In the RAIN block, storm events are delineated from within the continuous rainfall record using algorithms identical in performance to GeoSYNOP, described herein; depth and start and stop times of each event are recorded. In the RUNOFF block, the rainfall volume associated with each event is tracked between the volume lost and that which runs off; start and stop times of runoff for each storm are recorded for later use. Finally, in the STORAGE/TREATMENT block, the runoff volume associated with each storm event is tracked between treated volume, bypassed volume, infiltrated volume and evaporated volume. This constitutes a volume-tracking approach of calculating capture efficiency and volume reduction by storm event. The result of these algorithms is a capture efficiency and volume reduction for each storm in the period of record.

Resulting long-term average annual capture efficiency for each WQ basin is shown in Table B-16.

Flow Based BMP Capture Efficiency

Off-line BMPs (BMPs with a diversion structure for flows up to the treatment capacity) that provide treatment even when a fraction of the runoff is bypassed achieve higher capture

efficiency than in-line BMPs. Media filtration units function as off-line BMPs. 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. 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.

While the Newhall Ranch Sub-Regional Stormwater Mitigation Plan sizing standard for flow-based BMPs is 0.3 inches per hour, this value must be adjusted in the calculation method described above. Precipitation data used in the above method are hourly and the 0.3 inch per hour sizing standard is intended to account for intra-hour peak precipitation intensities. Therefore if it is applied to hourly intensities (inherently smoothed to be lower than intra-hour intensities), estimated capture efficiency would be biased high. For flow-based BMPs, the overriding Newhall Ranch Sub-Regional Stormwater Mitigation Plan performance standard of 80 percent average annual capture of stormwater runoff was used as the default and the design hourly precipitation intensity was adjusted to 0.19 inches per hour to yield this long term average.

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.

BMPs specifically designed to infiltrate stormwater runoff are not included in the stormwater management system. However, data in the International BMP Database have shown that as much as 30 percent of stormwater volume captured by dry extended detention basins 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. Volume reductions in the extended detention basins were estimated for each basin using long term continuous simulation in SWMM and incorporating the proposed dimensions of the basins. All basins are located in areas of

Group A (loamy sand, Basin A only) or Group B (sandy loam) soils (NRCS Soil Survey); the infiltration rate in basins was modeled as 0.3 inches per hour, which is believed to be representative of long-term infiltration rate in sandy loam type soils, accounting for some loss in hydraulic conductivity with long term operation. Significantly higher values may be actually be encountered in basins underlain by sand but were not modeled to avoid potentially overestimating volume reductions. High groundwater in the vicinity of Basin D may limit infiltration, thus no volume reduction is assumed in this basin. Evapotranspiration is expected to occur in vegetated basins as well but volume reduction contributions are anticipated to be much less significant than infiltration for wet weather routing calculations, and was not included in volume reduction estimates. Long term average volume reductions estimated in water quality basins are shown in Table B-16 as a percentage of captured volume.

Media filtration units are not designed to promote infiltration or evaporation and were thus modeled with no volume reduction.

BMP Capture Efficiency and Volume Reduction Results

The estimated average capture efficiencies for the dry extended detention basins in the Mission Village treatment system are shown in Table B-16. The capture efficiency methods described above were used to estimate the fraction of runoff captured by each type of BMP for each storm in the period of record.

Table B-16: Average BMP Percent Capture Estimates for the Water Quality Basins

BMP	Tributary Areac[1] (ac)	% Impervious	Basin Storage Volume (ac-ft)[1]	Estimated Capture Efficiency (%)	Modeled Volume Reduction[2] (%)
WQ Basin A	177.7	44.3	8.6	80	14.3
WQ Basin B	145.1	33.9	7.6	80	21.3
WQ Basin C	371.4	52.7	23.1	80	11.9
WQ Basin D[3]	735.2	43.2	41.0	80	0[4]
WQ Basin E	40.4	84.3	3.4	80	13.8

[1] Basin Storage Volume includes an additional 5% above required volume to account for sediment accumulation over time.
[2] Volume reduction estimates for Project water quality basins are believed to be conservative as they are based on a relatively simple model representation that does not account for all volume reduction processes. This simple representation was used for the purposes of remaining conservative in the estimation of pollutant load reductions achieved by Project BMPs. In contrast, volume reduction estimates reported in Section B.5 (LID Equivalency Analysis) are based on a more detailed representation of Project water quality basins that attempts to account for additional volume reduction processes including soil soaking and drying and the potential installation of gravel drainage layers and amended soil layers in the bottoms of water quality basins. Therefore, the volume reduction estimates reported in this section are not directly comparable to the volume reduction estimates reported in Section B.5.
[3]Basin D was sized as a regional basin with a total tributary area of approximately 735 acres. Overall percent capture assumed to be 80% based on appropriate sizing of the basin for all tributary area.
[4] High groundwater conditions under Basin D do not support infiltration.

As Table B-16 shows, volume-based treatment BMPs will be sized such that an overall capture efficiency of 80 percent is achieved for the treatment of stormwater runoff from the Project on an average annual basis.

Capture efficiency for media filtration was estimated as 80 percent on an average annual basis using the methodology described above.

B.2.5.2. BMP Pollutant Removal

BMP effluent quality, like land use EMCs, is highly variable. To account for this variability, effluent quality data were analyzed and descriptive statistics were generated by means of a technique similar to that used to generate land use EMCs. The descriptive statistics generated were used as BMP effectiveness inputs to the Monte Carlo model.

The International Stormwater BMP Database (www.bmpdatabase.org) is a comprehensive source of BMP performance information. The 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. Research on characterizing BMP performance suggests that effluent quality rather than percent removal is more reliable in modeling stormwater treatment (Strecker et al. 2001). Schueler (1996) also found in his evaluation of detention basins and stormwater wetlands that BMP performance is often limited by an achievable effluent quality, or "irreducible pollutant concentration;" acknowledging that a practical lower limit exists to which stormwater pollutants can be removed by a given technology. While there is likely a relationship between influent and effluent for some BMPs and some constituent concentrations, the analyses that have been conducted to date do not support flat percent removal values relative to influent quality. As such, the distribution of effluent concentrations of stormwater BMPs reported in the BMP Database are used to estimate BMP performance for water quality modeling of the proposed conditions.

Future studies may support a refinement to the approach of effluent concentration-based BMP performance modeling, such as the development of more complex influent-effluent relationships. However, it should be noted that the stochastic modeling approach accounts for, at least in part, the uncertainty of not knowing the relationship between influent and effluent concentrations since the BMP effluent distributions are based on a variety of BMP studies with a wide-range of influent concentrations, representing a variety of tributary drainage area land use characteristics. Furthermore, the Monte Carlo model employed only accounts for pollutant reductions if the predicted influent is greater than the achievable effluent quality estimated for the modeled BMP (i.e. effluent equals influent [or land use-based] concentrations up until the influent concentration exceeds the effluent concentration). Therefore, influent (or land use EMC-based) concentrations are considered by the model since they are directly used to determine whether or not treatment occurs.

Similar to the estimation of land use EMCs, final BMP effluent values used were determined using a combination of regression-on-order statistics and the "bootstrap" method. Log-normality was assumed for BMP effluent concentrations. This assumption was confirmed through goodness-of-fit tests on the BMP effluent concentration data, where it was found that 41% of the BMP data sets fit the lognormal distribution and the remaining data sets fit this distribution better than the normal distribution. Table B-17 summarizes the number of data points (individual storm events) and percent non-detects for the pollutants and BMP types of interest for which sufficient data were available. Table B-18 summarizes the log-normal statistics that will be used in the water quality model, and Table B-19 summarizes arithmetic descriptive statistics for those data sets.

BMP effluent concentrations are assumed to be limited by an "irreducible effluent concentration," or a minimum achievable concentration. Lower limits are currently set at the 10th percentile effluent concentration of BMP data in the International BMP Database for each modeled BMP type for which the BMP data show statistically significant differences in influent and effluent means. If the differences are not statistically significant, the 90th percentile is used as the minimum achievable effluent concentration, which essentially assumes no treatment. Table B-19 summarizes the irreducible effluent concentration estimates used by for water quality modeling of the proposed condition.

Detention basin values were estimated using the above procedure on the ASCE/USEPA International BMP Database data (ASCE, 2003). Infiltration BMPs are assumed to provide no treatment for water that either overflows the BMP or bypasses the BMP. Pollutant removal is only simulated for those pollutants with available data from the International BMP Database. In instances where data are not available for a parameter (e.g., nitrite-nitrogen and chloride), no concentration reduction was assumed for that parameter. However, load reductions may still be estimated as a result of volume reductions.

Effluent concentrations for media filtration BMPs have been developed from ASCE/USEPA International BMP database. Table B-18 shows the performance descriptors used to model media filters. No treatment was assumed for nitrite (NO_2), total aluminum, and chloride, so these constituents are not included on the following summary charts even though they were included in the model.

Table B-17: Summary of Number of Data Points and Percent Non-Detects for BMP Effluent Concentration Data from the International BMP Database

BMP		TSS	TP	NH3	NO3	TKN	Diss Cu	Tot Pb	Diss Zn
Detention Basins	Count	177	174	13	103	97	152	146	153
	% ND	5%	11%	23%	10%	14%	0%	12%	1%
Media Filters	Count	358	280	38	232	229	258	251	254
	% ND	4%	9%	50%	7%	5%	3%	18%	6%

Table B-18: International BMP Database Arithmetic Estimates of BMP Effluent Concentrations

BMP		TSS	TP	NH3	NO3	TKN	Diss Cu	Tot Pb	Diss Zn
	units	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*
Detention Basins	Mean	40.5	0.19	0.08	0.77	1.61	11.6	23.1	47.6
	St. Dev	77.7	0.2	0.11	0.82	1.26	12.2	30.3	44.4
Media Filters	Mean	39.3	0.23	0.62	1.01	2.04	10.9	10.2	66.1
	St. Dev	96	0.38	1.08	1.05	2.18	12.9	15.7	102.3

Table B-19: International BMP Database Lognormal Statistics of BMP Effluent Concentrations

BMP		TSS	TP	NH3	NO3	TKN	Diss Cu	Tot Pb	Diss Zn
Detention Basins	Mean	2.930	-2.058	-2.992	-0.643	0.234	2.079	2.642	3.550
	St. Dev	1.242	0.883	0.996	0.873	0.693	0.861	1.000	0.791
Media Filters	Mean	2.700	-2.143	-1.174	-0.364	0.335	1.957	1.718	3.581
	St. Dev	1.394	1.149	1.179	0.860	0.871	0.934	1.102	1.105

Table B-20: International BMP Database Arithmetic Irreducible Effluent Concentration Estimates

BMP	TSS	TP	NH3	NO3	TKN	Diss Cu	Tot Pb	Diss Zn
	mg/L	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*
Detention Basins	3.04	0.019	0.208	1.684	3.16	24.26	1.64	101.3
Media Filter	2.76	0.04	0.006	2.029	3.78	23.45	0.61	5.92

B.2.6. Model Parameter Reliability & Assumptions

The input parameters for the water quality model fall into the following five main categories:

1. Rainfall data;
2. Runoff Coefficients;
3. Land Use data;
4. Stormwater pollutant EMCs; and
5. BMP performance estimates.

Each of the categories of input data is evaluated for accuracy in reflecting the project site conditions:

Rainfall Data: A comparison of yearly average precipitation at the LACDPW daily-recording Castaic Junction gauge to yearly average precipitation at the Newhall gauge indicates approximately 4 inches per year greater precipitation at Newhall (Elev. 1,243 ft) than at Castaic Junction (Elev. 1,005 ft). The Project has elevations that range from approximately 1,000 to 1,200 feet, therefore would likely be expected to experience rainfall depths somewhat less on average than experienced at the Newhall gauge and potentially greater than experience at Castaic Junction. The use of Newhall gauge rainfall data is results 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 dependent 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. 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, 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 LACDPW from land use characterization stations and generally do not have site design and source control BMPs that will be implemented for the Project. Therefore the stormwater pollutant EMCs estimated from the LACDPW 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 SWMM to provide results on a storm-by-storm basis for input into the water quality model, to accurately reflect the anticipated performance of the dry extended detention basins. Infiltration, evaporation and flows out of the basin were estimated using a stage-storage discharge curve excel model which incorporates infiltration, basin geometry, and dimensions to determine basin losses. Capture efficiency of media filtration was estimated using a spreadsheet model which determines capture based on a storm-by-storm basis using hourly rainfall intensity data for each storm to determine volume captured and bypassed for each storm. Capture efficiency and volume reduction are believed to be estimated accurately.

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 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 the Project. It is anticipated that the BMPs for the 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 Project.

B.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.

This method was applied to the Project using Project-specific inputs as described above. The modeled pollutants for the Project were:

- Total Suspended Solids (sediment)
- Total Phosphorus
- Ammonia
- Nitrate
- Nitrite
- Total Nitrogen[2]
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- Chloride

[2] TKN is modeled, but the results are not reported. Total Nitrogen results are reported from the sum of nitrate, nitrite, and TKN.

- Total Aluminum

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.

B.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 40 complete years in the available period of record from WY 1969 – 2008. The modeled average number of storm events per year (> 0.1 inches) was 15.2, with a standard deviation of 6.0. Figure B-8 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:

$$N_{storms} = 15.2 + 6.0\ R_N$$

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.

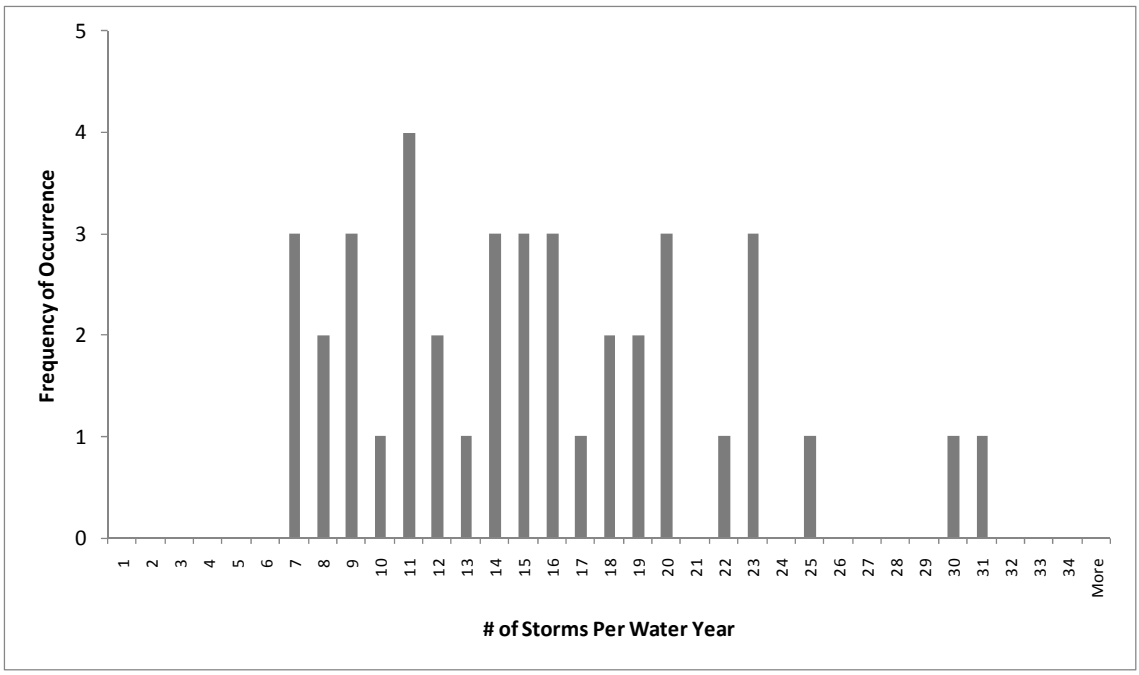

Figure B-8: Distribution of Storms per Year at the Newhall Gauge

Step 2 – Estimate the Volume of Storm Runoff from a Storm Event.
The runoff volume from each storm was estimated using the following equation:

$$V = R_v PA \qquad (5)$$

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 volumetric runoff coefficient for each storm event, 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:

$$V_{wshed} = \Sigma_{lu} V_{lu} = \Sigma_{lu} (R_{v\,lu} PA_{lu}) \qquad (6)$$

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 609 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).

B.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:

$$C_{land-use} = \exp\left(\mu_{\ln x} + \sigma_{\ln x} R_N\right) \qquad (7)$$

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:

$$V_{wshed} = V_{land-use1} + V_{land-use2} + \ldots + V_{land-usei} \qquad (8)$$

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:

$$L_{wshed} = V_{land-use1} C_{land-use1} + \ldots + V_{land-usei} C_{land-usei} \qquad (9)$$

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:

$Cap_{\%}$ = the volumetric percent capture of the BMP.

C_{eff} = the randomly determined effluent concentration from the BMP.

$VR\%$ = the percent reduction in effluent volume achieved by the BMP (see Section B.2.5.1.3).

C_{eff} was determined from sampling from the lognormal distribution described by the parameters contained in Table B-16. 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:

$$C_{wshed\_BMPs} = L_{wshed\_BMPs} / V_{wshed\_BMPs} \quad (12)$$

where:

$$V_{wshed\_BMPs} = V_{wshed} \times \left[1 - (Cap_{\%} \times VR\%)\right] \quad (13)$$

The results of step 4D (Eq 11) and step 4E (Eq. 12) were used to compute model results for developed conditions with treatment.

Figure B-9 provides a diagrammatic representation of these water quality calculations.

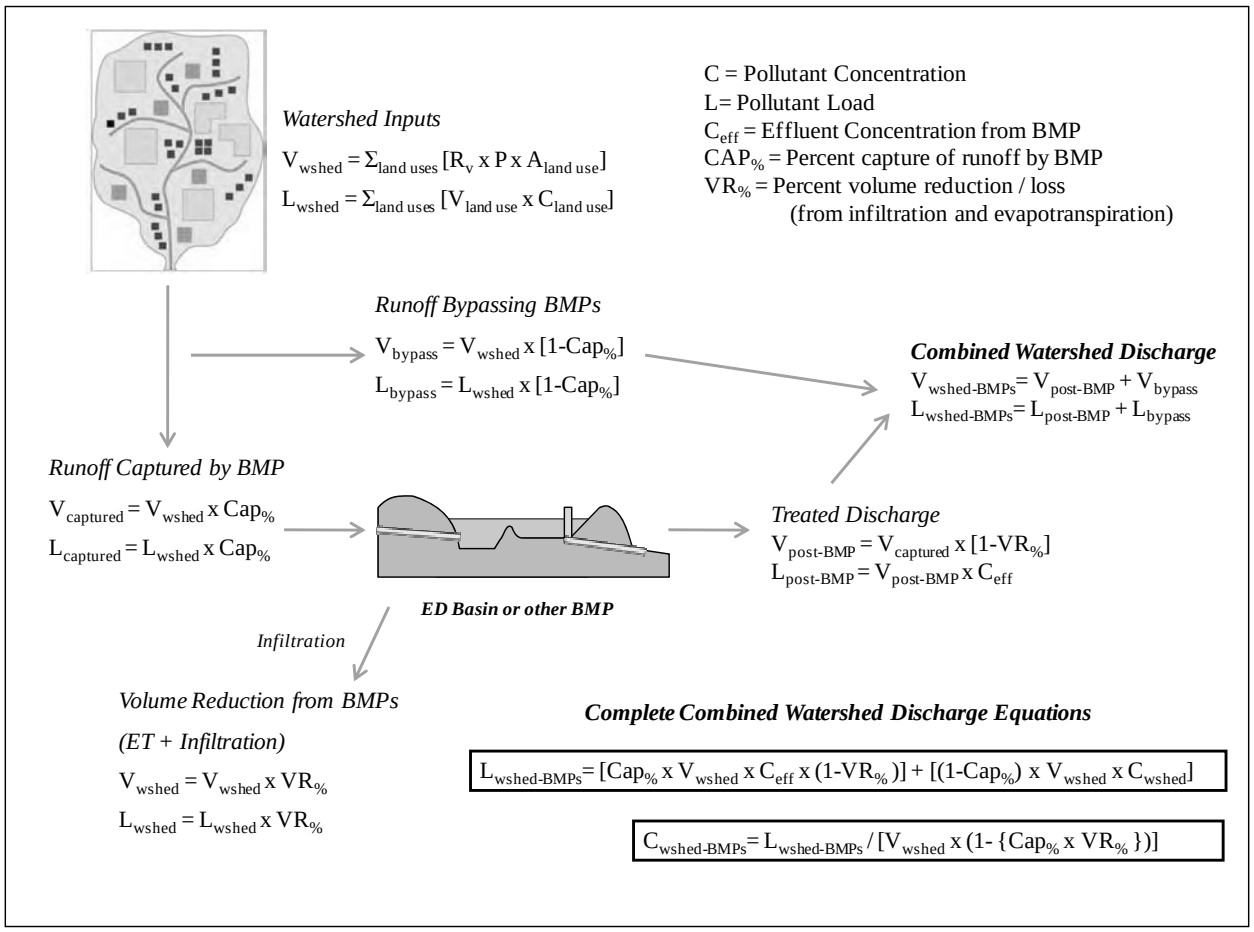

Figure B-9: Diagrammatic representation of water quality calculations

B.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.

B.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 B-11 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 B.2.7, 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 storms per year, the resulting average annual rainfall output from the water quality model is typically in the range of 17.4 to 17.6 inches per year. This is in close agreement with the average annual rainfall from runoff producing storms of 17.4 inches determined directly from the rainfall data (see Table B-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) <u>Assumption of No Correlation between Model Parameters</u>: The water quality model randomly selects stormwater pollutant concentrations independent of the storm depth or antecedent dry period for each storm event modeled. The validity of the assumption of independence between variables 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 tended to decrease 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 has been demonstrated between the stormwater EMCs and the rainfall depth or the antecedent dry period, with weak or no correlation observed for most pollutants and land-uses. On this basis, random selection of stormwater pollutant concentrations, independent of storm depth and antecedent dry period, is warranted for the water quality model.

Effluent concentrations are considered a 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 as described in Section B.2.5.3.

4) BMP Performance – Limiting Pollutant Removal Estimates to Available Data: Table B-18 and Table B-20present model parameters used for estimating BMP pollutant effluent concentrations. Pollutant removal is only simulated for those pollutants which have available data in the IBMPDB. 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.

B.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 0.6 to 1.8 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 changes in pollutant concentrations and loads.

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C. NEWHALL RANCH STORMWATER MONITORING DATA

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		10	1290	350	30	2230		136	0.4	0.4	2
E-Top of Chiquito Canyon		40	11700	970	150	6280	3	210	1.4	1	10

	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
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		170	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		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

D. 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 E

E. 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

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Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

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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)

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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

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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)

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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

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FIGURES

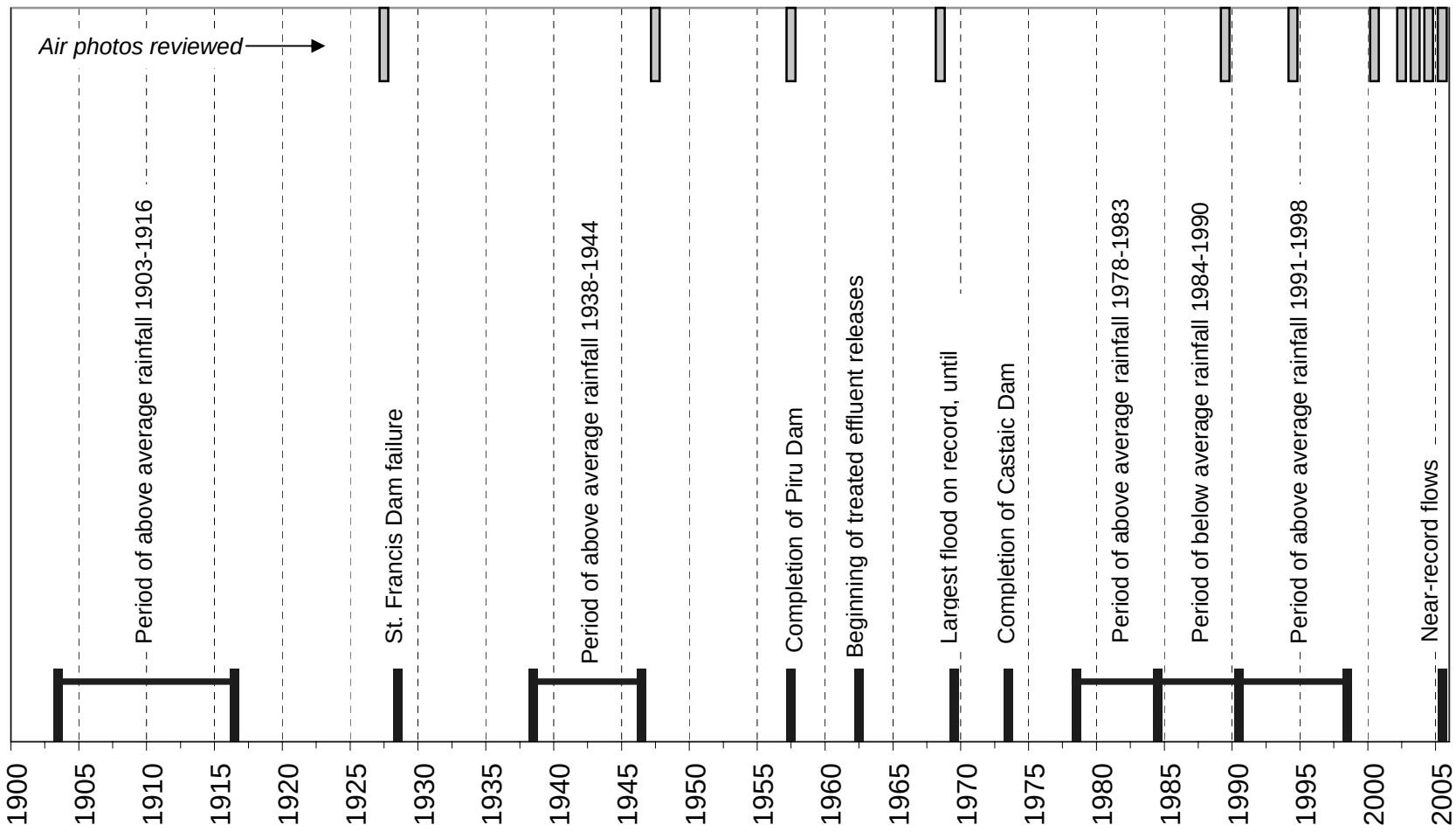

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Figure 1. Timeline of selected major events in the upper Santa Clara River, California. Also shown (at top) are the years for which aerial photographs were analyzed.

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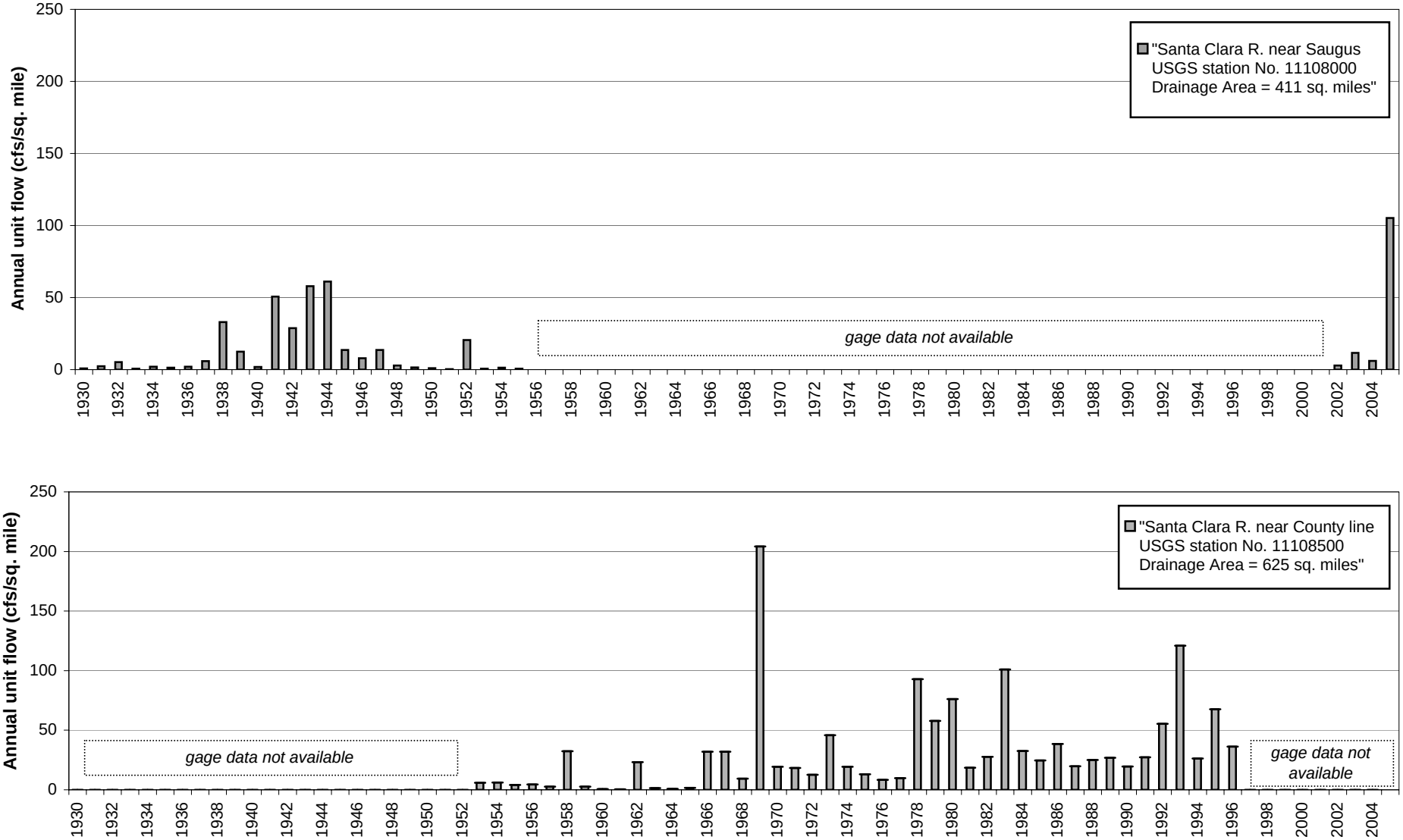

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Figure 2. Annual unit runoff (annual flow per square mile) for the Santa Clara River near Newhall at two separate gaging stations. Note that flow in drier years has increased since the 1960s, most likely due to release of treated effluent to the River.

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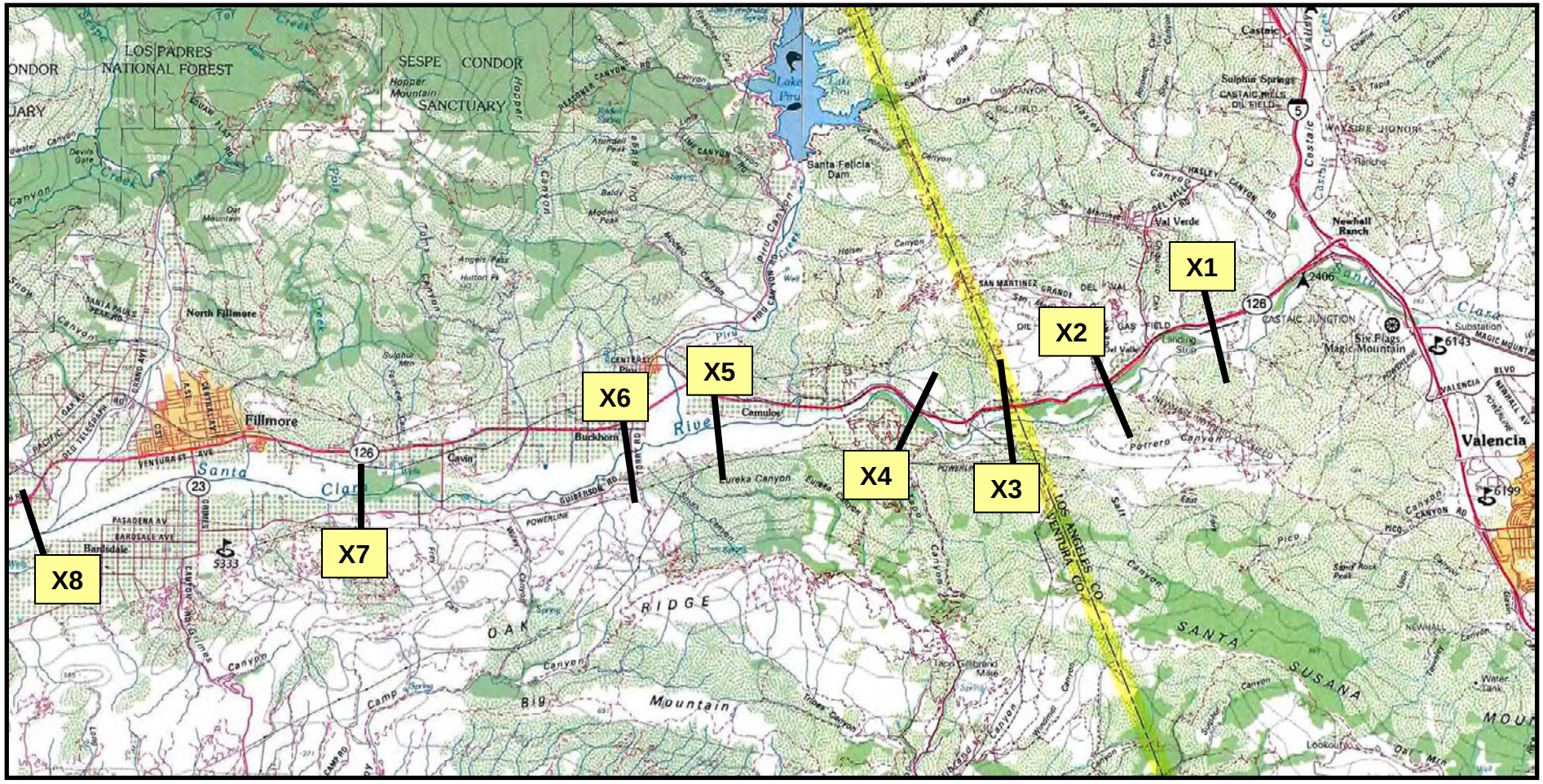

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Figure 3. Location of channel cross sections on the Santa Clara River, measured on aerial photographs.

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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.

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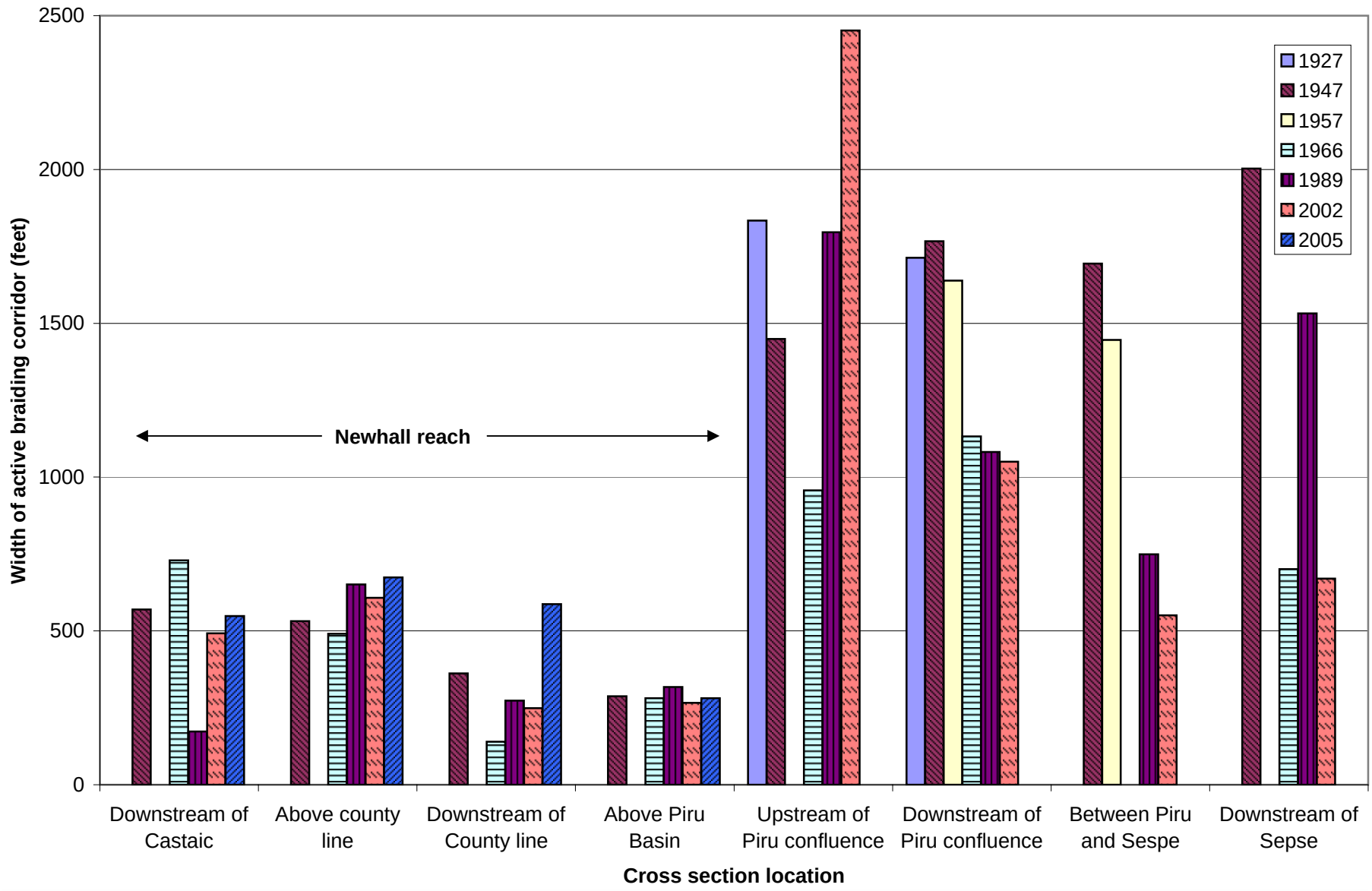

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Figure 5. Measurements of active braiding corridor width from aerial photographs, for cross sections on the Santa Clara River.

Photo cross section data.xls, Summary graph

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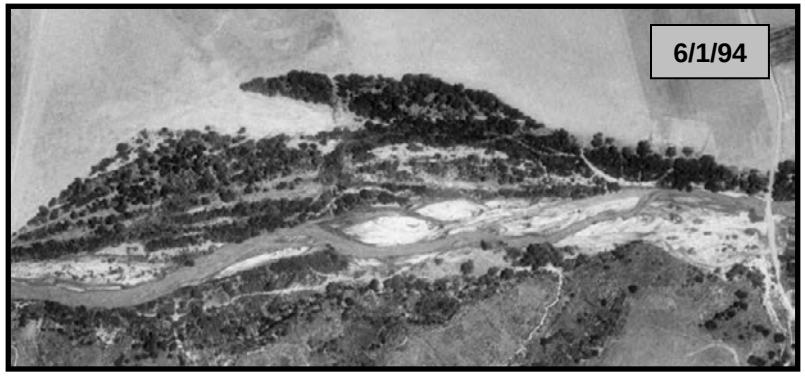

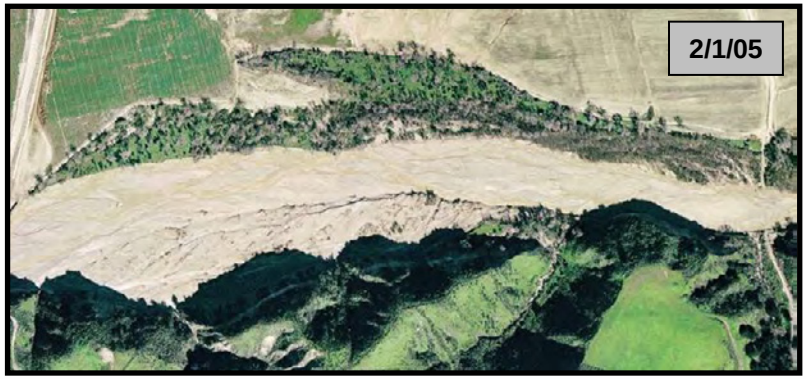

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Figure 6. Progression of aerial photographs downstream of Castaic Canyon, showing channel change between 1993 and 2005. Note that there was little change between 2000 and 2004, but the active corridor widened significantly in response to the 2005 events, and that channel traces within the active corridor were effectively erased. See appendix A for photo sources.

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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

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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

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APPENDIX F

F. BASIS OF DESIGN: LION CANYON

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M E M O R A N D U M

Date:	May 3, 2007
To:	Newhall Land Company
Organization:	PWA
From:	Amanda Heins, Andy Collison, Adam Parris and Jeffrey Haltiner
PWA Project #:	1820
PWA Project Name:	Newhall Ranch
Subject:	**Basis of Design: Lion Canyon**

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 Lion Canyon. 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 development projects.

The present channel system includes a combination of stable and unstable reaches, with extremely high 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 Legacy Village project area will result in increased peaks and duration of runoff (hydrograph modification) and within the Newhall Ranch and Legacy Village projects will result in a reduction in sediment supply. To be stable under future conditions, the stream channel will require a lower than existing gradient and somewhat increased flow capacity (width and depth). Lion Canyon 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 Lion Canyon channel design approach, analysis, and dimensions. 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.
- 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. We expect that 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 design represents an optimization of the above project goals. To minimize long-term maintenance and possible impacts to the restored habitat, we are proposing a more active initial restoration design. We are also assuming a relatively conservative equilibrium channel slope, based on the assumption that some minor channel aggradation is preferable to erosion. 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, we have designed it to require very infrequent maintenance and 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 project 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 project goals (a stable channel corridor that provides flood protection, habitat values, aesthetics, and appropriate access) are consistent with both the goals and requirements of all the various regulatory agencies, and the proposed plan has been developed to accomplish them.

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* – 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* – 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. Considering the complexity of actual channel morphology, we recommend using a combination of several different methods, 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 project needs. 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. We have also designed safety features into the channel structures to accommodate the level of uncertainty in final equilibrium slope without structural damage. We have adopted three different methods of calculating channel width, depth and slope that fulfill the LACDPW and LARWQCB requirements and are based on performance of channel designs in a variety of settings.

The channel width, depth and slope are interdependent. In keeping with standard river restoration design practices, we use a "slope first" design approach in which channel equilibrium gradient is determined, followed by width and depth. In this approach, the stable channel gradient is estimated. 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). These will be designed as a sequence of "step-pools." These step-pool structures are then designed to be hydraulically-stable during the design flow (capital flood or "Q_{cap}").

2. EXISTING GEOMORPHIC CONDITIONS ASSESSMENT OF LION CANYON

PWA conducted a geomorphic assessment of Lion Canyon in the summer of 2006. The channel shows widespread evidence of disturbance and erosion from concentrated runoff adjacent to the channel in the form of knickpoints (headcuts), gullies and failing banks. To support the qualitative geomorphic assessment, we conducted a hydraulic model analysis of the creek to compare channel capacity with the dominant discharge flow. By assessing whether the five-year flow was contained within the banks, we were able to quantitatively assess the degree of channel widening or incision. For example, reaches which appear visually stable and where the five-year flow is close to escaping out of bank onto an area of floodplain were classified as "stable". Reaches where flows much greater than the five-year flow do not reach close to a floodplain were classified as either incised or over-widened. The resulting classification is shown in Figure 1. Photo points are shown in Appendix A. In addition we measured equilibrium channel gradient upstream of a road crossing that acts as a grade control structure (boundary of Reaches 4 and 5). Measuring gradient in such locations gives a measure of the stable gradient under existing conditions. By comparing stable gradient with existing gradient we can estimate the elevation of channel drop that would need to be taken up by drop structures in order to create stable channel conditions under existing flow and sediment conditions.

Lion Creek can be generally divided into two sets of reaches (Reaches 1-4 and Reaches 5-7) based on degree of channel erosion, with the grade control structure at the existing road crossing providing the boundary. Downstream of the culverts, the channel is heavily eroded and the floodplain is disconnected and eroded. Upstream, the channel is relatively stable and well vegetated. The channel is maintaining a relatively steep gradient for a watershed of this size and with a sand bed. One reason for this is the high sediment delivery rate. The principal sediment source appears to be bed and bank erosion of the channel in the lower reaches, and a combination of channel and headwall erosion in the upper reaches. The eroding gullies that extend up into the canyon walls in many locations are an additional source of sediment.

Reach 1 is deeply incised and confined. The channel has an 8 foot knickpoint at the lower end (Appendix A-1) which is evidence of channel incision. The knickpoint is cut into alluvial deposits and is not considered stable (i.e., under existing conditions it will migrate headwards, undermining the banks upstream). Immediately upstream of the knickpoint, the northeastern bank is a high, oversteepened slope (shown in Appendix A-2) that is very vulnerable to channel erosion and toe undercutting under existing conditions. Under existing conditions, the gradient of Reach 1 is 5.3% but the equilibrium gradient is 2.9%. Thus to stabilize existing conditions requires 23 feet of vertical drop to be picked up in step-pool structures (approximately 7-8 structures assuming 3 feet of drop per structure). Under existing conditions, bank stabilization or channel realignment would also be required on the right (northeastern) bank. For proposed conditions, additional structures would be required to allow for higher flows and lower sediment yield.

Reach 2 is overwidened and has extensive gully erosion on the dissected floodplain terrace (Appendix A-3). Lateral migration has undermined the left (southwest) bank (Appendix A-4), creating an unstable

slope. Where the channel is not close to the high terraces, more stable conditions are found (Appendix A-5). Reach 2 has an existing gradient of 4.4%, compared to a stable gradient of 2.9% under existing conditions. Thus, 11 feet of drop would be required to stabilize and arrest channel downcutting for existing conditions (requiring approximately 4 drop structures), with additional structures required for proposed conditions. Under existing or proposed conditions we recommend stabilizing and regrading the southwest bank by laying the bank back to a stable gradient (approximately 3:1) and protecting the toe from scour with planted rip rap or an appropriate biotechnical stabilization treatment.

Reach 3 transitions from overwidened to incised and deeply confined (Appendix A-6). The confined section has a sharp eroding outside bend (Appendix A-7) and has eroded to bedrock. The incised conditions and resulting bank instability threaten several mature oak trees under existing conditions (Appendix A-8) on the top of the bank. This reach has an existing gradient of 4.4%, compared to a stable gradient of 2.9% under existing conditions. Thus 15 feet of drop would be required to stabilize for existing conditions (requiring approximately 5 drop structures), with additional structures required for proposed conditions. Both banks require stabilization under existing conditions, and such stabilization is likely to be challenging given the proximity to the existing oak trees. Given the difficulty of stabilizing the southwest bank under existing conditions without laying it back (which would likely require the removal of at least one oak tree), it may be necessary to either partially fill the channel (using 2-3 additional drop structures) to reduce the channel depth and bank height, or to fill the channel completely (using additional drop structures and erosion control at either end) and realign it across the floodplain in a more southerly location.

Reach 4 is a confined reach. The lower section (Appendix A-9) is straight and very narrow. Upstream the channel deepens and the banks have eroded to widen the channel, leading to a knickpoint intercepted by the current road crossing (Appendix A-10). The knickpoint is approximately 12 feet deep, indicating 12 feet of incision since the culverts were installed. Based on the apparent relatively new condition of the culverts, this indicates rapid channel erosion under existing conditions. This reach has an equilibrium gradient of 2.9% and a current gradient of 4.4%, resulting in the need for 8 feet of drop (2-3 structures) under existing conditions.

Reach 5 is a stable reach that is well connected with its floodplain. The channel is much smaller than downstream (Appendix A-11), presumably indicating the combined effects of lower flows and protection from downstream incision by the current road crossing. In general the transition from incised to non-incised conditions suggests that runoff from the road downstream is at least a partial cause of channel degradation. Upstream, the effect of the road appears to have less impact on the channel and to be more buffered by the well vegetated floodplain. The channel varies from slightly aggradational (Appendix A-12) to stable (Appendix A-13 and Appendix A-14). No structures would be required to stabilize this reach under existing conditions.

Reach 6 is stable to slightly incised, but incision is on a much less significant scale than Reaches 1-4. The channel is well defined and has eroded below the floodplain creating a series of low terraces (Appendix

A-15). Under existing conditions, 6 feet of elevation difference would require stabilization (2 drop structures).

Reach 7 is stable and appears well connected to the floodplain, which supports a good mix of trees and herbaceous vegetation (Appendix A-16). No structures would be required to stabilize for existing conditions.

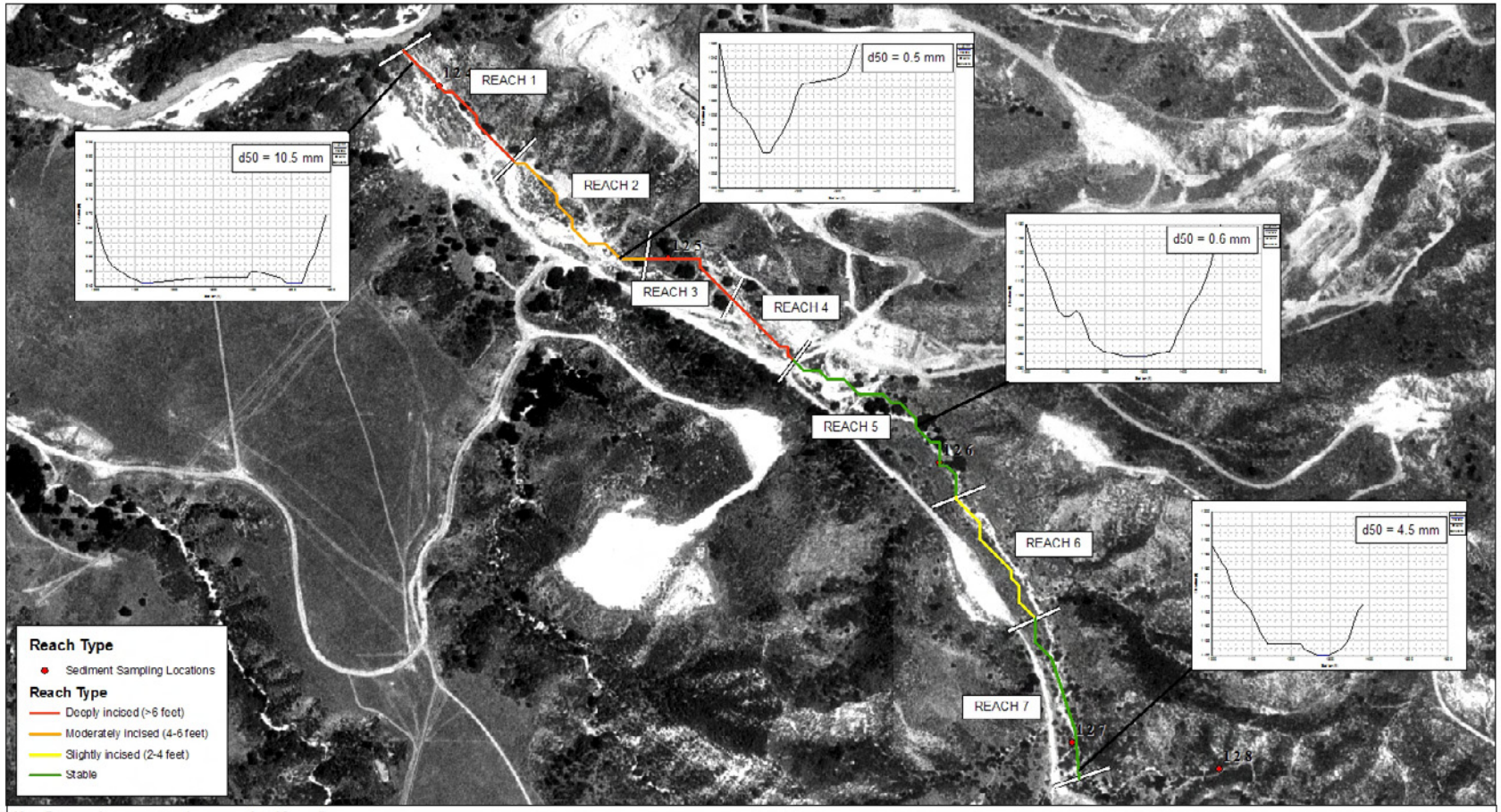
Reach 8 is slightly incised, but on a much smaller scale than reaches 1-4. The channel has slightly scoured into the floodplain, creating a series of low terraces (Appendix A-17 through Appendix A-20). The increase in erosion upstream may reflect the increasing proximity to the dirt road, which appears to have generated concentrated flow into the channel (see Appendix A-20). Approximately 2 structures would be required to stabilize existing conditions in this reach.

Table 1. Lion Canyon Geomorphic Description by Reach with Design Recommendations

Reach Number	Location Along Channel Centerline §(ft)	Description	Recommended Treatment
1	1050 – 1750	Heavily incised, confined channel with steep banks.	Relocate channel away from steep right bank. Re-grade and stabilize banks. Toe protection at bottom of mesa slope.
2	1750 – 2470	Moderately incised channel with steep left bank.	Re-grade and stabilize left bank. Potential Habitat Enhancement Area (Oak Woodland/Mule Fat Scrub).
3	2470 – 3060	Heavily incised, confined channel with coarse bed material and steep banks.	Preserve existing Oak Woodland habitat where feasible.
4	3060 – 3490	Heavily incised, confined channel.	Re-grade and stabilize banks. Potential Habitat Enhancement Area (Oak Woodland/Mule Fat Scrub).
5	3490 – 4400	Stable, well defined channel.	Preserve existing Oak Woodland habitat.
6	4400 – 5030	Slightly incised, well defined channel. Proposed Magic Mountain Parkway Crossing.	Existing Oak Woodland habitat. Maintain existing grade or steeper using drop structure.

7	5030 – 7770	Stable, well defined channel.	Preserve existing Oak Woodland habitat. Re-grade and stabilize banks.

[§] **Centerline starts at 1050 and proceeds upstream**



Note. Figures refer to separation between predicted 5 year flow elevation and floodplain elevation.

Source: USGS (images, DEM), PACE (HEC-RAS)

figure 1

Newhall Ranch

Geomorphic Stream Assessment Map - Lion Canyon

ref. 1820

PWA

\\Sfs1\GIS\NewhallRanch\1820_Geomorph_Lion.mxd

3. PROJECT HYDROLOGY: DEVELOPMENT OF DESIGN DISCHARGES

LACDPW specifies the design discharges to be used for their methods as Q_{cap} and 0.25 Q_{cap}. The LARWQCB requirements do not specify a specific design flow to form the basis of design, but require assessing the channel design over a continual time series of flow. For this project we have selected dominant discharge as the design basis for the main low flow channel, in keeping with standard geomorphic practices. Dominant discharge is the event that fills the channel to the 'bankfull' level, and is the event that cumulatively transports the majority of sediment over a long period of time. Based on local hydrology and watershed conditions, the Stormwater Monitoring Coalition (SMC) (Coleman et al., 2005) have shown that bankfull discharge for small watersheds (less than 10 square miles) in Los Angeles and Ventura Counties is approximately the 5-year flow when calculated using USGS regression methods. Using a separate method, Geosyntec (Geosyntec, 2006) has shown that for the Newhall Ranch watersheds the dominant discharge lies between the 2- and 5-year recurrence interval storms. The literature (USACE, 2001), as well as Geosyntec's work, shows that in sand bedded streams dominant discharge and bankfull do not necessarily coincide, and that dominant discharge will often be less than bankfull because of bank erosion and channel widening. Based on our review, we recommend use of the 5-year flood as the design event for the low flow channel, insuring that these designs are also consistent with the LACDPW approaches.

4. CHANNEL GRADIENT DESIGN

The design channel gradient will be dynamically stable (should neither erode nor accumulate excess sediment over the long-term). Small amounts of cyclical erosion and deposition are expected 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 channel is designed using LA County methods supported by additional analysis (PWA method) and is then checked for stability and adjusted, if necessary, using the erosion potential method.

4.1 METHOD 1. LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS METHODS

LACDPW has developed two methods of calculating equilibrium channel gradient. 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

4.1.1 Method 1a: LACDPW Empirical Method

The LACDPW empirical method involves using the increase in channel velocity and the decrease in sediment availability following development for the Qcap flood event and a quarter of Qcap. The increase in velocity between existing and proposed conditions for these two flows is calculated, and the highest percentage increase is used in subsequent analysis. The most appropriate of three plots is selected (existing gradient of 0.5%, 1% or 5%; see Figure 2). On each plot there are curves for four different changes in sediment supply: no reduction, 33% reduction, 66% reduction or 90% reduction. The curve corresponding to the closest change in sediment supply is used. The percent increase in velocity following development on the x-axis is used with this curve to provide the value than needs to be subtracted from the original slope to provide the stable slope. An automated version of these plots was produced by PWA. The increase in channel velocity, decrease in sediment availability, and an initial channel slope is provided, and a spreadsheet interpolates between the three graphs and the four lines on each graph to provide a stable channel slope.

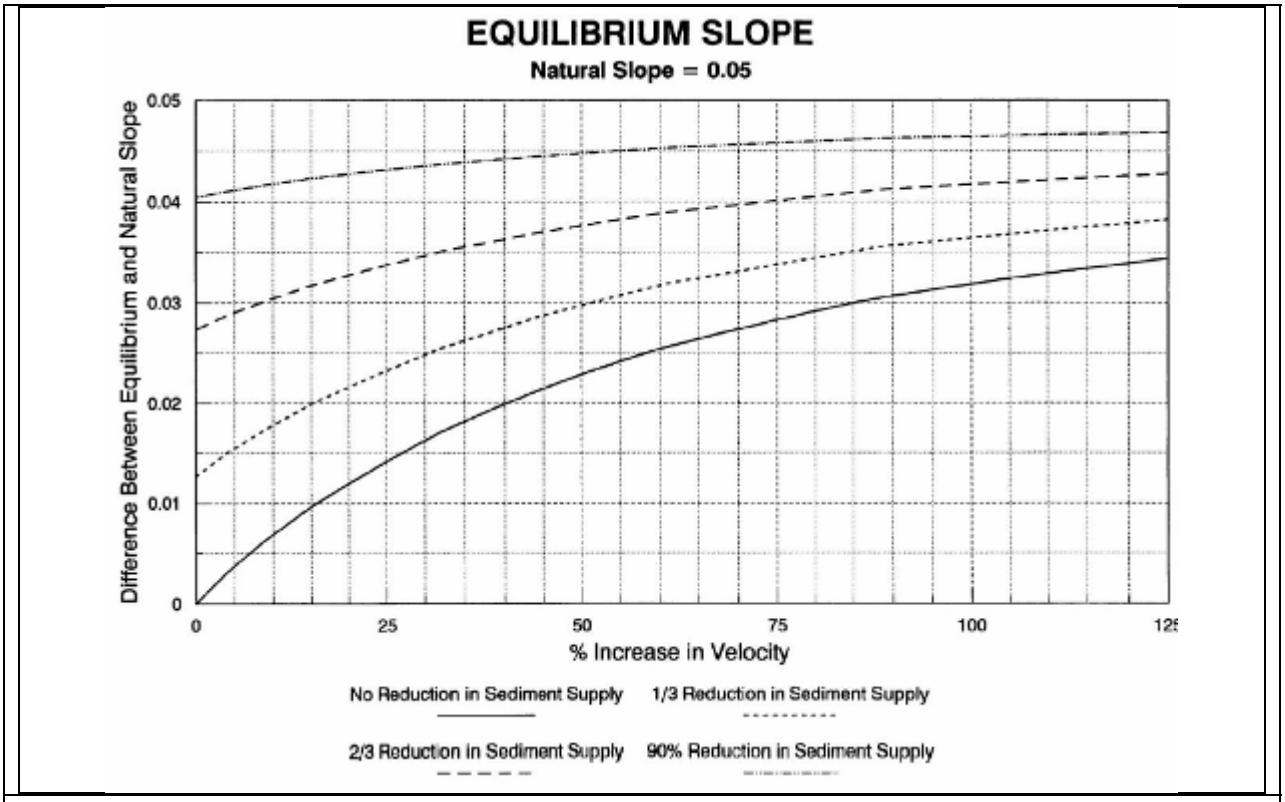


Figure 2. Nomograph for estimating equilibrium slope.
Source: LA County Dept of Public Works, 2006. Appendix C.

4.1.2 Method 1b: LACDPW Analytical Method

This method is specified for soft bottomed channels with levees. The basis of the approach is to re-create equilibrium conditions where a channel neither degrades nor aggrades for the discharge predominantly responsible for channel characteristics. The upstream supply reach to the location being considered was identified, and the hydraulic parameters for the dominant discharge were computed. Sediment transport capacity was calculated for the existing conditions at the dominant discharge (defined by LACDPW as 0.25 x Q_{cap}). 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

For Lion Canyon, the Colby methodology was selected as it is intended for sandbed channels with shallow flow. The bed material sediment size (D_{50}) was calculated by averaging all bed material samples collected in Lion Creek during field reconnaissance. The sediment size was considered to be the same for existing and proposed conditions. Hydraulic parameters for existing conditions were calculated using a

HEC-RAS hydraulic model generated from site topographic data. Model nodes where the Froude number was greater than 2 were removed from averages (these represent flow over knickpoints, etc., and are not representative of the overall channel slope). The sand discharge (in tons per day) was calculated for the four supply reaches.

A channel invert longitudinal slope for proposed conditions was estimated. The hydraulic parameters (mean velocity, depth and width) for the proposed dominant discharge (0.25 Qcap) using this slope were estimated using Manning's equation. The Colby equation was again applied and the daily sand load through each supply reach was computed. An iterative process was carried out increasing or decreasing channel slope, recalculating hydraulic parameters, and recomputing the subsequent sediment discharge, until the proposed and existing conditions sediment transport rates were equal. The proposed channel slope at these conditions was considered to be the stable slope for proposed conditions.

4.2 METHOD 2. PWA CHANNEL DESIGN METHOD

PWA has developed a method of identifying stable channel slopes that encompasses both field (reference reach) and analytical (sediment transport methods). The PWA approach is as follows:

- *Account for existing instability in the channel*. We developed field relationships between watershed area and channel gradient (Figure 3) for reference reaches of channels in the Newhall Ranch project area that are in equilibrium (usually upstream of grade control structures). By comparing existing channel gradients with gradients estimated from the field relationships we identify the gradient reduction required to account for existing instability due to historic watershed impacts.
- *Calculate equilibrium gradient for post development discharges*. By relating watershed area to dominant discharge (based on watershed area vs. 5-year flow relationships developed for the Newhall Ranch area we can use the same field relationship to predict the stable gradient for channels with post-project flows. This initial prediction assumes that the new channel is sediment transport capacity limited rather than sediment supply limited.
- *Account for sediment supply reduction*. Since sediment supply is likely to be reduced, we then calculate the effect of this reduction on the equilibrium channel gradient. This step accounts for the shift from a transport capacity-limited condition to supply-limited condition that is assumed to occur once much of the watershed is developed and stabilized. By conducting a series of analytical simulations in the USACE SAM sediment transport model for channels with different geometries and sediment supplies, we can calculate the required reduction in channel gradient for a given reduction in sediment supply. Using the same series of simulations we can calculate the channel geometry (width and depth) that fulfills the minimum stream power conditions.

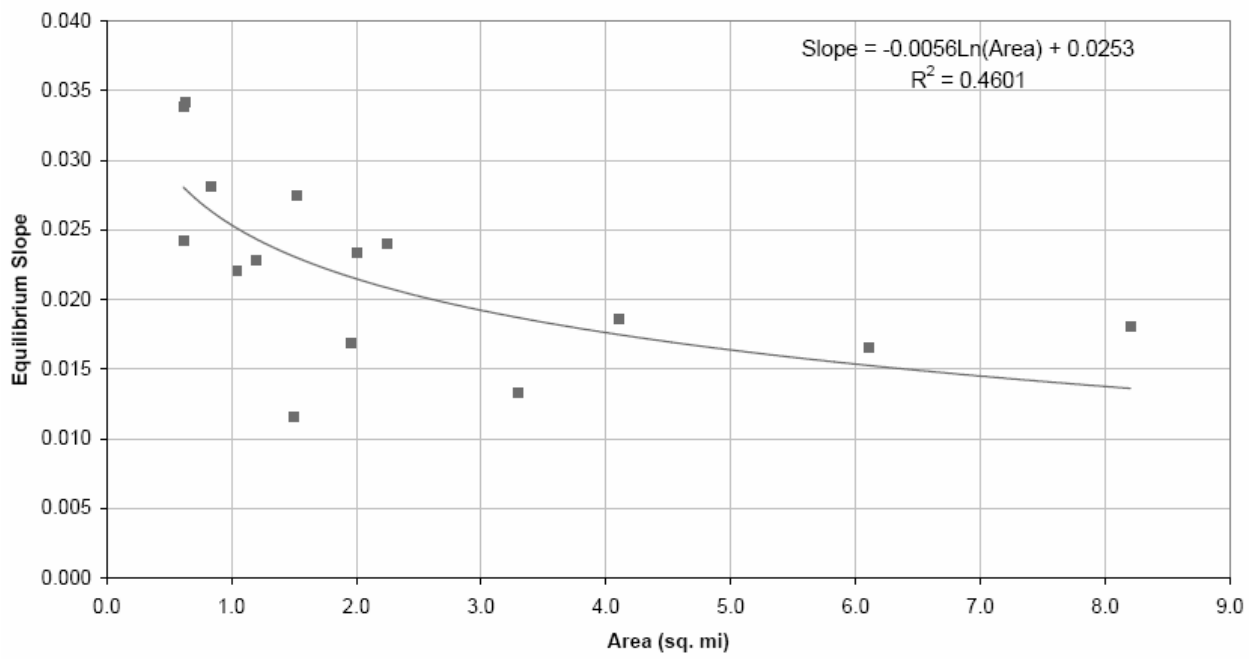


Figure 3. Equilibrium Slope for Rural Reference Reaches

Table 3. Description of PWA Method

	Method 2 - PWA
Inputs	Existing and proposed dominant discharge (from continuous rainfall-runoff modeling in SWMM) Existing and proposed capital discharge Qcap (from HEC-HMS per LA County method) Existing and proposed watershed area Reduction in sediment supply (% reduction in sediment contributing area) Bed particle size d50
Events Assessed	Dominant discharge (5-yr flow using Geosyntec continuous flow data)
Approach	1. Field-derived empirical curve to relate watershed area to equilibrium slope for existing conditions 2. Field-derived empirical curve to relate proposed discharge to equilibrium slope for proposed conditions assuming unlimited sediment supply 3. Sediment transport model to calculate reduction in slope required to account for reduced sediment supply
Output	Width, depth and slope of equilibrium channel

4.3 VERIFICATION USING EROSION POTENTIAL METHOD

Erosion potential (Ep) is a measure of the effective work done on the channel by hydraulic forces, as well as a measure of the total sediment load transported over long periods of time. By 'effective' we mean 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 (Ep) is used to assess hydrograph modification impacts on channels, and to ensure that 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. For example, a ratio of 2 indicates that the proposed condition has 2 times more erosive capacity and 2 times more sediment load transported than predicted under the existing condition. 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 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, as is the case for Lion Canyon, 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 hydromodification verification methodology therefore incorporates a risk-based approach that limits the variance in erosion potential to ±20% of the target, as hydromodification impacts would not be expected within this range.

Table 4. Description of Geosyntec 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
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.

4.4 SELECTION OF DESIGN CHANNEL GRADIENT

Each of the above design approaches produces a slightly different combination of slopes, widths and depths. We reviewed these methods, based on their local applicability. In addition we are including in the grade control structures 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 4 below). The design also includes 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.

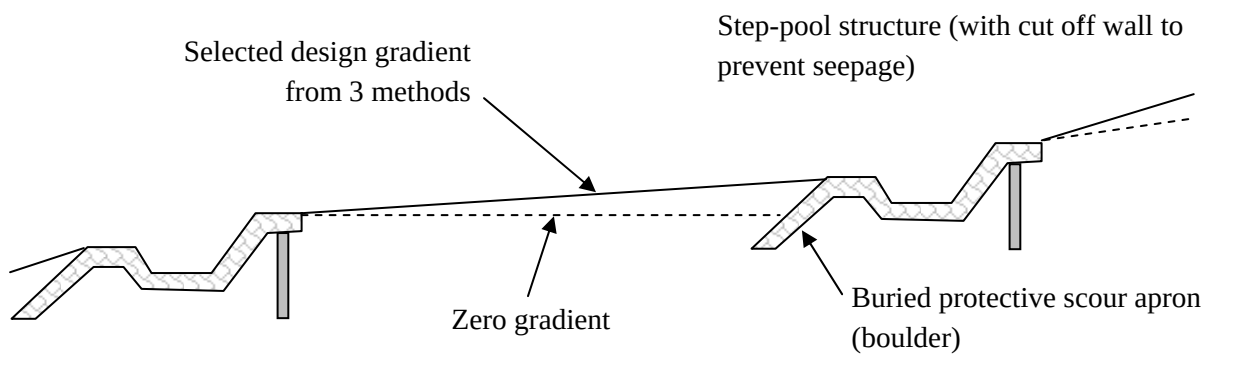


Figure 4. Conceptual Sketch of Step-pool Structures Showing Relationship Between Design Gradient and Lowest Predicted Gradient

5. CHANNEL WIDTH AND DEPTH

Channel width and depth have been selected to convey the dominant discharge (approximately the 5-year flood as predicted using the USGS methodology, or the 2-year flood using continuous rainfall-runoff simulations). Three methods have been used: an analytical approach using the minimum stream power concept (USACE Stable Channel Design Approach), an empirical approach using local reference reaches (Coleman et. al. 2005), and an erosion potential assessment to ensure that the design meets the appropriate target erosion potential within the 20 percent threshold.

5.1 STABLE CHANNEL DESIGN APPROACH

The US Army Corps of Engineers Stable Channel Design Approach (SCD) uses a sediment transport model within the HEC-RAS hydraulic modeling package to identify the channel dimensions (width, depth and slope) that will be in equilibrium for a given input of water and sediment. The SCD model evaluates a combination of channel widths, depths and slopes to determine those that have a sediment transport capacity equivalent to the incoming sediment load (i.e., will be in equilibrium). The resulting combinations describe two curves, one showing channel slope versus channel width, and a second showing channel slope versus channel depth (see Figures 5 and 6). Typically the channel with the minimum stream power is selected, on the assumption that selection of an alternate configuration would generally lead to channel evolution (through erosion and deposition) towards this geometry.

5.2 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 7). We integrate the results from these channel systems with the estimates produced by other methods.

Table 5. Summary of Southern California Field Regressions

	Method 4 - SMC method
Inputs	Dominant discharge
Events Assessed	Q5
Approach	Use regression equation from regional reference reaches to estimate channel width and depth
Output	Equilibrium width and depth of channel

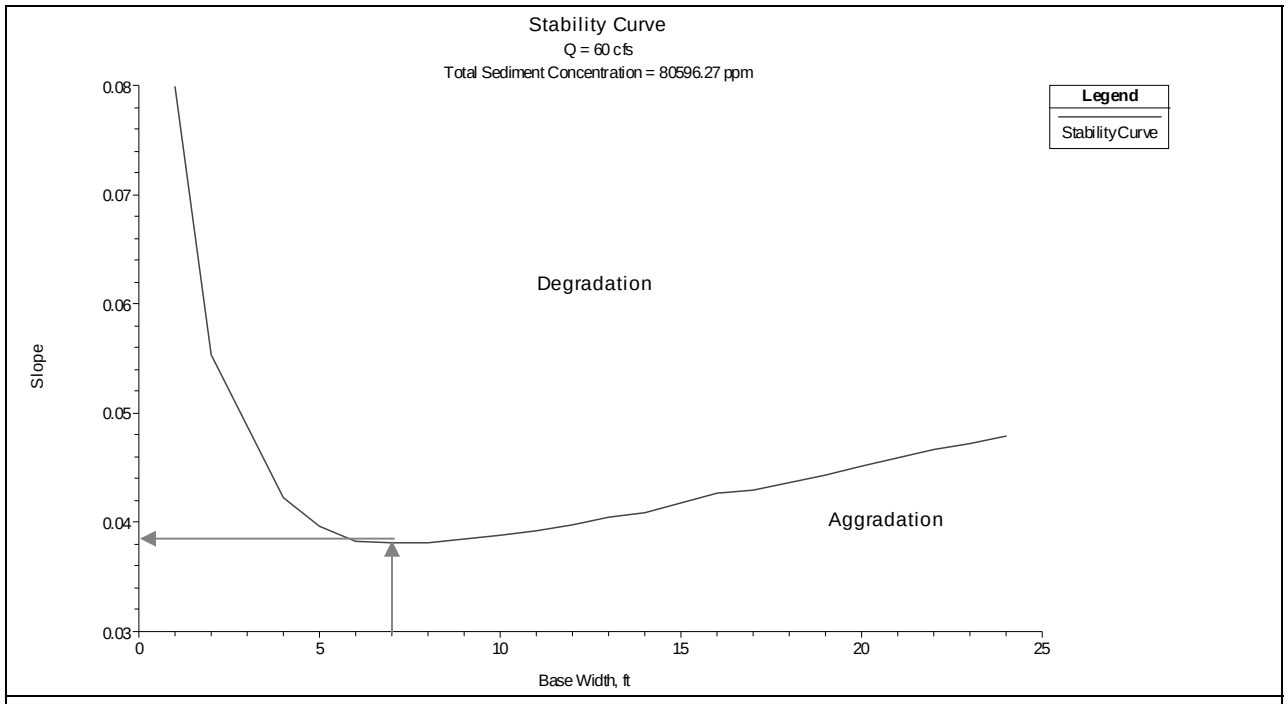


Figure 5. Stability Curves for a Hypothetical Example; Width and slope corresponding to the minimum stream power is indicated by the red line.

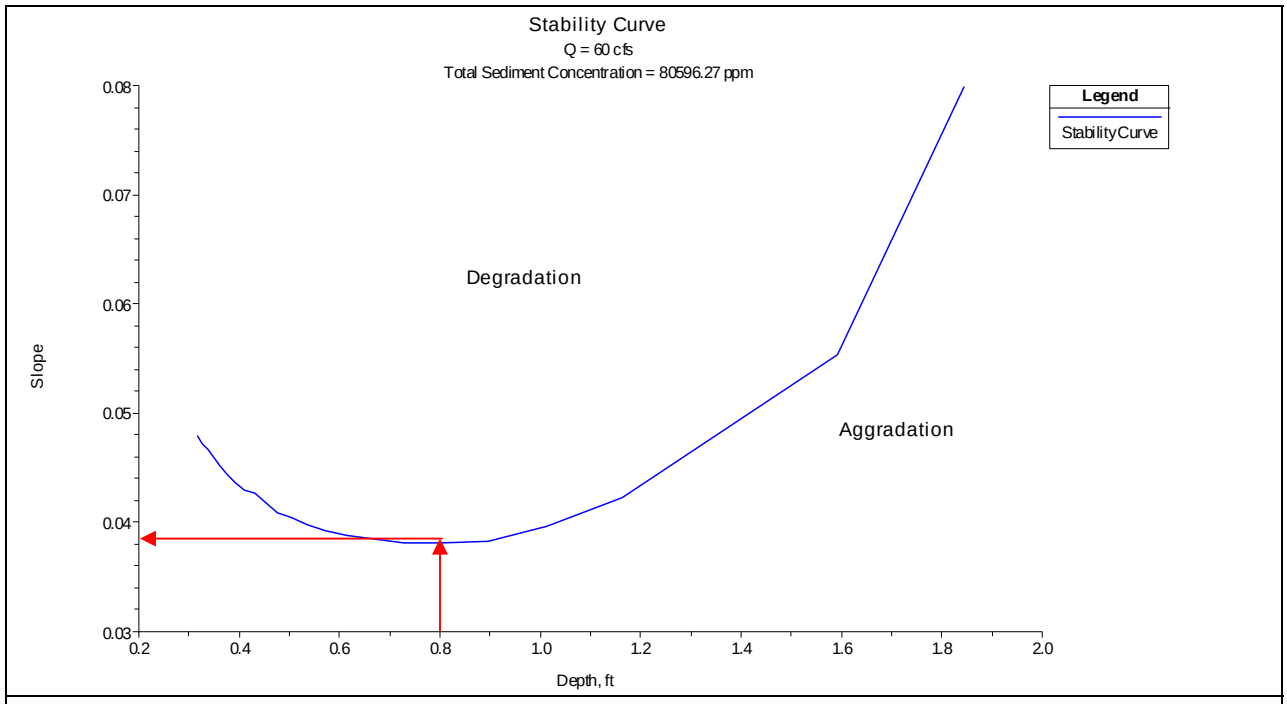


Figure 6. Stability Curves for a Hypothetical Example; Depth and slope corresponding to the minimum stream power is indicated by the red line.

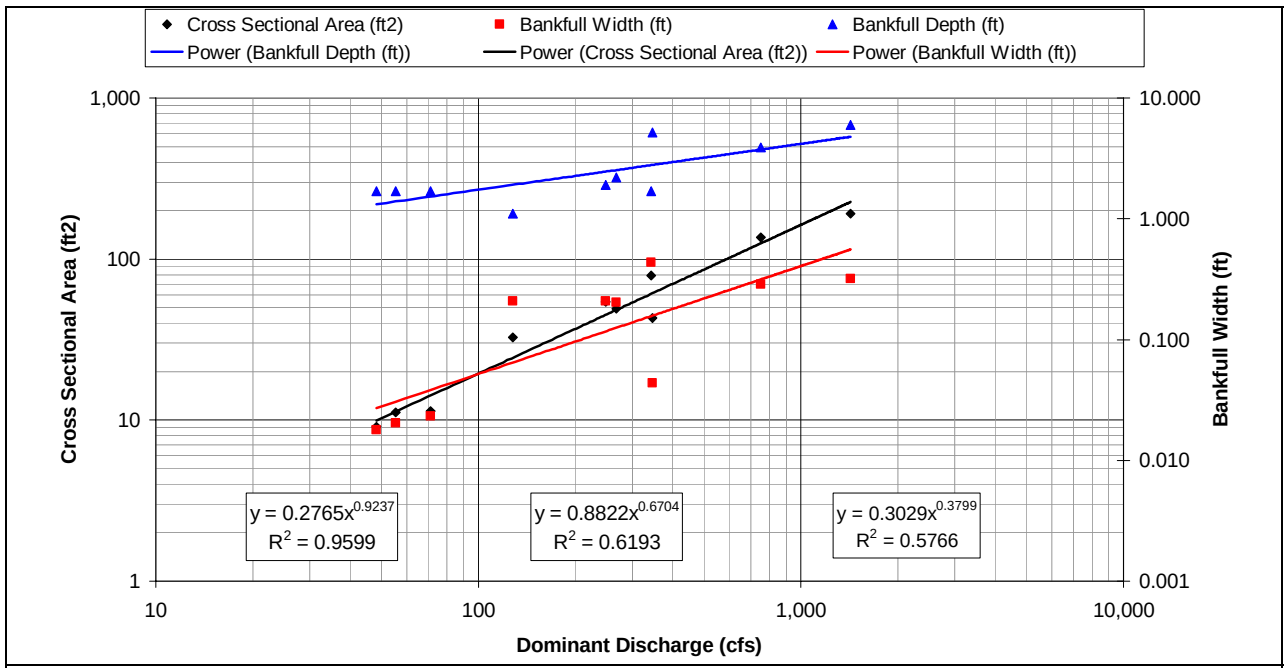


Figure 7. Southern California Stream Morphology Relationships
Note: Plots derived from Coleman et al. (2005) Table 5.6

5.3 SELECTION OF A DESIGN CHANNEL WIDTH AND DEPTH

Following estimation of design parameters with the three methods, we developed design recommendations for the channel slope 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 were evaluated hydraulically to ensure that flow velocities are reasonable (bankfull flow velocities of less than 6 ft/sec where feasible) and unlikely to erode over the longer term.

6. PRELIMINARY STEP-POOL DESIGN

All three methods utilized predict that the bankfull channel gradient will be considerably flatter than the existing gradient, and that 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, we propose using a range of types of step-pool structures and armored riffles to accommodate the drops in channel elevation. Construction of these structures will likely include large boulders, soil cement or concrete and will mimic natural step-pool function and morphology (as identified in reference reaches) in appearance and function.

The approximate structure dimensions are proposed below. 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 GCSs or for bank protection. The detailed analysis and final design for the step-pool structures will be described in a subsequent memo.

The design sequence includes the following steps (Thomas et al; 2000):

1. Determine the step height (H) required for the step-pool structure.
2. Calculate the existing average channel slope of the reach.
3. Calculate the active channel width for the reach.
4. Calculate the weir width.
5. Determine the 2- and 25-year unit discharge for the weir.
6. Calculate the minimum (D_{30}) boulder size using the COE (1991) steep-slope, riprap design procedures (Equation 1) with the 25-year unit discharge. The minimum rock size may have to be increased to allow for burial. This will reduce the potential for local scour on the downstream side of the weir.

$$D_{30} = \frac{1.95 S^{0.555} q^{\frac{2}{3}}}{g^{\frac{1}{3}}} \qquad (1)$$

where S is the channel slope, and q is the unit discharge.

7. Compute the pool length using the Equation (2):

$$\frac{\text{Pool Length}}{\text{ACW}} = 0.409 + 4.211\frac{\text{H}}{\text{ACW}} + 87.341\frac{S_0 q_{25}}{\sqrt{g}\,\text{ACW}^{\frac{3}{2}}} \quad : R^2 = 0.65 \qquad (2)$$

8. Compute the scour depth using the Equation (3):

$$\frac{\text{Scour Depth}}{\text{ACW}} = -0.0118 + 1.394\frac{\text{H}}{\text{ACW}} + 5.514\frac{S_0 q_{25}}{\sqrt{g}\,\text{ACW}^{\frac{3}{2}}} \quad : R^2 = 0.69 \qquad (3)$$

9. Compute the contraction at the downstream tailwater control for the 2-year discharge event using Equation (4):

   Effective Width at downstream control = 0.92 * Weir Width (4)

10. Compute the maximum pool width at the downstream tailwater control for the 2-year discharge event using Equation (5):

    Maximum Pool Width = 1.20 * Weir Width (5)

11. Compute the bank elevation to ensure all flow up to the design discharge is confined within the channel at the weir.

For preliminary design, grade control structures with a maximum vertical drop of 3 feet (as specified by the LA County Manual) and horizontal length of 40 feet were assumed for post-development stabilization of Lion Canyon. These consist of a boulder crest crossing the entire Qcap corridor, with a rock-lined basin downstream of the drop to dissipate the hydraulic energy.

The calculated stable channel slope and existing surveyed slope were compared on a reach by reach basis to determine at what point the difference in vertical elevations differs by 3 feet; at these locations a grade control structure was located. These were adjusted as appropriate to reduce impacts in some high-values existing habitat areas, or to group structures for effectiveness.

7. HYDRAULIC ANALYSIS OF CHANNEL AND STEP POOLS

Once the initial channel design and step-pool design was completed, the channel configuration was evaluated for stability and hydraulic performance using HEC-RAS. HEC-RAS is used to assess the channel, floodplain and steps at a range of flow conditions to ensure:

- Final design of step-pools
- Rock sizing
- Compliance with LACDPW freeboard requirements (3 feet during Qcap)
- Sufficient dissipation of energy by step structures during high flow events

- Non-erosive velocities on floodplain and along constructed slopes

Initially individual step-pools were modeled through a range of flows to optimize hydraulic design. Sequences of steps were then added to the model to simulate proposed conditions throughout the project reach.

Additional hydraulic data will be provided in a subsequent memo.

8. CHANNEL DIMENSIONS FOR LION CANYON

Tables 5 and 6 below provide the input parameters and preliminary design parameters for the proposed Lion Creek channel design.

8.1 INPUTS

Table 5. Stable Channel Dimension Calculation Input Data

Parameter	Value for Lion Canyon
Low flow channel design discharge (proposed Q5)	109 to 139 cfs depending on node location (source: continuous SWMM simulation performed by Geosyntec)
Existing conditions Q5	36 to 80 cfs depending on node location (source: continuous SWMM simulation performed by Geosyntec)
Existing conditions Qcap	420 cfs to 1064 cfs (varies between reaches and node location)
Proposed Qcap	177 cfs to 310 cfs (varies between reaches and node location)
Existing conditions velocity at Qcap	10.9 f/s (from HEC-RAS model, average for channel reach)
Existing conditions velocity at 0.25 Qcap	8.0 f/s (from HEC-RAS model, average for channel reach)
Proposed conditions velocity at Qcap	11.3 f/s (from HEC-RAS model, average for channel reach)
Proposed conditions velocity at 0.25Qcap	8.3 f/s (from HEC-RAS model, average for channel reach)
Increase in velocity at Qcap	4.1 % (calculated from average for channel reach)
Increase in velocity at 0.25 Qcap	3.3 % (calculated from average for channel reach)

Parameter	Value for Lion Canyon
Reduction in sediment supply area following development	27.4 % to 35.9 % of watershed contributing sediment (depending on node location)
Initial Channel Gradient	4.4% (average for entire reach, including knickpoints)
Bed sediment size	D50 = 1.05 mm and D90 = 15 mm (based on average of PWA bed material samples)

8.2 RESULTS

Table 6. Summary of Stable Channel Dimensions Calculated by Each Method

Average Channel Dimension	LACDPW empirical method (Method 1a)	LACDPW analytical method (Method 1b)	PWA method (Method 2)	Southern California Regional Regression	Selected Design
Slope (%)	0.96 to 1.49	1.55 – 1.9	1.0	-	1.0*
Width (ft)	-	-	14.5	21.1 to 26.4	20
Depth (ft)	-	-	2.0	1.8 to 2.0	1.5

*Based on the Ep analysis described below the gradient will be reduced to 0.75% in the sub-reaches around cross section 4400 and 5500.

A design slope of 1% over all reaches was selected as a conservative choice from within the range of applicable methods. This design slope will be reduced to 0.75% in specific subreaches based on the results of the Ep analysis described below. Within the range of possible widths and depths, a mean width of 20 feet was selected. A slightly shallower depth of 1.5 feet was selected than the range of possible values provided by the different methods. This depth was chosen because: a) it minimizes E_p; b) a deeper channel would have held too much flow, reducing the habitat value of the surrounding floodplain; c) depth calculations have the greatest uncertainty; and d) a shallower channel eliminates the need for safety fencing that would be a habitat and aesthetic impediment.

8.3 EROSION POTENTIAL EVALUATION

Geosyntec evaluated the channel design proposed in Table 6 above using the Erosion Potential Methodology. The proposed design, modified slightly at two cross section locations, will meet the Ep targets within the 20% threshold. Table 7 presents the results discussed below.

The first column in Table 7 provides lists the channel cross sections used in the Ep analysis. The second column summarizes the field conditions for each of these cross sections. The third column lists the target Ep based on the estimated reduction in sediment supply for each cross section. Post development

condition sediment supplies are predicted to range from 27% to 37% of the existing condition. Column 3 also lists the target Ep plus 20%, which is the allowable upper Ep limit.

Column 4 summarizes the predicted future Ep values based on the proposed channel design slope and geometry listed above in Table 6. The results are discussed in two groups: 1) cross sections 1200 to 3000; and 2) cross sections 4000 to 5500. The first group of cross sections are considered generally unstable (although cross section 2400 is only slightly incised); therefore, the existing condition is not used as the baseline for design purposes. The upstream group of cross sections are generally stable and produce similar baseline work and transport conditions, thus existing conditions for the upstream cross sections were used to establish the baseline for the downstream reaches.

The predicted Ep values for six of the eight cross sections analyzed were within 20% of the target Ep value, are therefore predicted to be stable in the proposed design. Two cross sections, section 5500 and section 4400 were predicted to exceed the target Ep value by slightly more than 20%. The channel slope of these sub-reaches has therefore been lowered to 0.75 percent to bring the predicted Ep within the desired range.

Table 7. Results for the Erosion Potential Evaluation

1	2	3		4
Cross Section	**Current Channel Conditions**	**Erosion Potential** Target Ep	+20%	**Predicted Future Ep**
1200	Deeply Incised	0.36	0.43	0.38
1600	Moderately Incised	0.37	0.44	0.38
2400	Slightly Incised	0.37	0.44	0.38
3000	Deeply Incised	0.33	0.39	0.38
4000	Stable	0.33	0.39	0.35
4400	Stable	0.33	0.39	0.40
4800	Slightly Incised	0.33	0.39	0.38
5500	Slightly Incised	0.27	0.33	0.43

On the basis of the above Erosion Potential evaluation and a reduction of channel gradient in sub-reaches 4400 and 5500 to 0.75%, the proposed channel will not aggrade or generate excess sediment from erosion or create a larger than natural downstream impact from sedimentation associated with hydromodification.

[MSOffice1]

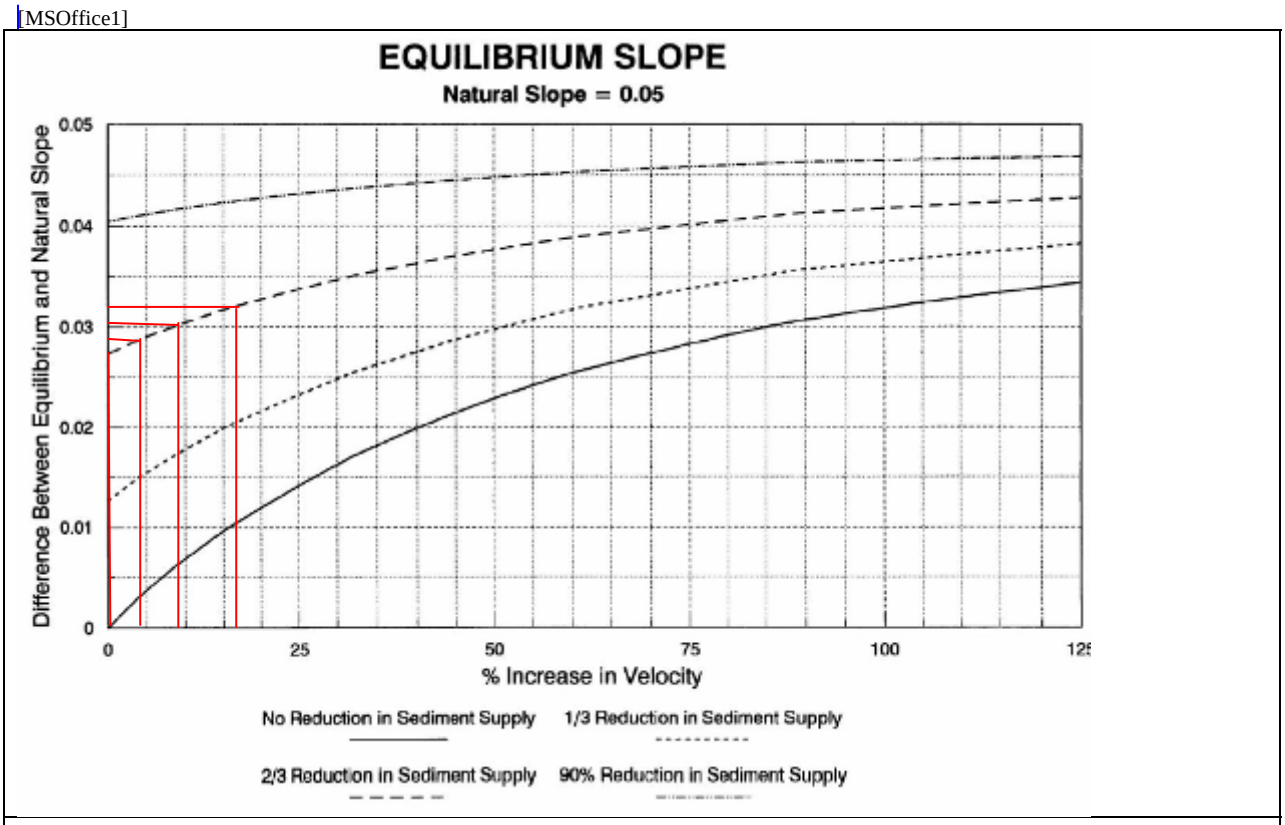


Figure 8. Nomograph for Estimating Equilibrium Slope in Lion Canyon
Source: LA County Dept of Public Works, 2006. Appendix C.

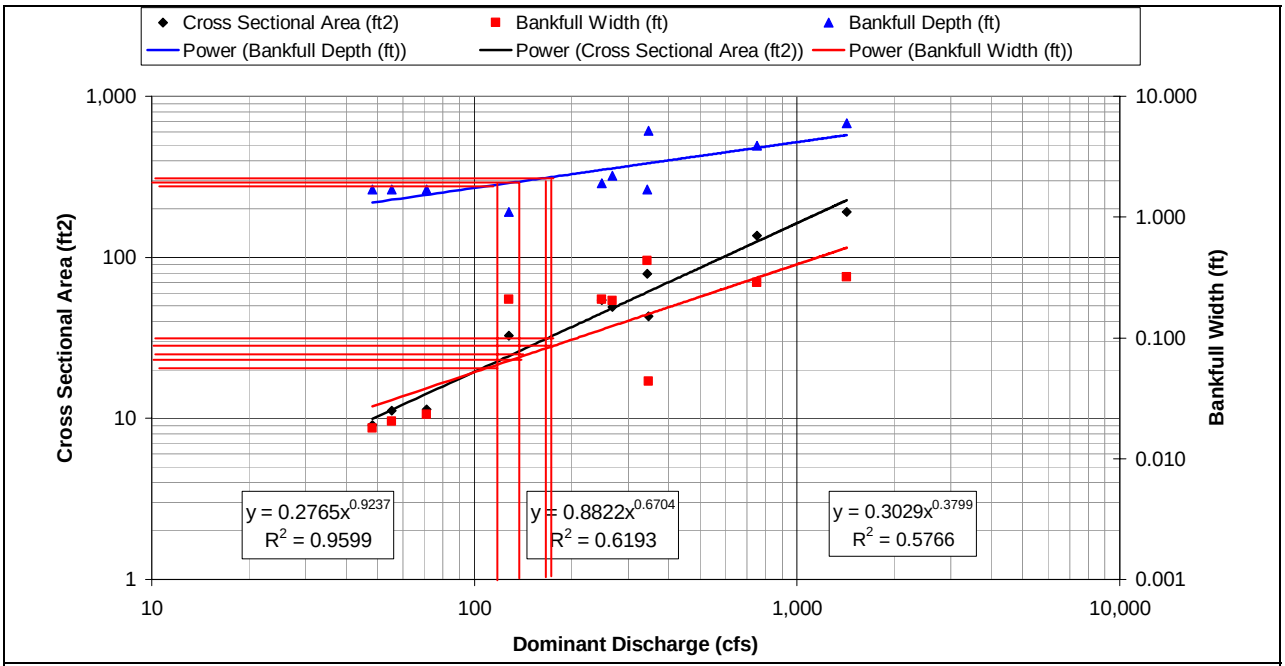


Figure 9. Southern California Stream Morphology Relationships Annotated with Lion Creek Values

9. REFERENCES

Coleman, D., MacRae, C., Stein, E.D. (2005). Effect of Increases in Peak Flows and Imperviousness on the Morphology of Southern California Streams – Southern California Coastal Water Research Project Technical Report 450.

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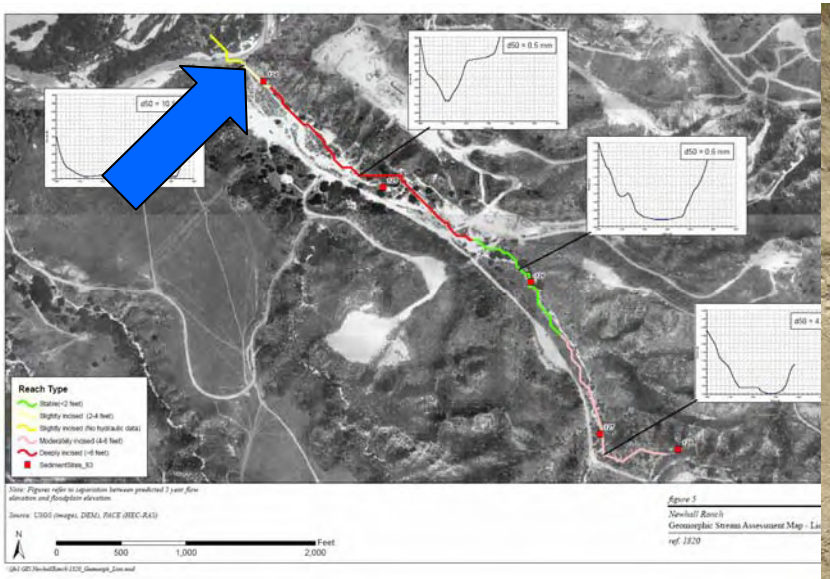
Ponce, V. M. (2001). Colby (1964) Sediment Transport Online Calculator http://octavian.sdsu.edu/~ponce/colby/colbyform.html

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), 2005. Hydromodification Management Plan. Prepared by Geosyntec Consultants for the Santa Clara Valley Urban Runoff Pollution Prevention Program. April 21, 2005.

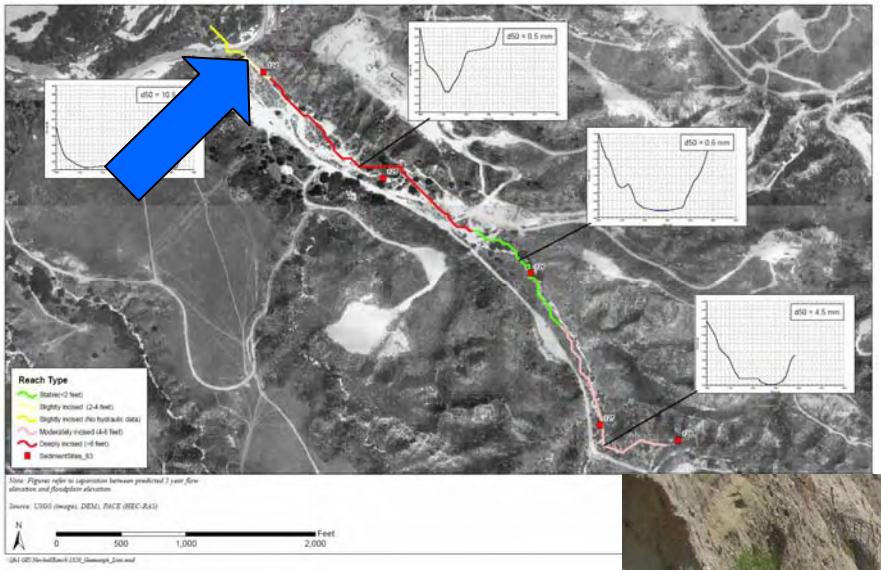
Thomas D. B., Abt, S. R., Mussetter, R. A, and Harvey, M. D. (2000). A Design Procedure for Sizing Step-Pool Structures. Joint Conference on Water Resource Engineering and Water Resources Planning and Management 2000

US Army Corps of Engineers. (2004). HEC-RAS and SAM Software. Version 3.1.2.



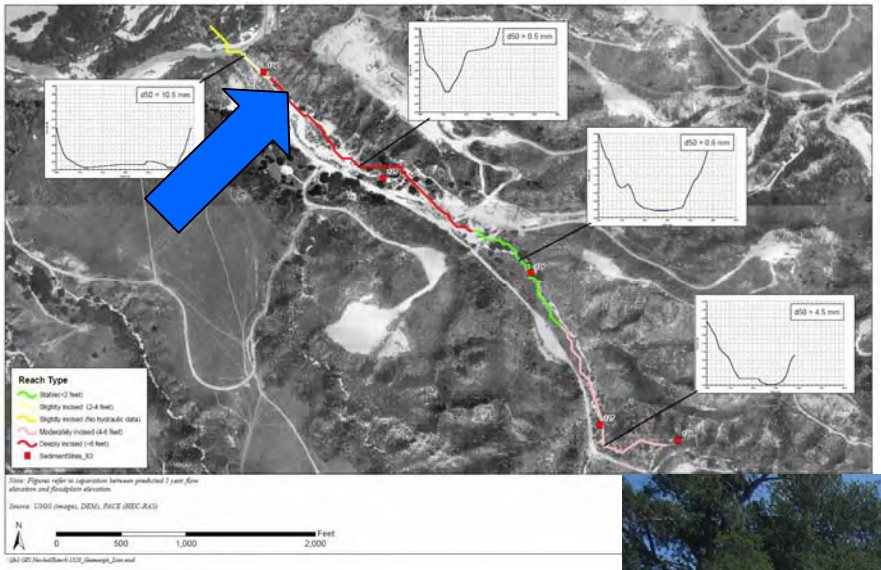
APPENDIX A-1

Point 3 –
Large (aprx. 8 ft) knickpoint



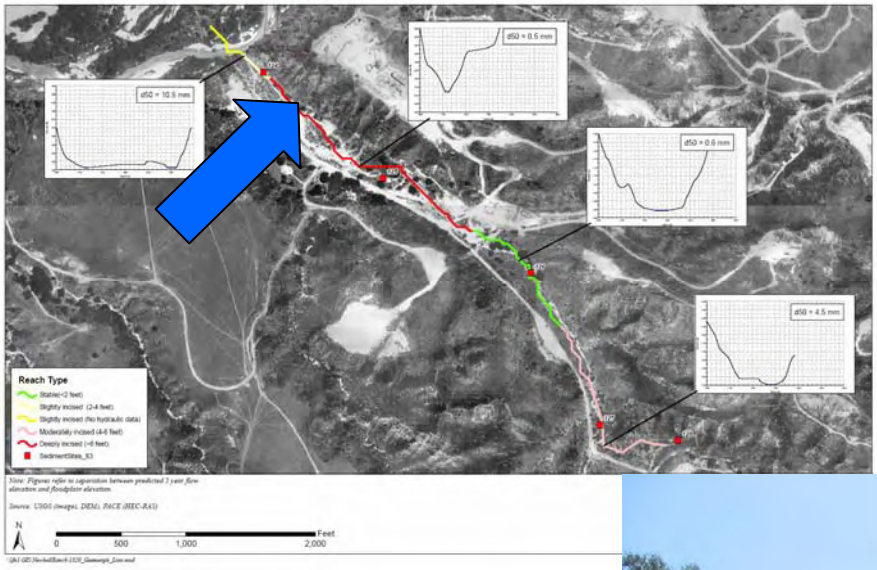
APPENDIX A-2

Point 4 –
Very steep undercut north eastern bank, realignment of this reach is suggested



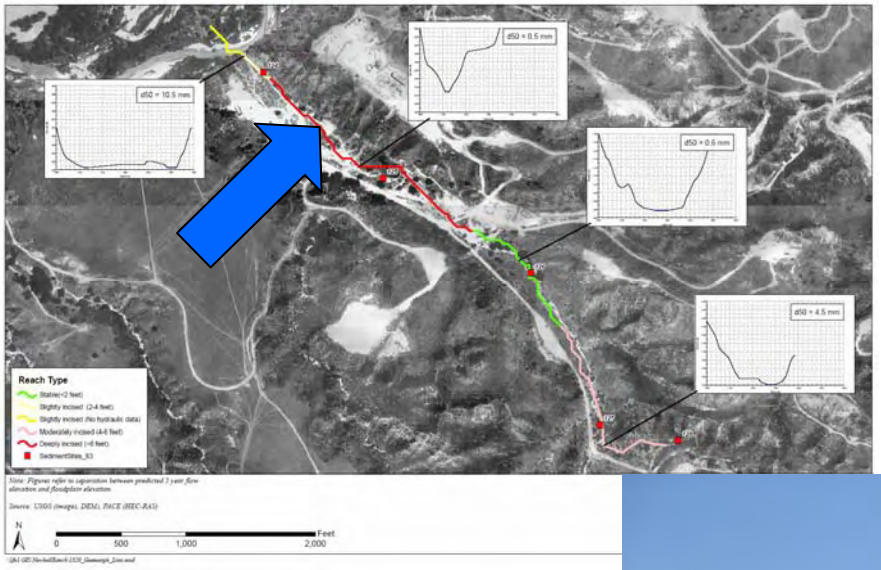
APPENDIX A-3

Point 11 –
Typical downstream conditions, overwidened cross section



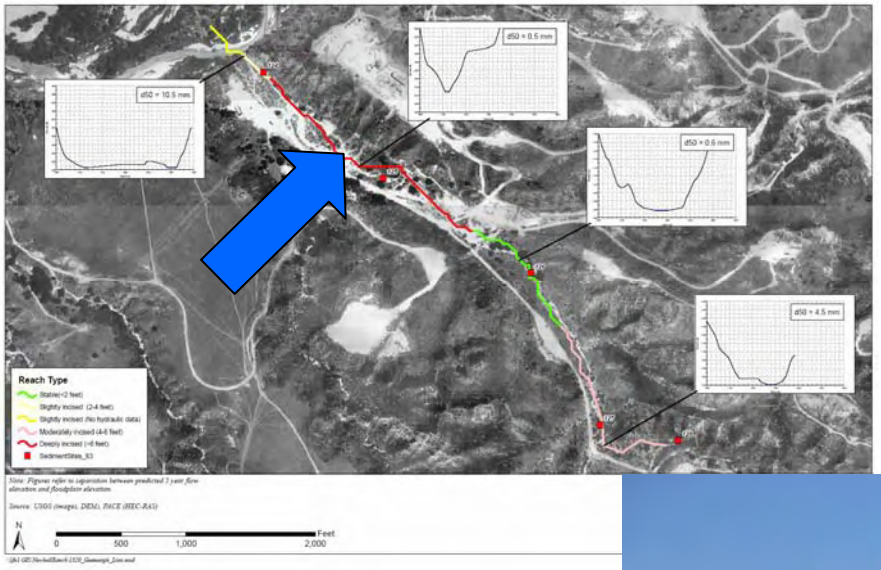
APPENDIX A-4

Point 15 – Failing block on south bank



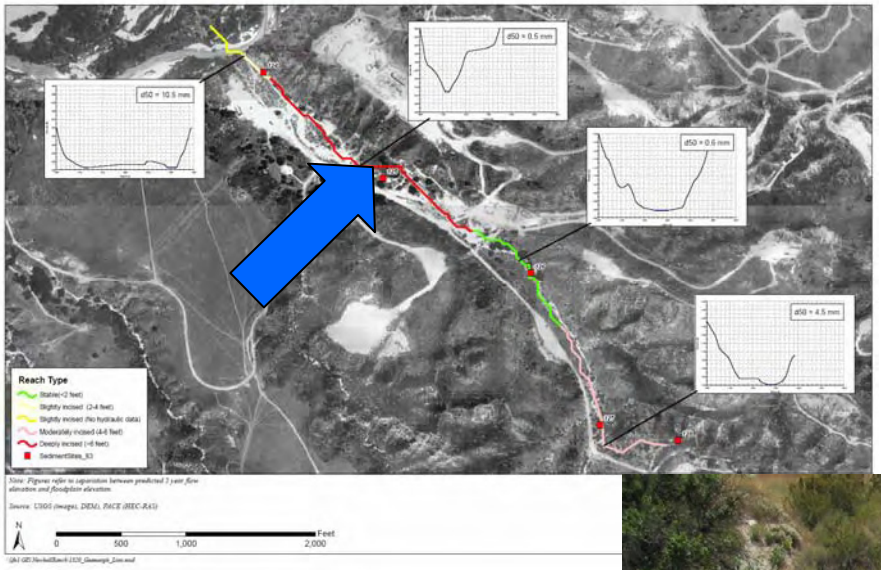
APPENDIX A-5

Point 20 –
Overwidened reach



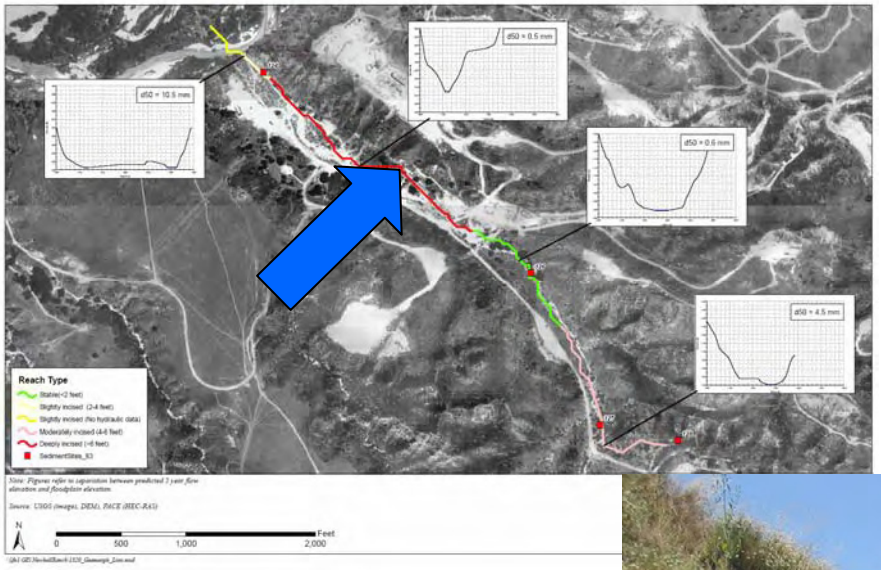
APPENDIX A-6

Point 25 –
Transition from overwidened to incised unstable channel conditions



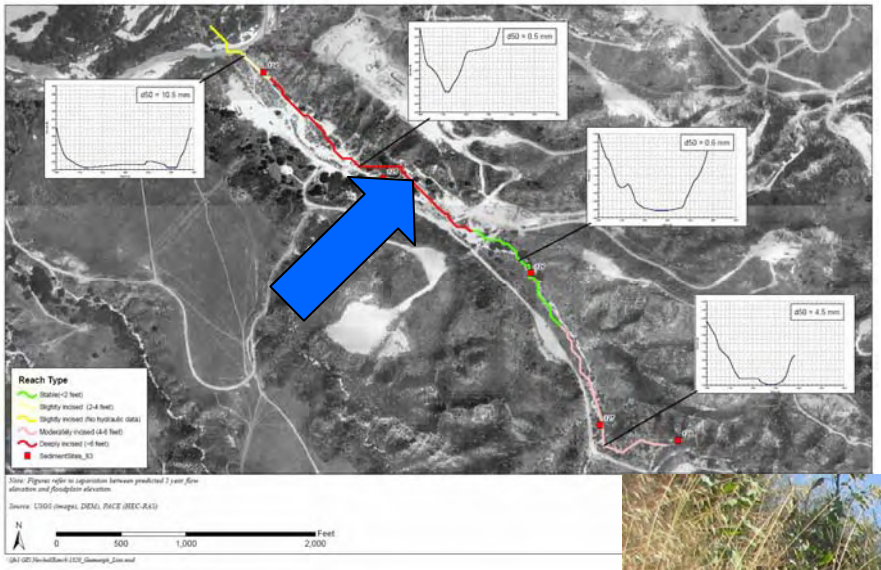
APPENDIX A-7

Point 31 –
Incised reach with steep south bank



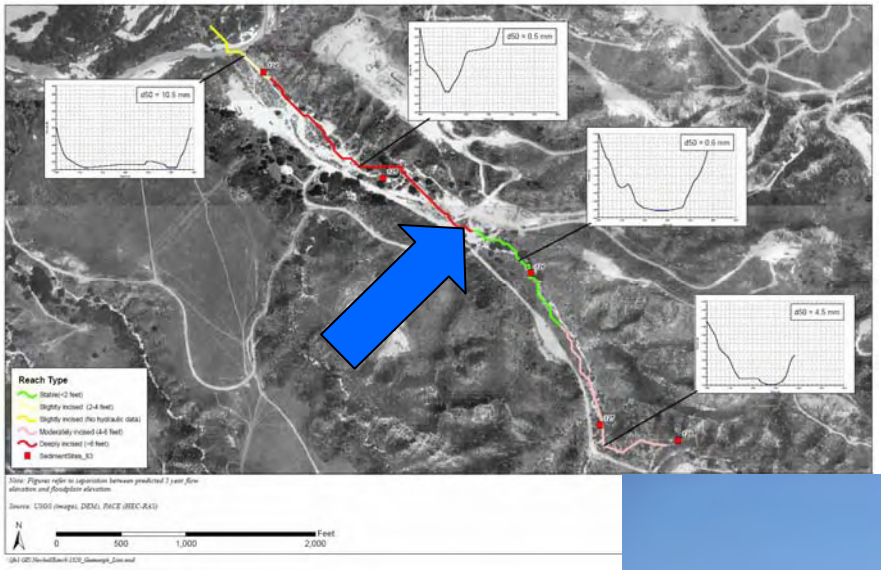
APPENDIX A-8

Point 35 –
Narrow, incised reach



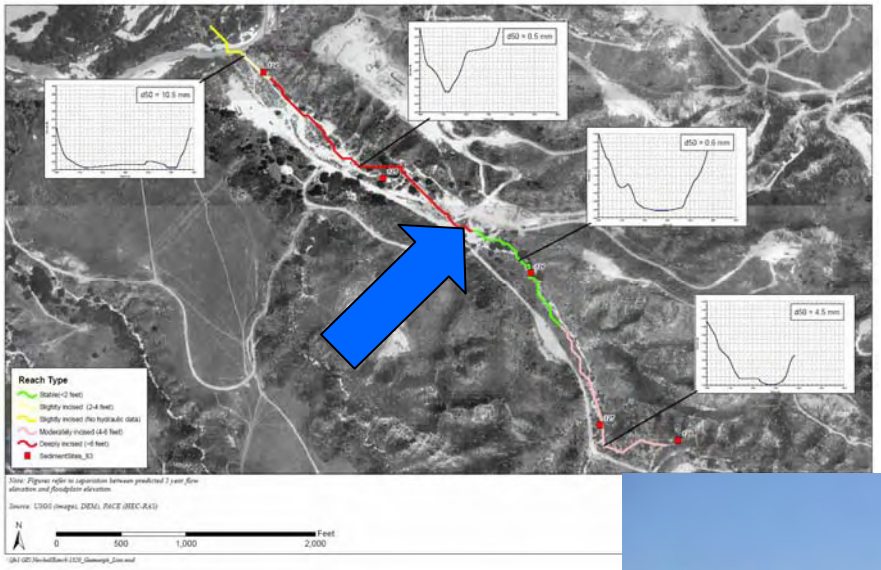
APPENDIX A-9

Point 40 –
Incised section, mature oaks threatened by bank failure



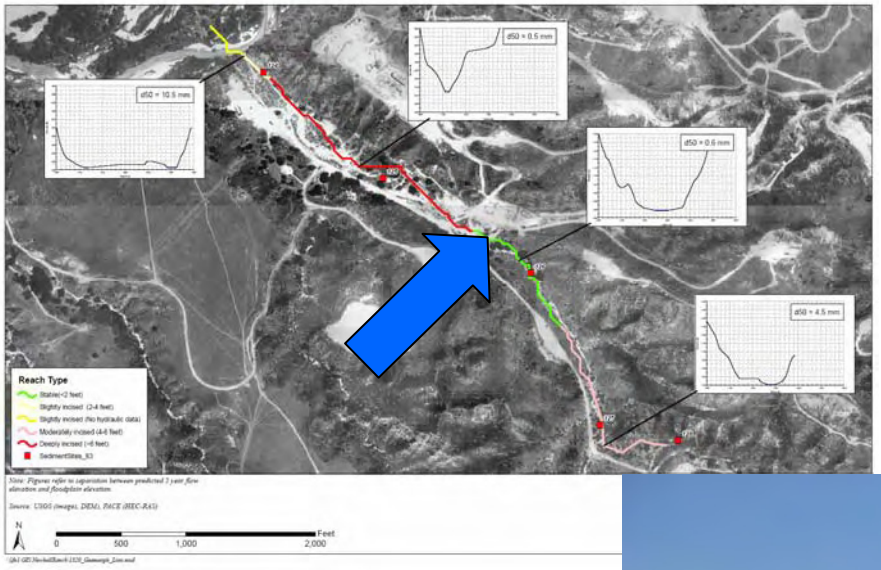
APPENDIX A-10

Point 48 –
Upstream boundary of incised reach. Road crossing causing aprx. 12 ft knickpoint



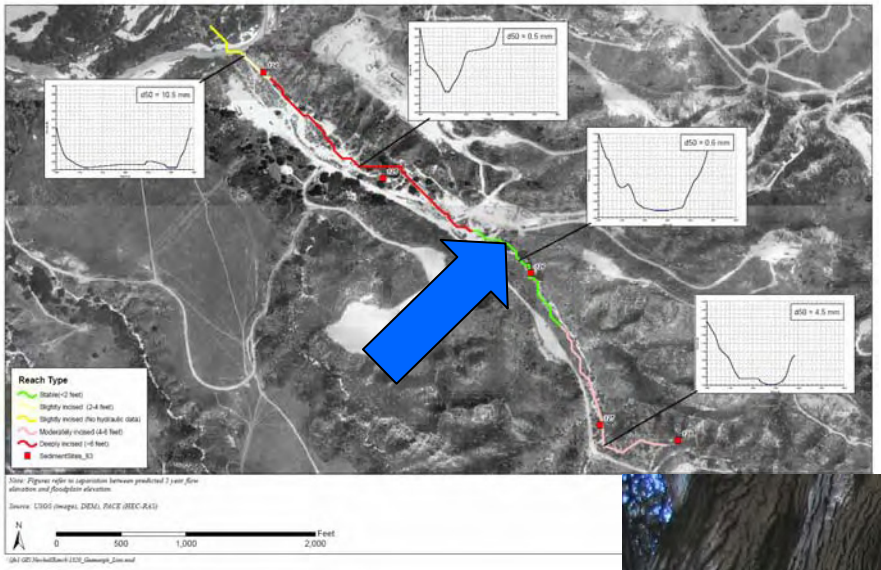
APPENDIX A-11

Point 49 –
Stable channel upstream of road grade control, equilibrium conditions



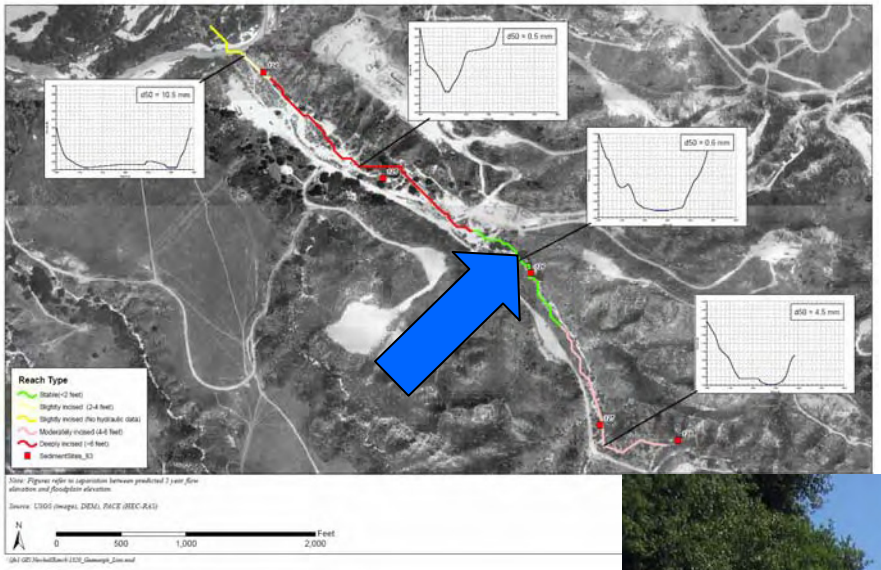
APPENDIX A-12

Point 54 –
Slightly aggradational channel, oak habitat



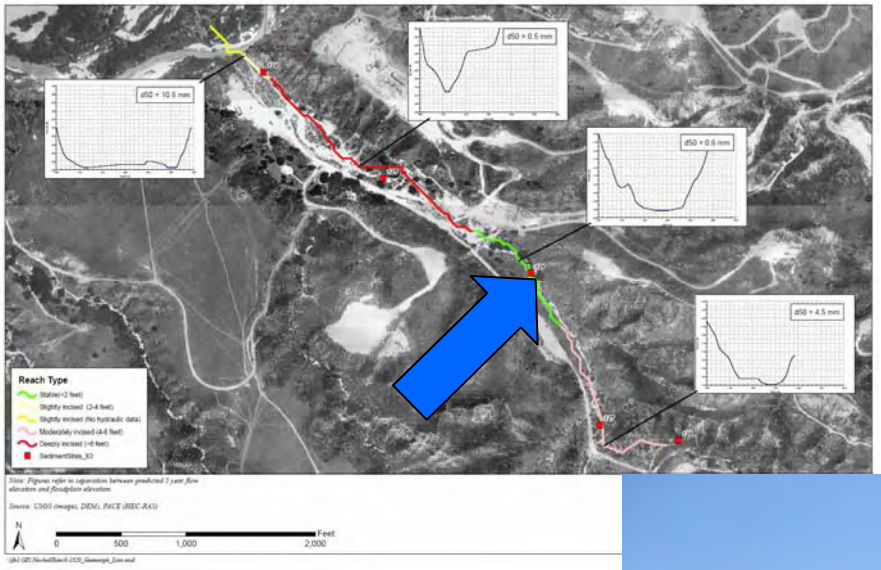
APPENDIX A-13

Point 59 –
Stable channel, oak habitat



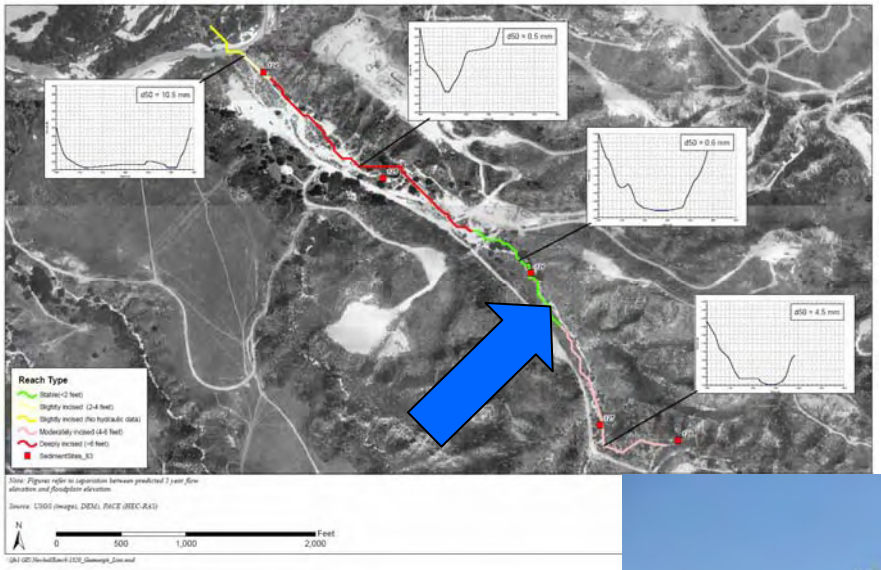
APPENDIX A-14

Point 63 –
Stable channel, oak habitat



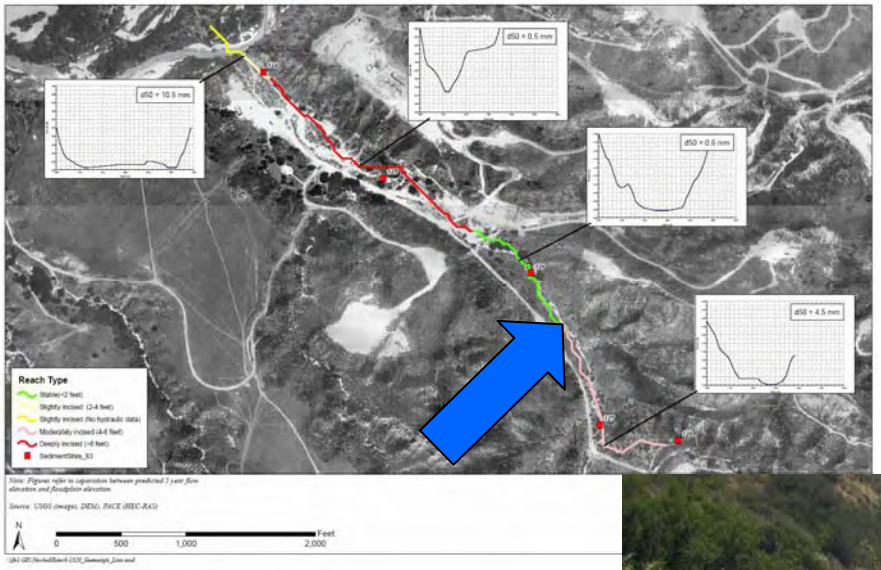
APPENDIX A-15

Point 70 – Relatively stable channel, some erosion of outer (west) bank



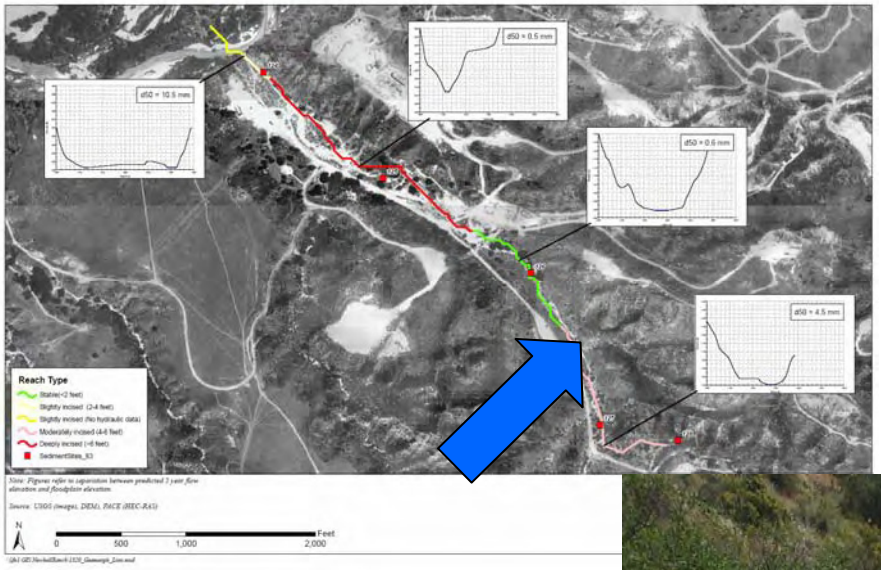
APPENDIX A-16

Point 77 – Stable reach



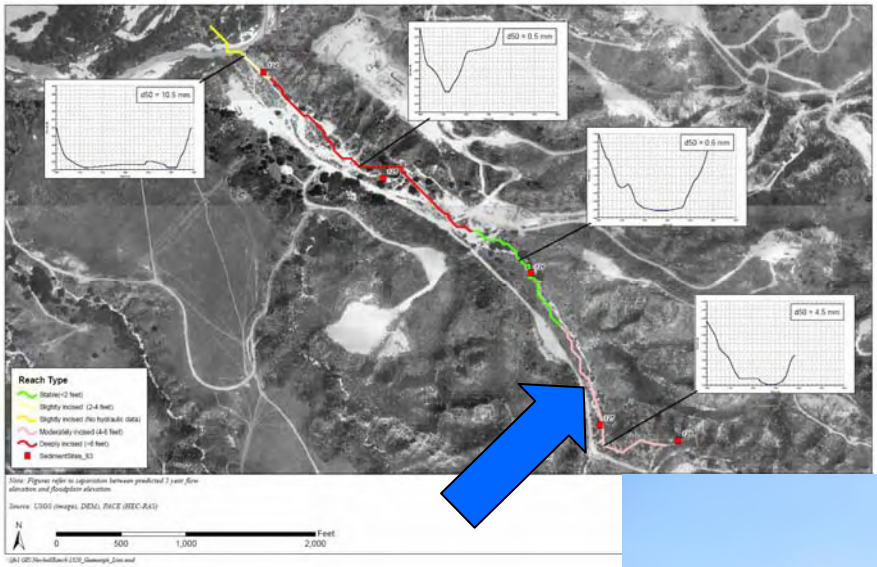
APPENDIX A-17

Point 82 –
Upstream boundary of stable reach, from this point upstream channel slightly incised



APPENDIX A-18

Point 88 –
Relatively stable section, slight channel incision

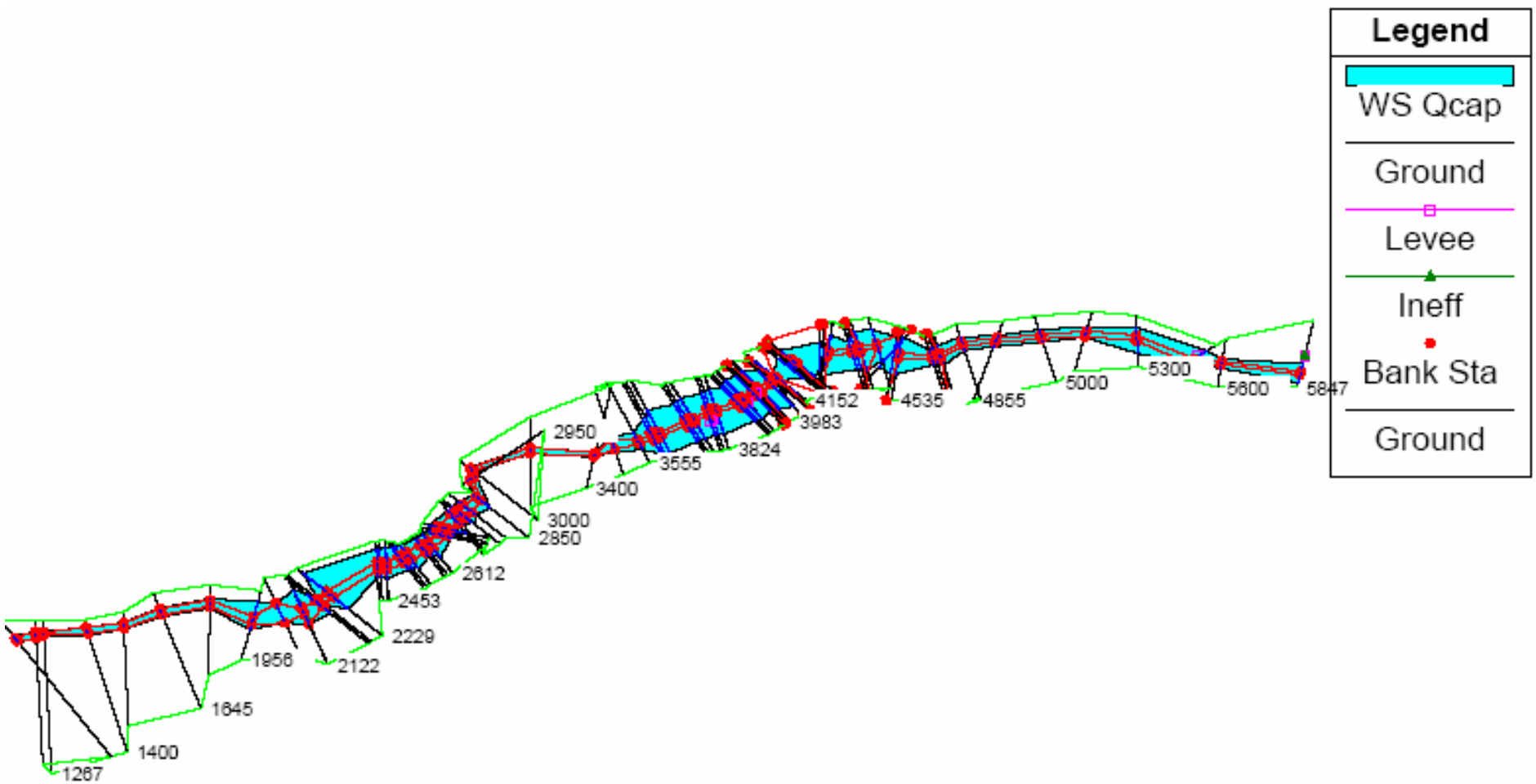


APPENDIX A-19

Point 97 – Slightly incised section, steep and undercut west bank

APPENDIX A-20

Point 106 – Upstream limit of project reach, start of defined channel



Source: PWA HEC-RAS Hydraulic Model

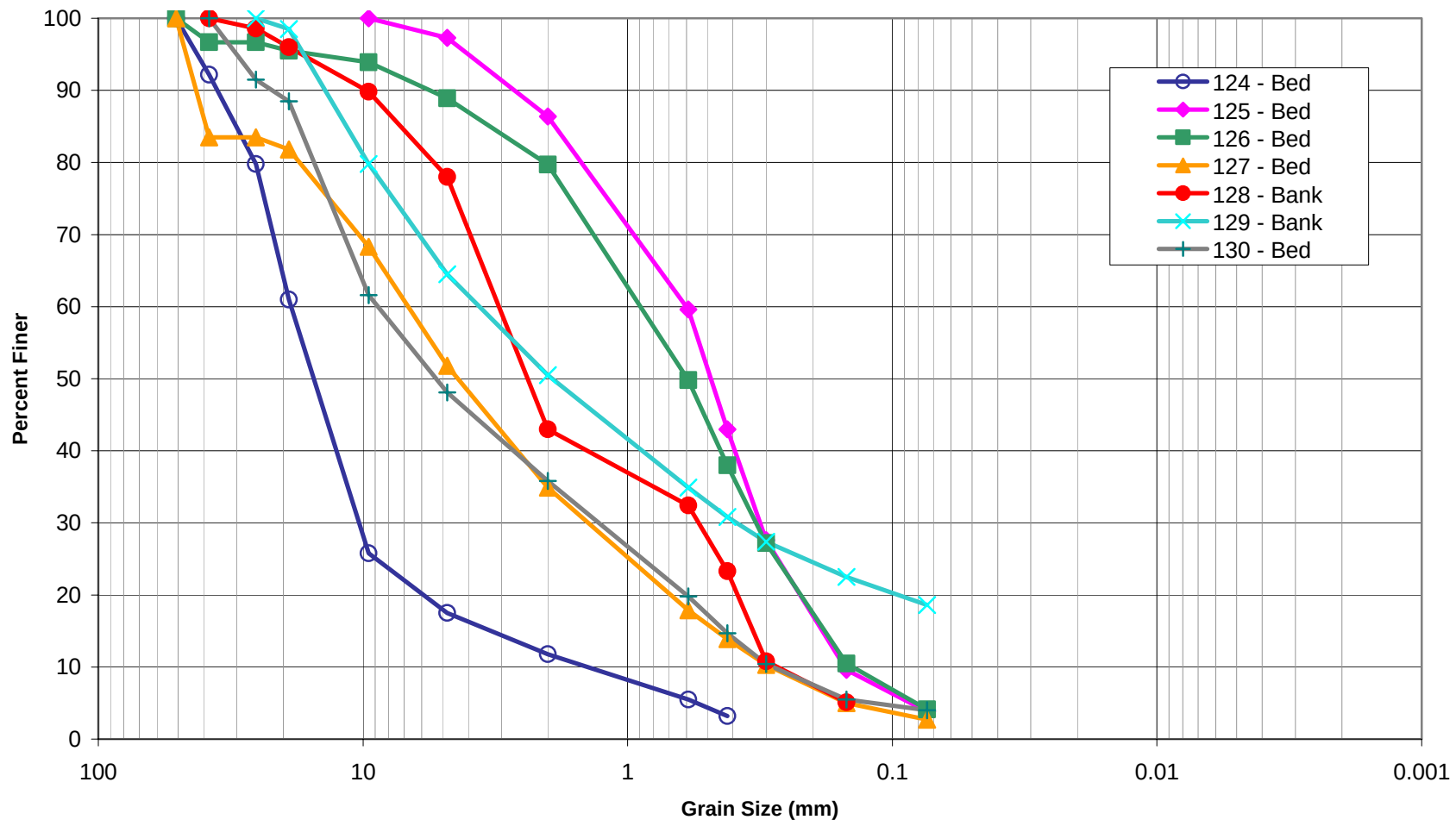
Appendix B

Newhall Ranch – Basis of Design: Lion Canyon

Schematic of HEC-RAS Hydraulic Model

PWA Ref# 1820

PWA



Source: Analysis of PWA bulk samples
Notes: Sample numbers increase from upstream to downstream along the longitudinal profile

Appendix C
Newhall Ranch – Basis of Design: Lion Canyon

Lion Canyon Bed Material Size

PWA Ref# 1820

PWA

APPENDIX G

G. GEOTECHNICAL EVALUATION OF INFILTRATION, VESTING TENTATIVE TRACT MAP NUMBER 61105, MISSION VILLAGE, NEWHALL RANCH, LOS ANGELES COUNTY, CALIFORNIA

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

January 26, 2010

Newhall Land and Farming Company
23823 West Valencia Boulevard
Valencia, California 91355

Job No. 94-502-60

Attention: Mr. Corey Harpole

Subject: Geotechnical Evaluation of Infiltration
Vesting Tentative Tract Map No. 61105
Mission Village, Newhall Ranch
Los Angeles County, California

Reference: See Attached References

Ladies and Gentlemen:

This submittal provides the results of R.T. Frankian & Associates (RTF&A) evaluation of rainfall and storm water infiltration relative to development of Mission Village (Vesting Tentative Tract Map No. 61105), Newhall Ranch, Los Angeles County, California. The evaluation was performed to assist Geosyntec Consultants in preparation of the Los Angeles County Low-Impact Development (LID) Ordinance Equivalency Analysis for the site. Specifically, RTF&A evaluated the geologic, geotechnical, and hydrogeologic site conditions to determine: 1) areas where the infiltration rate, or permeability, of the existing soil and/or rock units is above 0.5 inches/hour (in/hr); and 2) areas where rainfall and stormwater infiltration could adversely impact the future site development, from a geotechnical standpoint.

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SITE DESCRIPTION

The Mission Village site covers a total area of approximately 1,253 acres in the eastern portion of Newhall Ranch, Los Angeles County, California. The site is bounded by the Santa Clara River on the north and northwest, Magic Mountain Theme Park (Parcel Map 12337) and Vesting Tentative Tract Map (VTTM) 53295 on the west, VTTM 061996 on the south, and VTTM 060678 on the southwest. Site elevations range from 940 feet above mean sea level (msl), along the Santa Clara River, to 1,510 feet msl, in the southern portion of the project site. The topography in the northern and western portions of the site, along the Santa Clara River, is dominated by gently sloping mesas bordered by steep bluffs (including Airport Mesa and Exxon Mesa), and northwesterly-draining canyons. The central and eastern portions of the project site are characterized by moderate to moderately steep, north- to northeast-trending bedrock ridges and intervening canyons (including the northerly-draining Magic Mountain Canyon, along the eastern site boundary).

The site is largely undeveloped with the exception of roads and pads associated with past site usages that have included cattle grazing, agricultural activities, and petroleum exploration. Near-vertical or very steep cut slopes are commonly associated with several of the former oil well drilling pads. Vegetation within Mission Village includes native grasses, scrub and chaparral, as well as oak trees.

PERMEABILITY – EXISTING CONDITIONS

For the purpose of this evaluation, the geologic materials within the Mission Village site have been divided into five mappable units consisting of alluvial deposits within the major canyons (map unit "Qal"); landslides ("Qls"); terrace deposits

("Qt"); upper Saugus Formation units ("TQs_u"); and lower Saugus Formation units ("TQs_l"). Shallow surficial deposits overlying the Saugus Formation have been grouped with the Saugus formation for the purposes of this evaluation.

The approximate areal distribution of these units is depicted on the Geologic Map, Figure 1. Limited permeability testing of some of these units was performed by Allan E. Seward Engineering Geology, Inc. (AES) as described in their December 23, 2009 report. Presented below is a summary of the AES findings as it relates to the geologic units within Mission Village.

- Alluvial deposits within lower Middle Canyon, lower Magic Mountain Canyon, and Dead End Canyon: typically fine-grained with permeabilities less than 0.5 in/hr. Alluvial deposits within Lion Canyon, upper Middle Canyon, and upper Magic Mountain Canyon locally coarse-grained, but permeabilities undetermined.

- Landslides: permeabilities undetermined. Most landslides will be removed during grading. Water infiltration into remaining landslides should be avoided due to potential settlement or destabilization of slide mass.

- Terrace deposits: at Airport Mesa and Exxon Mesa, terrace deposits are typically capped by low permeability, fine-grained soils with permeabilities of 0.01 in/hr. Deeper portions are commonly coarse-grained and, if exposed, may have permeabilities above 0.5 in/hr

- Saugus Formation: permeabilities undetermined. The lower member of the Saugus Formation consists primarily of sandstone with conglomerate, siltstone, and mudstone interbeds. The upper member contains more silty sandstone and mudstone interbeds. The coarse-grained sandstone and conglomerate units may have permeabilities greater than 0.5 in/hr The lower member of the Saugus Formation will likely have permeabilities well below the 0.5 in/hr threshold.

The permeability characteristics of the coarse-grained sandstone and conglomerate units of the Saugus Formation are controlled by the level of cementation/induration of the individual beds, which varies both laterally and vertically within each bed. Hydraulic conductivity testing of wells established in Saugus Formation units within nearby Chiquita Canyon landfill indicates that permeabilities for the coarse-grained sandstone and conglomerate beds have an average conductivity of 0.04 in/hr (RTF&A, 2005), based on testing of 10 discrete beds. Beds which may meet the permeability criteria can not be easily quantified or identified at the site. Consequently, for planning purposes, we are classifying all Saugus Formation units as having permeabilities below 0.5 in/hr

Based on the AES testing, and our familiarity with the geologic units within Mission Village, existing materials that could potentially meet or exceed the permeability threshold of 0.5 in/hr are the alluvial deposits within Lion Canyon, upper Middle Canyon, upper Magic Mountain Canyon, and the terrace deposits. These areas are designated by the "yellow" (alluvium) and "orange" (terrace deposits) colored units on Figure 1. Terrace deposits that were considered for potential infiltration are confined to graded areas only.

The upper and lower Saugus Formation units, landslides, and alluvial deposits near the mouth of Middle Canyon and Magic Mountain Canyon are classified as materials not meeting the 0.5 in/hr permeability threshold. The relatively shallow surficial deposits overlying the upper and lower Saugus Formation units (i.e., af, Qsw, Qsf, and Qal) were excluded as not being deep enough for effective infiltration. Additionally, geotechnical recommendations call for the removal of the shallow surficial deposits during site grading. The upper and lower Saugus units are

designated as "green" and "purple", respectively, on Figure 1. The landslides are designated "gray" and alluvial deposits with low infiltration rates as "brown".

PERMEABILITES – GRADED CONDITIONS

Mission Village will be developed for residential and commercial use, with associated infrastructure. Included in the development will be an elementary school, library, park sites, a water tank site, water quality basins, a fire station, and a spineflower preserve. Major roadways will include the extensions of Mountain Parkway, Westridge Parkway, and Commerce Center Drive through the project site.

Conventional cut-and-fill grading will be used to develop level building pads. The maximum anticipated cut slope will be approximately 140 feet high; the highest proposed fill slope is approximately 130 feet high.

The consideration of potential infiltration areas must take into account the geologic units that will be exposed at or near final grade once grading operations have been completed. Major canyons, gullies, or other low-lying areas within the site will generally be filled with engineered fill created by the cutting of adjacent bedrock ridges. The cutting of the ridges will result in pads exposing both units of the Saugus Formation and terrace deposits, and to a lesser extent, alluvial deposits. RTF&A has evaluated potential infiltration areas based on the current cut-fill configuration and relative to the underlying geologic units. The areas are summarized below:

- Cut areas exposing Saugus Formation units are classified as not meeting the permeability threshold of 0.5 in/hr, as described above. Saugus Formation units constitute the majority of the geologic materials that will be exposed in future cut areas.

- Terrace deposits exposed in future cut areas could meet the permeability criteria. Most of the terrace deposits are present on Airport Mesa and Exxon Mesa.

- Alluvial deposits in the canyons and gullies could meet the permeability criteria. Most of the alluvial deposits that will remain at the completion of grading will be buried by fill materials.

The areas that could meet the permeability criteria, and are within the tract boundary, are defined on Figure 1 by the red hatching.

Permeability of fill samples fabricated by AES (2009) indicate that fill materials derived from the on-site geologic units, and consisting of a mix of fine- and coarse-grained materials, have permeabilities below the 0.5 in/hr threshold. The exception are the fill samples created solely from coarse-grained alluvium, including alluvium collected from Long Canyon, where the permeabilities ranged from 2.8 in/hr to 25.5 in/hr. The vast majority of compacted fill soils placed at the subject site are expected to have permeabilities well below 0.5 in/hr

In evaluating potential post-grading infiltration areas, RTF&A considered near-surface infiltration devices, infiltration basins, and dry wells as the most viable options for infiltration at the site. The selection of these methods are based on a review of the various infiltration methods presented in the LID Manual (2009), and the advantages/disadvantages associated with the outlined methods.

Infiltration basins or near-surface infiltration devices were considered in areas where soils with favorable permeability are exposed at future proposed grades. Limitations for use of infiltration basins include groundwater within 10 feet of the bottom of the proposed basins and down gradient areas where the addition of water could result in a geotechnical hazard.

Dry wells were considered for future fill areas where the anticipated fill materials do not meet the minimum 0.5 in/hr infiltration rate; the dry wells would extend through the fill and be established in natural materials with acceptable infiltration rates. The LID Manual (2009) states that dry wells are not suitable for fill sites. For this evaluation, we have conservatively assumed that fills at a specific location would have to be greater than 25 feet to be considered a fill site. When considering dry wells for fill areas, we have assigned a practical depth for dry wells as 25 feet or less, which also corresponds to limitations resulting from the definition of a fill site. The following criteria were utilized in identifying areas suitable for dry wells:

- at least 10 feet of permeable material is required below the upper infiltration point;
- infiltration of water can not occur into any layer that is at a higher elevation than the toe of any adjacent cut or fill slope;
- the historic high water table must be at least 10 feet below the outlet of a dry well; and
- infiltration can not pose a surficial or gross stability hazard to the performance of any adjacent natural, cut, or fill slopes.

GEOTECHNICAL HAZARDS ASSOCIATED WITH INFILTRATION

GENERAL

From a geotechnical perspective, as a rule, it is desirable to reduce water infiltration into the subsurface, due to adverse effects of subsurface water on slope stability and settlement or consolidation of on-site earth materials. Taking into

account the geologic and geotechnical conditions within Mission Village, it is RTF&A's opinion that intentional storm water infiltration should not be permitted for the following locations:

- areas of landslides;
- areas with adverse geologic structure;
- areas with a high groundwater table;
- areas where the liquefaction hazard and/or seismically induced settlements could be increased;
- areas where infiltration would result in water seepage at the face of natural or graded slopes; or
- areas where proposed improvements, such as pools, subsurface utilities, and streets could become distressed.

ALLUVIAL AREAS

Recommendations for proposed fill areas within Mission Village include the removal of all unsuitable alluvial materials to minimize the geotechnical hazards of liquefaction or hydroconsolidation (AES, 2004; RTF&A, 2009). Evaluation of liquefaction potential utilizes the historic high groundwater level in the analyses. The historic high level at the site is as high, or higher, than the seasonal high level recommended for usage in the LID Manual for assessing infiltration feasibility, based on a review of water well records for nearby wells. The concentrated addition of water at specific locations, especially when considering dry wells, could raise the groundwater level above the historic high, creating a greater liquefaction hazard.

Materials susceptible to hydroconsolidation will be removed and replaced as engineered fill during grading. Consequently, water infiltration associated with infiltration basins or dry wells will not influence hydroconsolidation of natural or fill materials. Water infiltration could increase the effective weight of natural and fill soils, which would increase the anticipated settlement of the engineered fill and natural soils.

LANDSLIDES

Landslides at the site have been identified on Figure 1. It is recommended that all but four of the landslides will be entirely removed during the site grading (AES, 2004 and RTF&A, 2009). The four remaining landslides will be partially removed and stabilized in-place. To avoid potential destabilization, any water infiltration in and around the area of these four landslides should not be permitted.

SLOPE STABILITY

Areas of potentially adverse and unstable geologic structure within Mission Village have been previously identified by AES (2004) and RTF&A (2009). Buttresses or stability fill slopes have been recommended for these areas. These areas are underlain by Saugus Formation units and have been eliminated for consideration as water infiltration areas due to permeabilities below the 0.5 in/hr threshold.

Infiltration of storm water that could laterally migrate to the face of cut or fill slopes should be avoided to minimize deep-seated or shallow slope instability. Most of the natural slopes are underlain by Saugus Formation units and are precluded for infiltration consideration as discussed above. The terrace deposits capping Airport

Mesa and Exxon Mesa are anticipated to be suitable for infiltration from a permeability perspective.

SHALLOW GROUNDWATER

The LID Manual (2009) indicates that areas where the "seasonal high groundwater table is within 10 feet of the surface" is exempt from consideration of water infiltration. With respect to the Mission Village project, these areas include the Santa Clara River, and the mouth or lower portion of Middle Canyon where a spring is present. In the remainder of the Mission Village site, the seasonal high groundwater table is well below future site grades.

CONCLUSIONS

The information summarized in this report was utilized to designate the areas within the proposed grading limits that have a permeability rate greater than 0.5 in/hr within the tract boundary. These areas are indicated with red hatching on the Geologic Map, Figure 1. Each of the red hatched areas presented on Figure 1 was evaluated relative to the limitations discussed in this report and the proposed site development. Areas considered suitable for infiltration after the completion of the proposed grading operations are indicated in blue hatching on the Potential Infiltration Areas, Figure 2. The red hatched areas on Figure 1, not considered suitable for infiltration, are discussed below.

During project grading, RTF&A should perform geologic mapping of cuts within the Saugus Formation for the purpose of identifying and delineating sandstone and conglomerate beds that may meet or exceed the 0.5 in/hr permeability threshold.

Additional areas for consideration of storm water infiltration could be recommended at that time. Conversely, areas considered acceptable for infiltration, based on the parameters set forth in this document, should also be evaluated during grading to confirm conformance with the 0.5 in/hr threshold.

TERRACE DEPOSITS

The terrace deposits within cut areas of the site have been included as materials that may meet or exceed the infiltration threshold. However, due to the presence of the less permeable Saugus Formation below the terrace deposits, it is anticipated that there will be significant water seepage where the terrace deposits/Saugus Formation contact is exposed at finished grade. This seepage could be adverse to the surficial and gross stability of cut, fill, and natural slopes and would need to be evaluated at the grading plan review level and during site grading. Any potential seepage into natural or restored areas would need to be investigated for any adverse impacts to biological resources.

COMPACTED FILL

The proposed elevation changes require mass grading which does not allow for fill placement to be performed only within individual building footprints, as suggested in the LID Manual. At the completion of grading, the majority of the site will consist of deep, relatively impervious compacted fills or low permeability Saugus Formation units. The majority of the compacted fill soils placed at the site will be derived from the upper and lower Saugus Formation units. Permeability studies performed by RTF&A for adjacent Chiquita Landfill, and our experience with fills

derived from these materials in the Santa Clarita Valley, indicate that the overall permeability of the fill being below 0.5 in/hr. Percolation testing by AES (2009) also indicates that the resulting permeability of the fill will be low. Within the fill areas, the method of infiltration primarily considered was dry wells that would extend to more permeable underlying materials, such as alluvium or terrace deposits. Within the compacted fill areas, there were not any natural permeable materials within 25 feet of proposed fill grade. Infiltration in compacted fill material is not recommended due to the anticipated percolation rate generally being well below 0.5 in/hr and the depth of fill exceeding the practical depth limit for dry wells of 25 feet.

ALLUVIUM

We have identified alluvial areas suitable for percolation in blue hatching on the Potential Infiltration Areas, Figure 2. These designated areas are generally located between the toe of proposed fill slopes and the tract boundary. Due to the liquefaction mitigation, the depth of removals in graded alluvial areas generally ranges from 10 to 20 feet, and the sites grades are generally being elevated. All of the alluvial deposits within the internal canyon areas within the grading limits are generally overlain with significant fill thickness which precludes percolation as discussed in the "Compacted Fill" section of this report.

LIMITATIONS

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for Newhall Land and Farming Company and their design consultants, to be used solely for planning and design of the Mission Village project, and associated grading. The report has not been prepared for use by other parties and may not contain sufficient information for purposes of other parties or other uses.

-oOo-

We appreciate the opportunity to be of service. Please call if you have questions or would like to discuss this report in more detail.

The following are attached and complete this report.

- References
- Geologic Map - Figure 1 (in pocket)
- Potential Infiltration Areas - Figure 2 (in pocket)

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STATE OF CALIFORNIA

Respectfully submitted,

R. T. FRANKIAN & ASSOCIATES

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Principal Engineering Geologist

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and: Alan W. Rasplicka
Principal Geotechnical Engineer

Distribution: (1) Newhall Land & Farming Company
Attn: Mr. Corey Harpole
("wet signed", stamped copy with 1 CD of pdf file)
(1) Geosyntec Consultants
Attn: Mr. Aaron Poresky

RTF&A
GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

REFERENCES

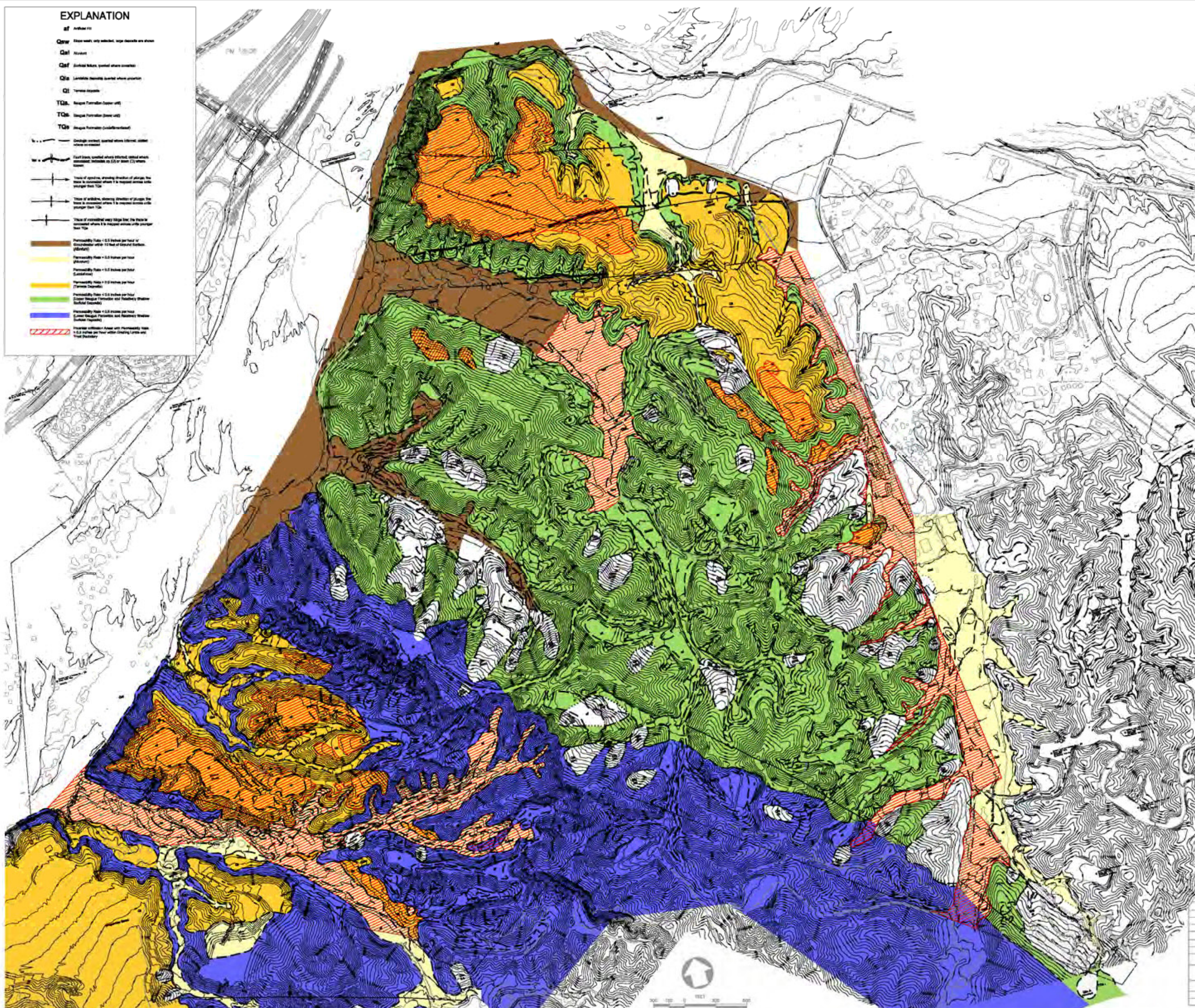
Frankian, R. T. & Associates, 2005, "Well Installation and Aquifer Testing Report," for Chiquita Canyon Landfill, dated August 26, 2005, Job No. 2002-036-91.

Frankian, R. T. & Associates, 2009, "100-Scale Plan Review, Revised Vesting Tentative Tract Map No. 61105, Mission Village, Newhall Ranch, Los Angeles County, California" for Newhall Land & Farming Company, dated December 21, 2009, Job No. 94-502-21

Los Angeles County, 2009, "Low Impact Development Standards Manual," dated January, 2009.

Seward, Allan E., Engineering Geology, Inc., 2004, "Geologic and Geotechnical Report Review of Vesting Tentative Tract Map 61105 (Dated June 14, 2004)" for Mesas East VTT61105, dated July 22, 2004, Job No. 04-2023-4.

Seward, Allan E., Engineering Geology, Inc., 2009, "Geologic/Geotechnical Report, Preliminary Infiltration Parameter Assessment, Newhall Ranch Specific Plan Area, Newhall Ranch, Entrada, Legacy Village, and PM 18108, Los Angeles County, California," for The Newhall Land and Farming Company, dated December 29, 2009, Job No. 09-115UE.



VICINITY MAP

NOT TO SCALE

EARTHWORK:

Area	Adjusted Cut Volume (CY)	Adjusted Fill Volume (CY)
Mission Village On-site	28,000,000	28,400,000
Magic Mountain Parkway Off-site	900,000	500,000
Offsite Utility Corridor	[illegible]	[illegible]
Total	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

PROJECT SUMMARY:

[illegible]

ASSESSOR'S PARCEL NUMBERS (APN)

Mission Village

[illegible]

GENERAL NOTES:

[illegible]

SURVEY NOTES:

[illegible]

LEGEND:

Lot 1

[illegible]

SHEET INDEX

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	SECTIONS & EASEMENTS
3	ONSITE VTTM
4	ONSITE VTTM
5	ONSITE VTTM
6	ONSITE VTTM
7	ONSITE VTTM
8	MAGIC MOUNTAIN PKWY EXTENSION
9	SEWER - INTERIM & ULTIMATE CONDITIONS & SCE SUBSTATION ALTERNATIVES
10	LARGE LOT PARCEL MAP AND PHASING MAP
11	OFFSITE UTILITY CORRIDOR
12	OFFSITE UTILITY CORRIDOR

SPECIAL NOTES:

[illegible]

OFF-SITE IMPROVEMENTS:

[illegible]

UTILITY PROVIDERS:

SEWER: L.A. COUNTY SANITATION DIST. 32 AND NEWHALL RANCH WRP
WATER: VALENCIA WATER COMPANY
ELECTRICAL: SOUTHERN CALIFORNIA EDISON
GAS: SOUTHERN CALIFORNIA GAS CO.
TELEPHONE: AT&T
CABLE TV: TIME WARNER CABLE

EX	EXISTING	SF	SQUARE FOOT	RW	RECLAIMED WATER
FM	FORCE MAIN	SD	STORM DRAIN	CLWA	CASTAIC LAKE WATER AGENCY
HP	HIGH POINT	SS	SANITARY SEWER	PVT	PRIVATE DRIVE
L	LENGTH	STD	STANDARD	P & F	PRIVATE AND FUTURE STREET
MIN	MINIMUM	R/W	RIGHT OF WAY	REC	RECREATION
GB	GRADE BREAK	W1	WATER ZONE - 1	O.S.	OPEN SPACE
PROP	PROPOSED	W2	WATER ZONE - 2	RUA	RESTRICTED USE AREA
R	RADIUS	W3	WATER ZONE - 3		

KEY MAP
NOT TO SCALE

LEGAL DESCRIPTION:

PARCELS 11, 12, 13, 22 AND A PORTION OF PARCEL 14 OF PARCEL MAP 24500-01, IN THE UNINCORPORATED TERRITORY OF THE COUNTY OF LOS ANGELES, AS SHOWN ON MAP FILED IN BOOK 293 PAGES 34 TO 87 INCLUSIVE, OF PARCEL MAPS, RECORDS OF LOS ANGELES COUNTY.

No. 55639 Exp. 12-31-10 CIVIL STATE OF CALIFORNIA

PSOMAS

MATTHEW G. HEDEMAN R.C.E. NO. 55639 DATE

DESIGNED: MGH/DE
DRAFTED: DE/MS
CHECKED: MGH

OWNER/DEVELOPER:

NEWHALL LAND

23823 WEST VALENCIA BOULEVARD
VALENCIA, CALIFORNIA 91355
TELEPHONE: (661) 255-4000
REPRESENTATIVE: COREY HARPOLE

MAJOR LAND DIVISION
VESTING TENTATIVE TRACT MAP
NO. 61105

COUNTY CASE NO. ______

LOCATED IN THE UNINCORPORATED AREA OF THE COUNTY OF LOS ANGELES STATE OF CALIFORNIA

REV: ______
DATE: 11/24/09
PROJECT NO.
SHEET 1 OF 12

[redacted]

RTFA

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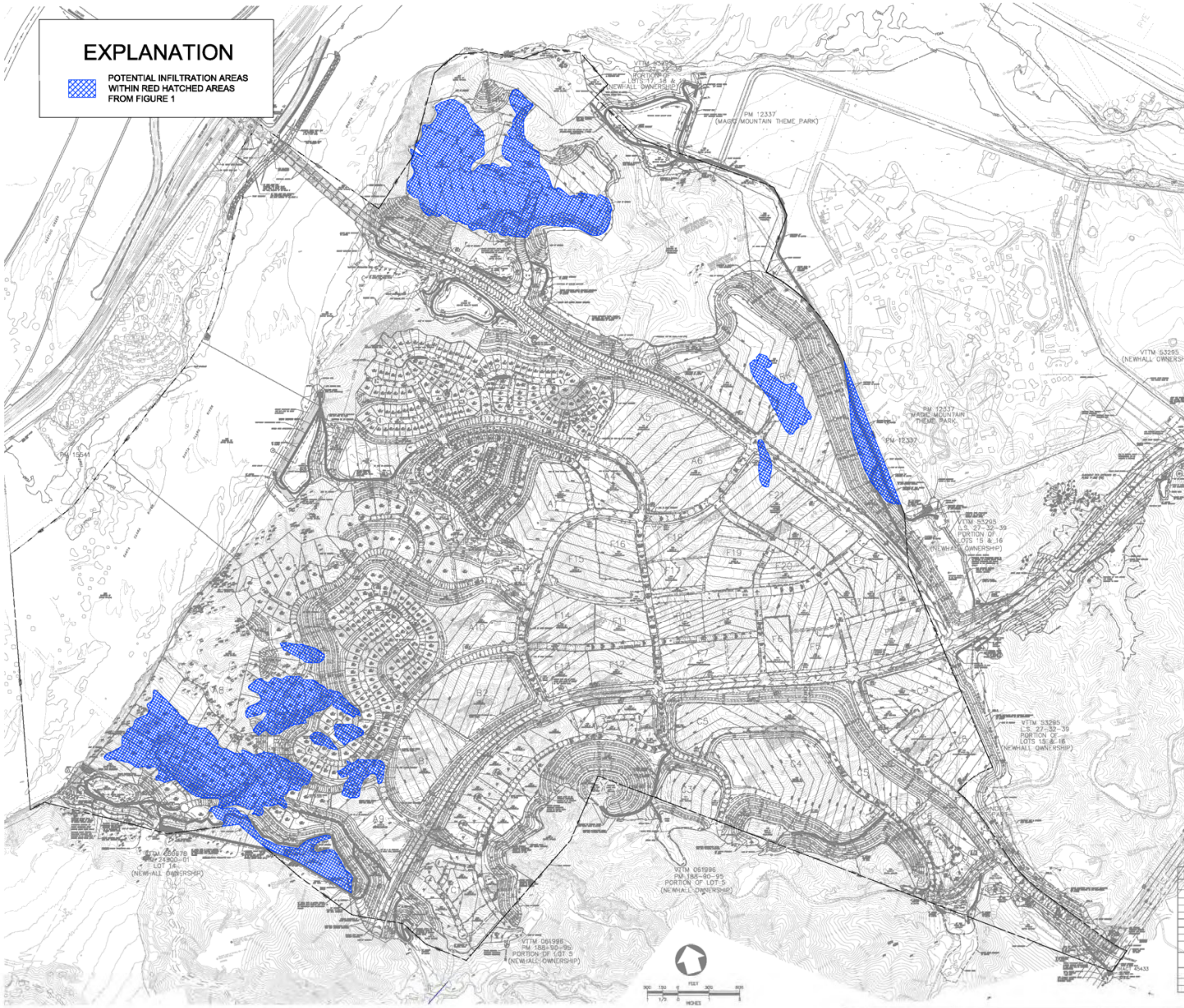

VICINITY MAP

NOT TO SCALE

EARTHWORK:

Area	Adjusted Cut Volume (CY)	Adjusted Fill Volume (CY)
Mission Village On-site	28,000,000	28,400,000
Magic Mountain Parkway Off-site	900,000	500,000
Off-site Utility Corridor	618,000	618,000
Total	29,518,000	29,518,000
Off-site SCE Substation (Alt 1)	7,000	7,000
Off-site SCE Substation (Alt 2)	139,000	3,000
Disposal Site For Alt 2	0	136,000

PROJECT SUMMARY:

GROSS AREA – 1252.8 Acres
TOTAL LOTS – 658
TOTAL D.U. – 4,412
EXISTING ZONING – SP (NEWHALL RANCH SPECIFIC PLAN)
PROPOSED ZONING – SP (NEWHALL RANCH SPECIFIC PLAN)
GENERAL PLAN LAND USE – SP (NEWHALL RANCH SPECIFIC PLAN)

Lot Numbers	No. of Lots	Type (Use)	Dwelling Units	Total Acres
Area A1				
157	1	Elementary School		9.5
Area A2				
1–123	123	38'x110' SFD (5,000 sf) min.	123	26.7
124–139	16	Open Space		12.8
140–149	10	Private & Future Street		8.2
Area A3				
550–640	91	50'x80' SFD (4,000 sf) min.	91	10.2
641–645	5	Open Space		6.7
Area A4				
158	1	Condominiums	60	5.1
159–160	2	Open Space		0.9
Area A5				
161	1	Condominiums	153	13.1
Area A6				
162	1	Condominiums	201	12.6
Area A7				
163–176,178–258	95	65'x110' SFD (7,150 sf) min.	95	22.5
177	1	Recreation		0.3
259–273	15	Open Space		6.3
274–278	5	Private & Future Street		6.4
Area A8				
279–351	73	1ac/lot avg. SFD*	73	73.0
352	1	Water Quality Basin		2.8
353–358,360,362–366	10	Open Space		34.6
368–370	3	Private & Future Street		11.5
371–375	5	Private Drive		2.8
Area A9, A10, B1 and B2				
361	1	Area A9 Condominiums	60	6.7
376	1	Area A10 Condominiums	80	9.4
377–379	3	Open Space (LDZ)		0.7
380	1	B1 Condominiums	92	12.7
381	1	B2 Condominiums	186	14.2
382–383	2	Open Space (LDZ)		1.8
Area C1				
384–387	4	Age Qualified Condominiums	63	9.7
388–390	3	Private Drive		1.8
391–395	5	Open Space		8.3
396	1	Fire Access Road		0.5
Area C2				
397–407, 411	12	Age Qualified Condominiums	113	17.7
408–410, 412	4	Private Drive		1.7
414–422	9	Open Space		30.3
423	1	Water Tanks		1.4
Area C3				
424	1	Recreation Center		4.6
425	1	Open Space		1.6
426	1	Open Space (LDZ)		0.4
Area C4				
427	1	Age Qualified Condominiums	128	21.3
428–431	4	Open Space		18.3
Area C5				
434	1	Age Qualified Condominiums	88	16.3
435–437	3	Open Space		12.9
438	1	Open Space (LDZ)		< 0.1
Area C6				
439	1	Age Qualified Condominiums	34	7.3
440	1	Open Space		1.9
441–442	2	Open Space (LDZ)		0.1
Area C7				
443	2	Apartment/Condominium	96	4.6
444	2	Open Space (LDZ)		0.1
Area C8				
445		Apartment/Condominium	179	6.7
446		Open Space (LDZ)		0.6
Area C9				
447	1	Mixed Use Commercial 154,000 sf		6.6
449, 451–452	3	Open Space		11.7
453–454	2	Open Space (LDZ)		1.0
455–459	5	Private Drive		13.1
460–467	8	Open Space (LDZ)		3.8
Area D1				
468	1	Apartment/Condominium	326	10.3
470–475	6	Open Space		37.0
476–479	4	Open Space (LDZ)		0.6
Area E1				
480–484	5	Mixed Use Commercial 697,000 sf		38.1
485	1	Private Drive		1.5
486	1	Water Quality Basin		1.8
487–495, 498–499	11	Open Space		45.4
502–507	6	Open Space (LDZ)		4.0
Village Center				
F1 508	1	Mixed Use Commercial 337,170 sf		6.9
F2 530	1	Mixed Use Commercial 35,000 sf		2.4
F3 509, 510	2	Mixed Use Commercial 139,100 sf		5.2
F4 511	1	Mixed Use Residential/Commercial 48,100 sf	264	5.1
F5 512	1	Mixed Use Residential/Commercial 18,300 sf	272	4.5
F6 513	1	Apartment/Condominium	96	3.2
F7 514	1	Apartment/Condominium	216	7.8
F8 515	1	Library		4.0
F9 516	1	Transit		1.2
F10 517	1	Condominiums	99	3.6
F11 518	1	Condominiums	96	4.4
F12 519	1	Condominiums	128	5.1
F13 520	1	Condominiums	96	5.1
F14 521	1	Condominiums	105	6.7
F15 522	1	Condominiums	126	7.8
F16 523	1	Condominiums	114	5.3
F17 524	1	Condominiums	87	3.5
F18 525	1	Condominiums	120	6.5
F19 526	1	Recreation Center		6.9
F20 527	1	Private Park		2.9
F21 528	1	Continued Care Retirement Community	351	13.6
F22 529	1	Mixed Use Commercial 126,430 sf		2.4
531–532	2	Open Space		3.0
533–540	8	Private Drive		13.8
541–549	9	Open Space (LDZ)		3.7
Miscellaneous				
150–156	7	Open Space		12.8
357, 646, 654	3	Sewer Lift Station		0.5
358–359	2	Open Space (Lyon Cyn)		17.3
367, 655	2	Open Space (River Adjacent)		27.2
413, 432, 450, 497	4	Debris Basin		3.6
433	1	Water Facilities		1.4
448	1	Fire Station		1.5
469	1	Park		21.0
496, 547, 656	3	Water Quality Basin		13.7
500–501	2	Spineflower Preserve		85.7
648	1	Open Space		1.8
649	1	CCD Bridge		3.7
650–651, 657–658	4	Open Space (River)		218.0
652	1	Open Space		4.5
653	1	Park		8.2
		Public R/W		67.7
		CALTRANS R/W		2.2
Total	658		4412	1252.8

* ALLOWS 73 SECONDARY UNITS (1/LOT)

ABBREVIATIONS:
MMP = MAGIC MOUNTAIN PARKWAY   SFD = SINGLE FAMILY DWELLING UNIT
CCD = COMMERCE CENTER DRIVE   LDZ = LANDSCAPE DEVELOPMENT ZONE

ASSESSOR'S PARCEL NUMBERS (APN)

Mission Village	
2826-002-022	2826-003-028
2826-003-021	2826-003-029
2826-003-022	2826-003-030
2826-003-023	2826-003-031
2826-003-024	2826-007-019
2826-003-025	2826-008-030
2826-003-026	2826-009-081
2826-003-027	
Off-Site Improvements	
Easterly Extension of Magic Mountain Parkway	
2826-008-030	2826-008-020
2826-007-016	
Water Quality Basin	
2826-007-019	
Utility Corridor	
2826-003-031	2826-002-021
2826-004-040	2826-002-023
Electrical Substation Alt 1	
2826-123-002	
Electrical Substation Alt 2	
2826-009-104	

GENERAL NOTES:

1. GRADE ELEVATIONS ON THE VTTM ARE APPROXIMATE. CHANGES IN THE ELEVATIONS DEPICTED ON THE TENTATIVE MAP WHICH WILL NOT SUBSTANTIALLY ALTER THE APPROVED GRADING PLAN OR RESULT IN PAD ELEVATION CHANGES OF MORE THAN 10 FEET ARE PERMITTED SUBJECT TO THE PROVISIONS OF SECTION 5.2 OF THE NEWHALL RANCH SPECIFIC PLAN.
2. PERMISSION IS REQUESTED FOR LOT LINES TO BE ADJUSTED TO THE SATISFACTION OF DRP AND DPW PROVIDED NO ADDITIONAL DEVELOPABLE LOTS ARE CREATED. THE DEGREE OF ADJUSTMENT SHALL BE CONSISTENT WITH THE INTENT OF THE SUBDIVISION MAP APPROVAL AND THE SUBDIVISION MAP ACT.
3. ALIGNMENT AND GEOMETRICS OF STREETS AND TRAILS ARE APPROXIMATE. PERMISSION IS REQUESTED FOR ADJUSTMENTS TO STREETS TO BE MADE PROVIDED THE DEPARTMENT OF PUBLIC WORKS AND DRP DETERMINE THAT THE ADJUSTMENTS ARE CONSISTENT WITH THE INTENT OF THE SUBDIVISION APPROVAL. ADJUSTMENTS TO TRAILS CAN BE MADE WITH APPROVAL BY DRP AND THE DEPARTMENT OF PARKS AND RECREATION.
4. BUILDING FOOTPRINTS SHOWN ON THE TENTATIVE MAP OR ACCOMPANYING SITE PLAN EXHIBIT MAPS ARE ONLY FOR ILLUSTRATIVE PURPOSES. RELOCATION OF BUILDINGS, OR ADJUSTMENTS IN BUILDING SQUARE FOOTAGE, NUMBER OF BUILDINGS, PARKING REQUIREMENTS AND OTHER FEATURES WHICH WILL NOT RESULT IN AN INCREASE IN TOTAL SQUARE FOOTAGE OR THE NUMBER OF DWELLING UNITS ARE PERMITTED SUBJECT TO THE PROVISIONS OF SECTION 5.2 OF THE NEWHALL RANCH SPECIFIC PLAN.
5. PERMISSION IS REQUESTED TO FILE "LARGE LOT" PARCEL MAPS OF 20 ACRES OR MORE (WITHOUT IMPROVEMENTS) OR 5 ACRES OR MORE (WITH IMPROVEMENTS) AS THE FIRST UNIT FINAL MAP. RECORDATION OF A LARGE LOT PARCEL MAP SHALL BE CONSIDERED THE FILING OF THE FIRST UNIT MAP FOR THE PURPOSES OF TIME EXTENSIONS PURSUANT TO THE SUBDIVISION MAP ACT BUT SHALL NOT REQUIRE THE OBLIGATION OF FEES, DEDICATIONS (E.G. RIGHTS OF WAY OR PARKS) EXACTIONS OR INFRASTRUCTURE EXCEPT AS MAY BE REQUIRED BY CHAPTER 21.32 OF THE SUBDIVISION MAP ACT.
6. PERMISSION IS REQUESTED FOR UNIT MAP PHASING.
7. PERMISSION IS REQUESTED TO COMBINE LOTS.
8. PERMISSION IS REQUESTED TO RECORD ADDITIONAL OPEN SPACE LOTS.
9. THE LOCATIONS OF APPURTENANT STRUCTURES (E.G., PASEOS, PEDESTRIAN BRIDGES, TRANSIT SHELTERS) MAY BE RELOCATED IF DETERMINED TO BE CONSISTENT WITH THE APPROVED TENTATIVE MAP BY DRP AND DPW.
10. PROPOSED RETAIL AND OFFICE FLOOR AREA ARE INTERCHANGEABLE IF THE REQUIRED PARKING IS PROVIDED.
11. REQUEST PERMISSION TO PHASE MASS GRADE TO THE SATISFACTION OF DRP AND DPW AND THE PROVISIONS OF THE COUNTY CODE, APPROVED PROJECT CONDITIONS AND MITIGATION MEASURES.
12. PROPOSED STREET GRADES ARE APPROXIMATE AND SUBJECT TO ADJUSTMENTS PENDING DETERMINATION OF FINAL DEVELOPMENT LAYOUT AND PLANS. ANY CHANGES SHALL BE TO THE SATISFACTION OF DPW.
13. PROVIDE PROPERTY LINE RETURN RADII OF 13 FEET AT ALL LOCAL STREET AND PRIVATE DRIVE INTERSECTIONS, AND 27 FT AT THE INTERSECTION OF LOCAL STREETS OR PRIVATE DRIVES WITH PLANNED HIGHWAYS (THOSE ON THE COUNTY HIGHWAY PLAN) AND WHERE ALL PLANNED HIGHWAYS INTERSECT OR WHERE ONE OF THE ROADS SERVES A COMMERCIAL OR INDUSTRIAL DEVELOPMENT PLUS ADDITIONAL RIGHT OF WAY FOR CORNER CUT OFF TO MEET CURRENT GUIDELINES OF THE AMERICANS WITH DISABILITIES ACT (ADA) TO THE SATISFACTION OF PUBLIC WORKS.
14. ALL DIMENSIONS SHOWN ARE APPROXIMATE.
15. TOPO COMPILED ON 11/15/06 BY HUNSAKER FROM DATA FLOWN 5/24/06.
16. REQUEST MODIFICATION OF STREET FRONTAGE REQUIREMENTS PER SECTION 21.24.040 OF THE L.A. COUNTY CODE
17. SHARED AND RECIPROCAL PARKING IS DEPICTED PER THE PROVISIONS OF THE NEWHALL RANCH SPECIFIC PLANS SUBJECT TO CONFORMANCE REVIEW OR APPROVAL OF A PARKING PROGRAM.
18. NOT ALL RETAINING WALL ARE DEPICTED ON THE TENTATIVE MAP. ADDITIONAL RETAINING WALLS MAY BE NECESSARY.

SURVEY NOTES:

VERTICAL DATUM:
LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS BENCHMARK DESCRIBED AS FOLLOWS: LACDPW L8403 RND HD SPK IN LOWER CONC HDWL @ N END 24 FT W/O C/L THE OLD RD (N HDWY) AND 0.8 MI S/O HENRY MAYO DR @ MI MKR 65.25 NEWHALL QUAD, 1985 ADJUSTMENT (NAVD 1988) ELEVATION = 1031.831

THERE IS APPROXIMATELY 3.3 FEET DIFFERENCE BETWEEN PREVIOUS COUNTY OF LOS ANGELES DATUMS BASED UPON NAVD 1929 AND NAVD 1988 (NAVD 1988 IS 3.3 FEET HIGHER THAN NAVD 1929).

AERIAL PLANIMETRY:
THIS SURVEY WAS PREPARED BY PHOTOGRAMMETRIC PROCESSES, UTILIZING AERIAL PHOTOGRAPHY DATED NOVEMBER 15, 2006. THE OUTLINE OF BUILDINGS AND OTHER ROOFED IMPROVEMENTS, MAY INCLUDE EAVES, CANOPIES AND BALCONIES, SINCE BUILDINGS BELOW THESE ITEMS ARE NOT VISIBLE TO THE CAMERA.

TOPOGRAPHY:
BY PHOTOGRAMMETRIC PROCESSES FROM LIDAR IMAGING DATED NOVEMBER 15, 2006, AND COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.

CONTOUR INTERVAL:
10 FOOT, UNLESS OTHERWISE NOTED.

LEGEND:

Lot 1 — LOT NO.
1,000 SF — LOT AREA (SQUARE FEET)
1010.0 — PAD ELEVATION
PROJECT BOUNDARY
PROPOSED RIGHT OF WAY
PROPOSED UTILITY EASEMENT
EXISTING EASEMENT
FUTURE RIGHT OF WAY
1000 — PROPOSED CONTOUR
DAYLIGHT LINE
RIDGE LINE
SD — STORM DRAIN
SS — SANITARY SEWER
W — WATER
STORM DRAIN INLET
CATCH BASIN
EXISTING POWER POLE
SEA — SEA, RIVER CORRIDOR
FEMA — FEMA
CSD — EXISTING COUNTY FLOODPLAIN
404_1603
BURIED BANK STABILIZATION
LINE OF SIGHT EASEMENT
ACCESS ROAD
SLOPE TOE PROTECTION
ABANDONED OIL WELL
EXISTING OAK TREE WITH NUMBER

SHEET INDEX

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1	TITLE SHEET
2	SECTIONS & EASEMENTS
3	ONSITE VTTM
4	ONSITE VTTM
5	ONSITE VTTM
6	ONSITE VTTM
7	ONSITE VTTM
8	MAGIC MOUNTAIN PKWY EXTENSION
9	SEWER – INTERIM & ULTIMATE CONDITIONS & SCE SUBSTATION ALTERNATIVES
10	LARGE LOT PARCEL MAP AND PHASING MAP
11	OFFSITE UTILITY CORRIDOR
12	OFFSITE UTILITY CORRIDOR

SPECIAL NOTES:

1. WATER QUALITY BASINS AND CATCH BASIN FILTERS WILL PROVIDE FOR TREATMENT OF STORM WATER RUN OFF.
2. THE WATER QUALITY BASINS SHALL BE DEDICATED TO THE COUNTY WHEN COMPLETED AND ACCEPTED.
3. PROPOSED RECLAIMED WATER LINES WILL BE LOCATED IN PUBLIC STREETS AND TRAILS.

OFF-SITE IMPROVEMENTS:

1. REGIONAL WATER QUALITY BASIN IS PROPOSED WITHIN THE PROJECT BOUNDARY OF VTTM 53295/ENTRADA.
2. THE UTILITY CORRIDOR WILL GENERALLY RUN ALONG SEA 23 (SANTA CLARA RIVER) INCLUDING THE CONNECTION FROM THE WATER RECLAMATION PLANT LOCATED WEST OF PROPOSED NEIGHBORING LANDMARK VILLAGE/VTTM 53108, AND WILL ALSO INCLUDE COMMERCE CENTER DRIVE BRIDGE.
3. MAGIC MOUNTAIN PARKWAY WILL BE EXTENDED FROM ITS EXISTING TERMINUS JUST EAST OF THE PROJECT BOUNDARY AND WILL PROVIDE A WESTWARD THOROUGHFARE THROUGH THE PROJECT AND INCLUDE IMPROVEMENTS OF THE EXISTING ROADWAY FROM THE OLD ROAD WITHIN VTTM 53295.
4. AN ELECTRICAL SUBSTATION IS PROPOSED TO BE LOCATED SOUTH OF THE PROJECT BOUNDARY IN POTRERO VALLEY. THE TENTATIVE MAP DEPICTS TWO POTENTIAL LOCATIONS FOR THIS SUBSTATION WITHIN VTTM 61996.
5. WATER TANKS PARTIALLY LOCATED WITHIN THE PROJECT AND WITHIN VTTM 61996.
6. GRADING ASSOCIATED WITH THE SOUTHERLY EXTENSION OF WESTRIDGE PARKWAY, INCLUDES IMPORT OF MATERIALS FROM THE EXTENSION OF MAGIC MOUNTAIN PARKWAY.

NOTE: SPECIFIC DETAILS OF OFFSITE IMPROVEMENTS MAY BE FOUND IN THE APPLICATIONS (I.E. CUP SUNRIDGE OF PROJECT), PLANNER'S NOTEBOOK AND/OR NEWHALL RANCH SPECIFIC PLAN.

RTFA

UTILITY PROVIDERS:

SEWER: L.A. COUNTY SANITATION DIST. 32 AND NEWHALL RANCH WRP
WATER: VALENCIA WATER COMPANY
ELECTRICAL: SOUTHERN CALIFORNIA EDISON
GAS: SOUTHERN CALIFORNIA GAS CO.
TELEPHONE: AT&T
CABLE TV: TIME WARNER CABLE

EX	EXISTING	SF	SQUARE FOOT	RW	RECLAIMED WATER
FM	FORCE MAIN	SD	STORM DRAIN	CLWA	CASTAIC LAKE WATER AGENCY
HP	HIGH POINT	SS	SANITARY SEWER	PVT	PRIVATE DRIVE
L	LENGTH	STD	STANDARD	P & F	PRIVATE AND FUTURE STREET
MIN	MINIMUM	R/W	RIGHT OF WAY	REC	RECREATION
GB	GRADE BREAK	W1	WATER ZONE – 1	O.S.	OPEN SPACE
PROP	PROPOSED	W2	WATER ZONE – 2	RUA	RESTRICTED USE AREA
R	RADIUS	W3	WATER ZONE – 3		

KEY MAP
NOT TO SCALE

LEGAL DESCRIPTION:
PARCELS 11, 12, 13, 22 AND A PORTION OF PARCEL 14 OF PARCEL MAP 24500-01, IN THE UNINCORPORATED TERRITORY OF THE COUNTY OF LOS ANGELES, AS SHOWN ON MAP FILED IN BOOK 293 PAGES 34 TO 67 INCLUSIVE, OF PARCEL MAPS, RECORDS OF LOS ANGELES COUNTY.

PSOMAS
28470 Avenue Stanford, Suite 300
Santa Clarita, CA 91355
(661) 219-6000 (661) 775-2718 (FAX)

MATTHEW G. HEIDEMAN R.C.E. NO. 55639 DATE

DESIGNED: MGH/DE
DRAFTED: DE/MS
CHECKED: MGH

OWNER/DEVELOPER:
NEWHALL LAND
23823 WEST VALENCIA BOULEVARD
VALENCIA, CALIFORNIA 91355
TELEPHONE: (661) 255-4000
REPRESENTATIVE: COREY HARPOLE

MAJOR LAND DIVISION
VESTING TENTATIVE TRACT MAP
NO. 61105
COUNTY CASE NO. ______
LOCATED IN THE UNINCORPORATED AREA OF THE COUNTY OF LOS ANGELES STATE OF CALIFORNIA

REV: ______
DATE: 11/24/09
PROJECT NO. 1NRC0120.00
SHEET 1 OF 12

ME003-01.dwg

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

NEWHALL LAND SPECIFIC PLAN

SUB-REGIONAL STORMWATER MITIGATION PLAN

Prepared by

Geosyntec consultants

engineers | scientists | innovators

2566 Overland Avenue, Suite 670
Los Angeles, California 90064

Project Number PW0114

April 2008

NEWHALL RANCH SPECIFIC PLAN

SUB-REGIONAL STORMWATER MITIGATION PLAN

Prepared for

Newhall Land
Valencia, California

Prepared by

Geosyntec Consultants
Los Angeles, California

April 2008

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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 south-

trending 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 Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California (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)

[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 CaCO3 are considered hard; waters with a hardness concentration above 300 mg/L as CaCO3 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)

	LACDPW Mass Emission Station	NRSP Area Tributary Monitoring					Newhall Ranch WRP Startup Monitoring		USGS Wet Weather Monitoring
Constituent	***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	Newhall Ranch WRP Startup Monitoring	USGS Wet Weather Monitoring
	S29	*NR3*	*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

	SCR Mass Emission Station	**USGS Dry Weather Monitoring**	**Newhall Ranch WRP Startup Monitoring**	
Constituent	*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. Basin Plan

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. Construction Permits

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. Lake or Streambed Alteration Agreement (LSAA)

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. Groundwater Pollutants of Concern

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. Hydrologic Conditions of Concern (Hydromodification)

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. Significance Criteria and Thresholds for Significance

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,

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[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. Summary of Surface Water Quality Impacts

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. Groundwater Impacts

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 (aggredation) 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:

- 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).

- 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 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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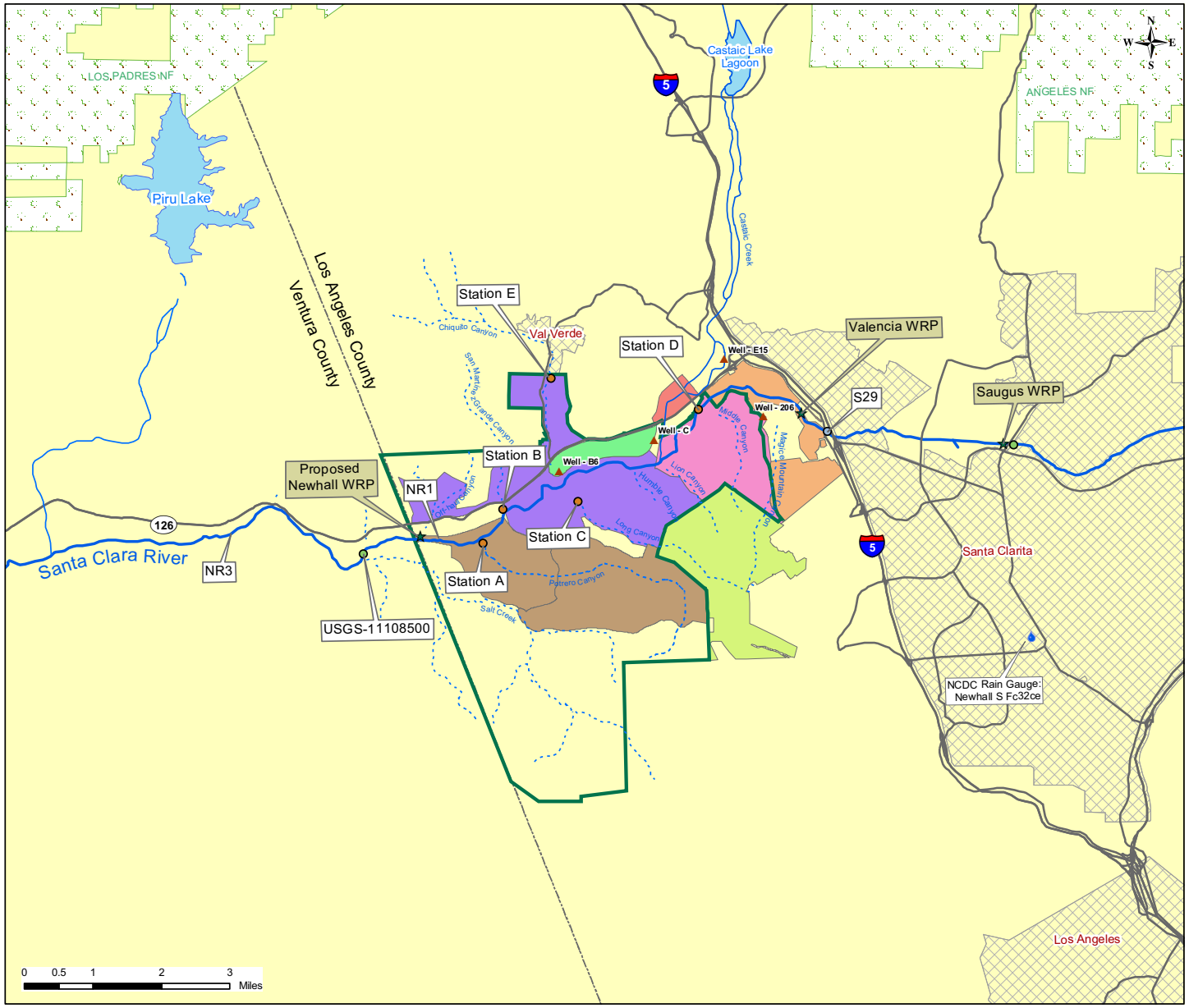

Legend

- Rain Gage
- Water Reclamation Plant

Monitoring Stations

- LACDPW Mass Emissions Station
- Newhall Ranch Sampling Site
- USGS Station
- Groundwater Monitoring Wells
- Rivers and Streams
- Roads
- Major Basin Tributaries
- Newhall Ranch Specific Plan
- Water Bodies
- Legacy Village
- Portrero
- Entrada
- Landmark Village
- Homestead
- Mission Village
- Commerce Center
- National Forest
- City Boundaries
- County Boundaries

Figure 2-1
Newhall Ranch Specific Plan
Location Map

December 2007

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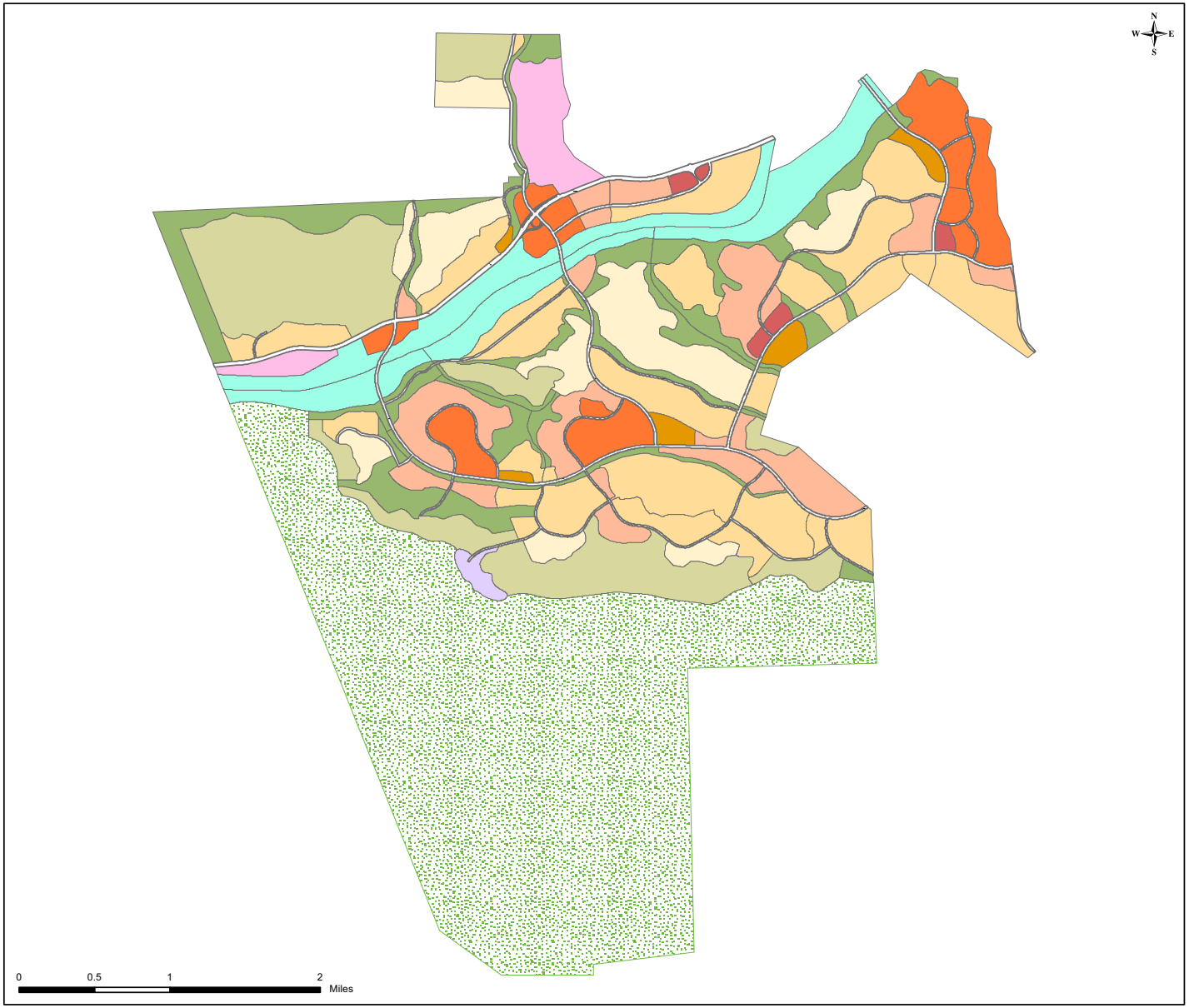
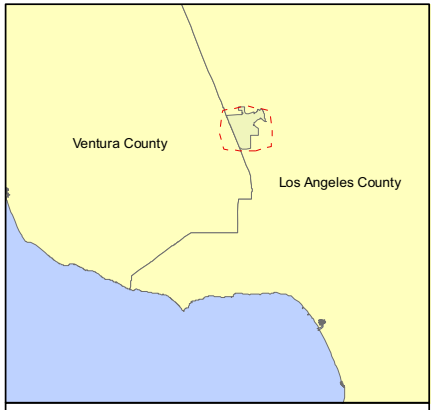
Prepared By: A. Poresky





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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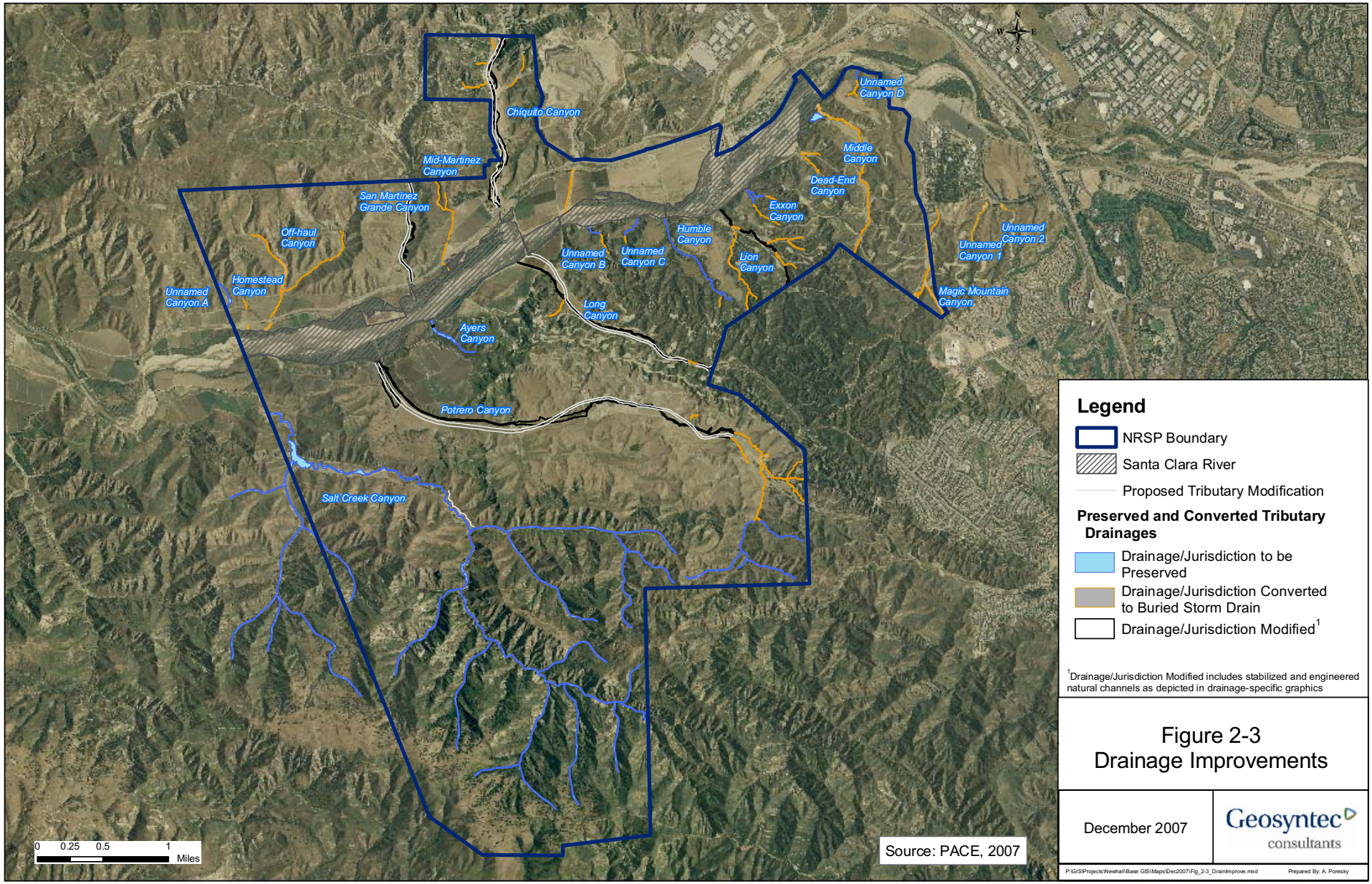
Prepared By: A. Poresky


Chiquito Canyon
Mid-Martinez Canyon
San Martinez Grande Canyon
Off-haul Canyon
Homestead Canyon
Unnamed Canyon A
Ayers Canyon
Potrero Canyon
Salt Creek Canyon
Unnamed Canyon B
Unnamed Canyon C
Long Canyon
Humble Canyon
Lion Canyon
Exxon Canyon
Dead-End Canyon
Middle Canyon
Unnamed Canyon D
Unnamed Canyon 1
Unnamed Canyon 2
Magic Mountain Canyon
N
W
E
S
0 0.25 0.5 1
Miles
Source: PACE, 2007
Legend
NRSP Boundary
Santa Clara River
Proposed Tributary Modification
Preserved and Converted Tributary Drainages
Drainage/Jurisdiction to be Preserved
Drainage/Jurisdiction Converted to Buried Storm Drain
Drainage/Jurisdiction Modified[1]
[1]Drainage/Jurisdiction Modified includes stabilized and engineered natural channels as depicted in drainage-specific graphics
Figure 2-3
Drainage Improvements
December 2007
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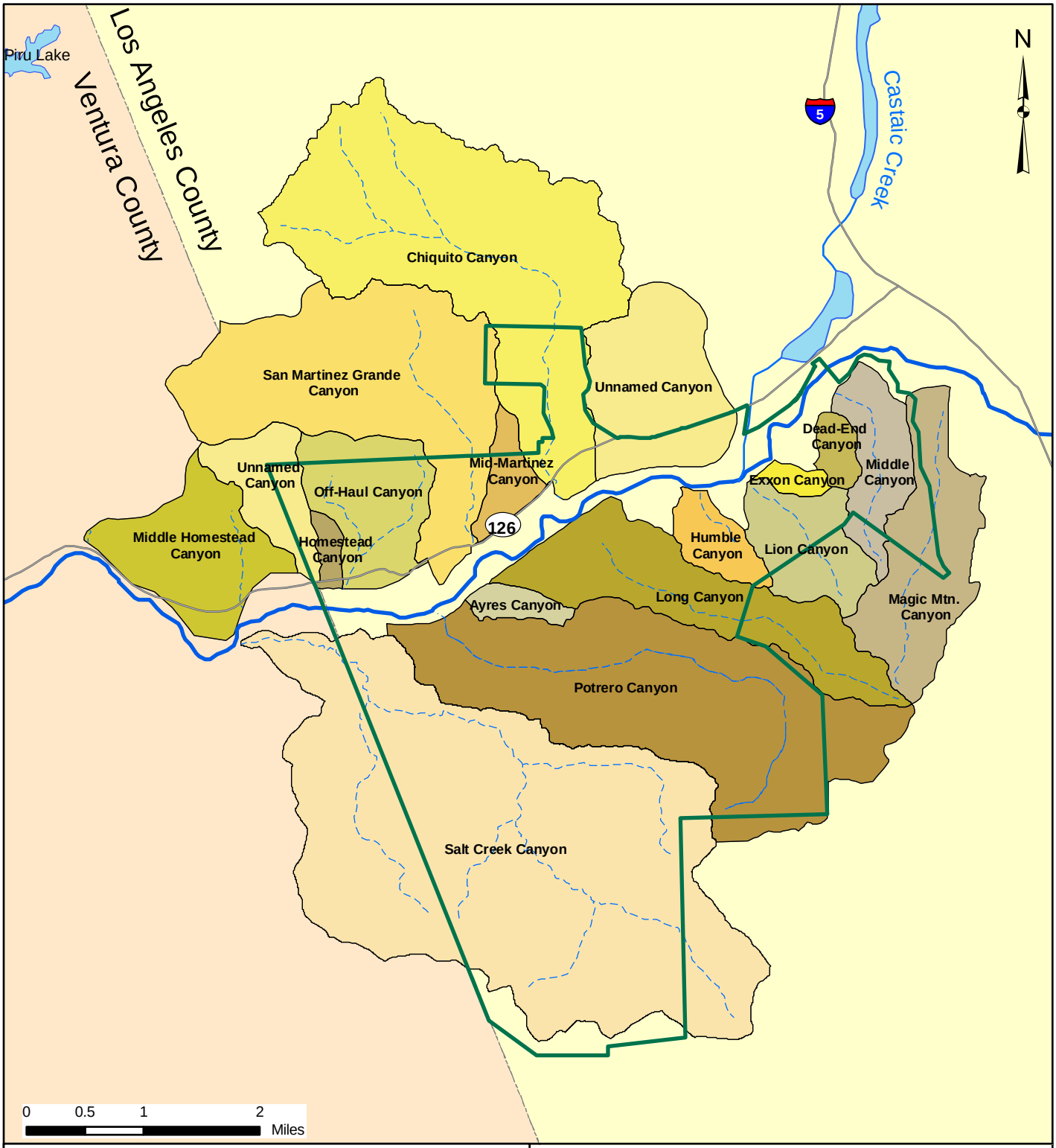
Prepared By: A. Poresky



Legend

- Highway
- Canyon Tributary
- Santa Clara River
- Water Bodies
- Subwatersheds
- Los Angeles County
- Ventura County
- NRSP Boundary

Figure 2-4
Newhall Ranch Specific Plan
Subwatershed Boundaries

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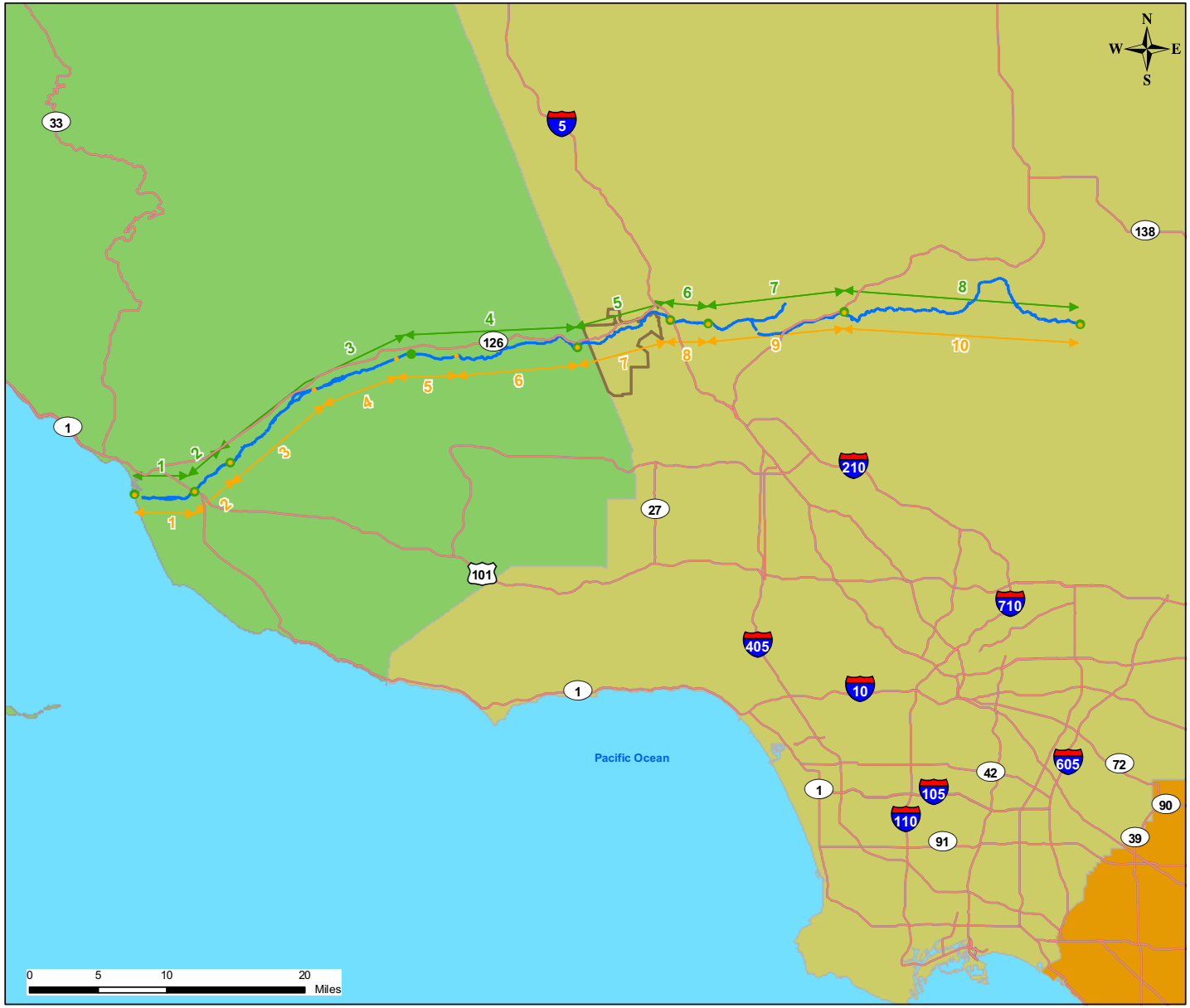
Prepared By: A. Poresky



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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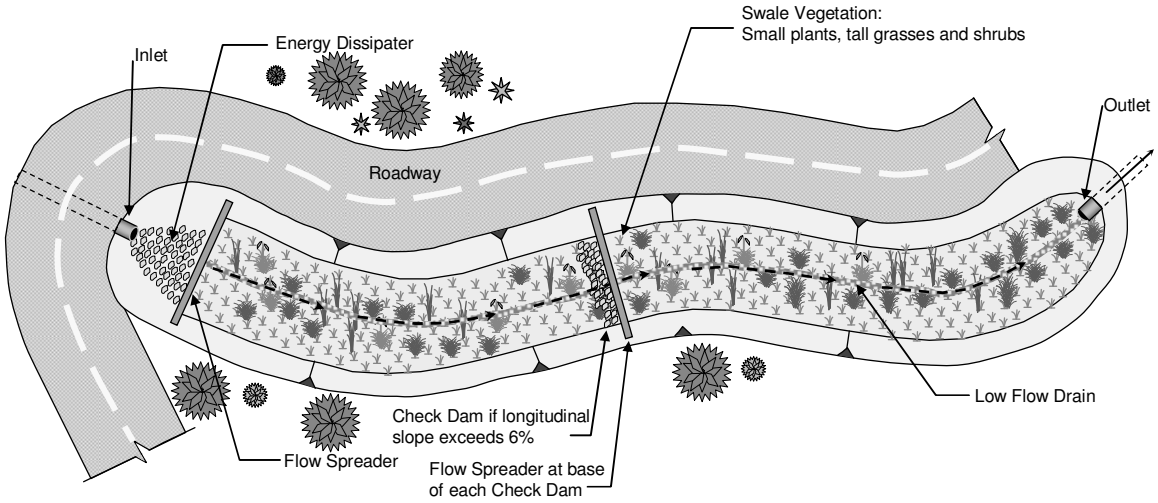
Prepared By: A. Poresky

Plan View



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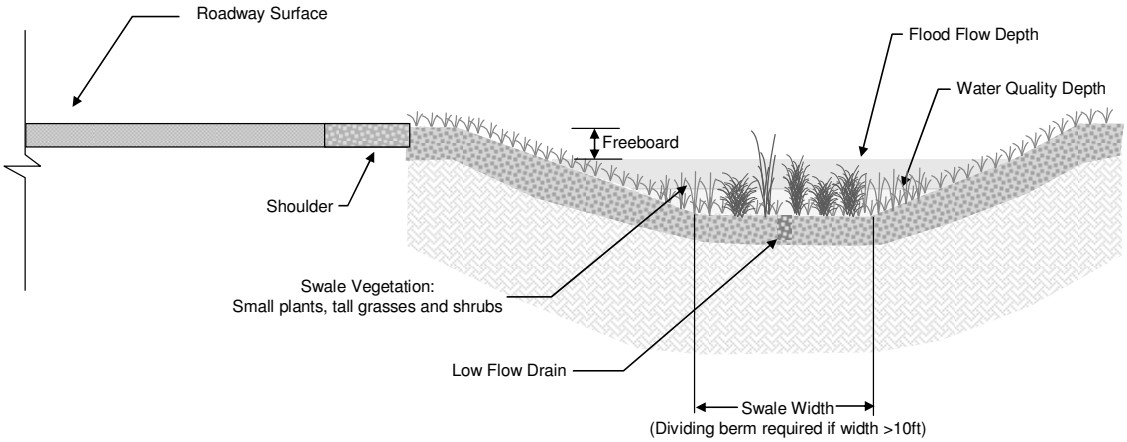
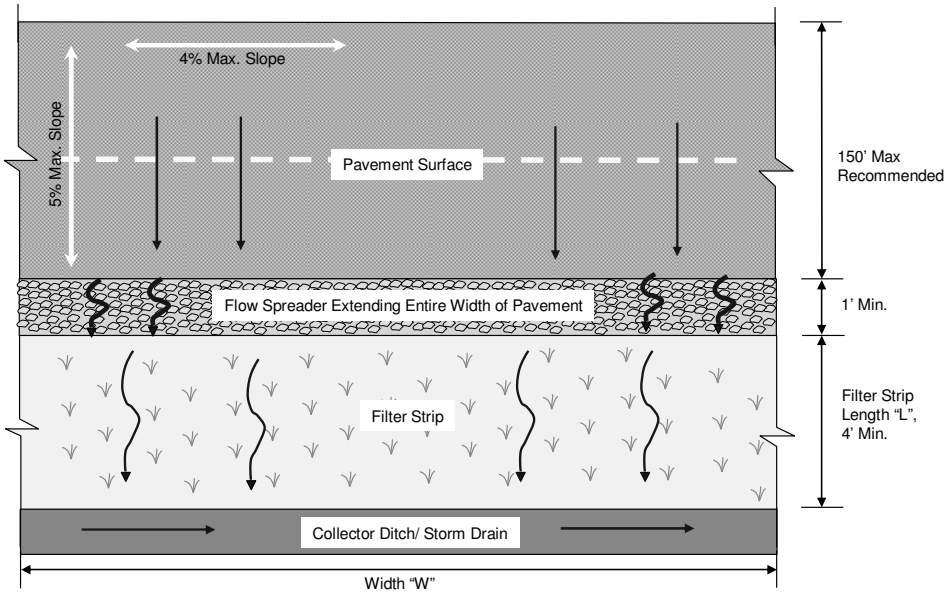


Figure 5-1
Conceptual Illustration of a Vegetated Swale

Figure 5-2
Examples of Vegetated Swales

Plan View



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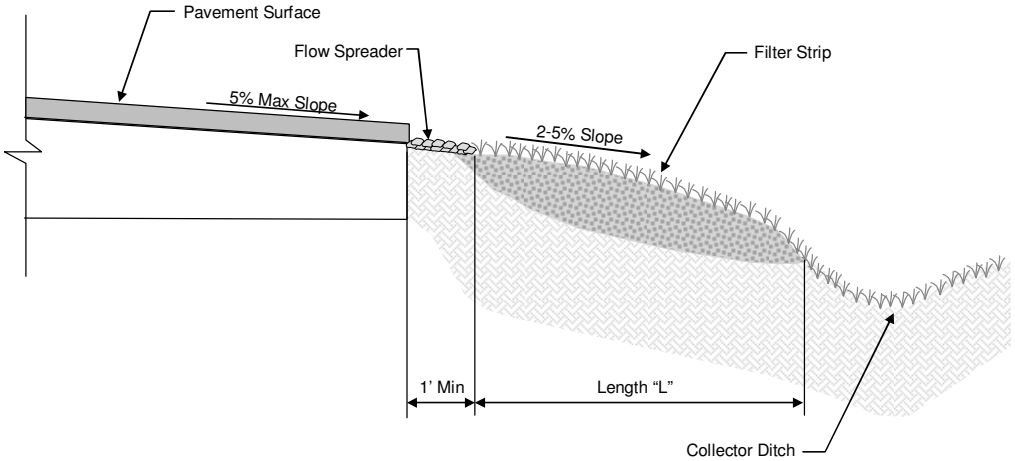
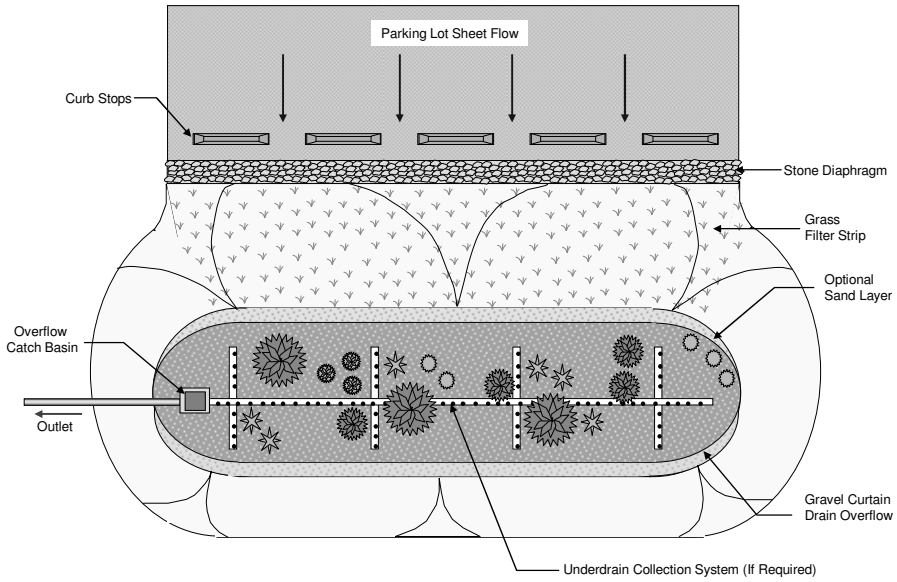


Figure 5-3
Conceptual Illustration of a Filter Strip

Plan View



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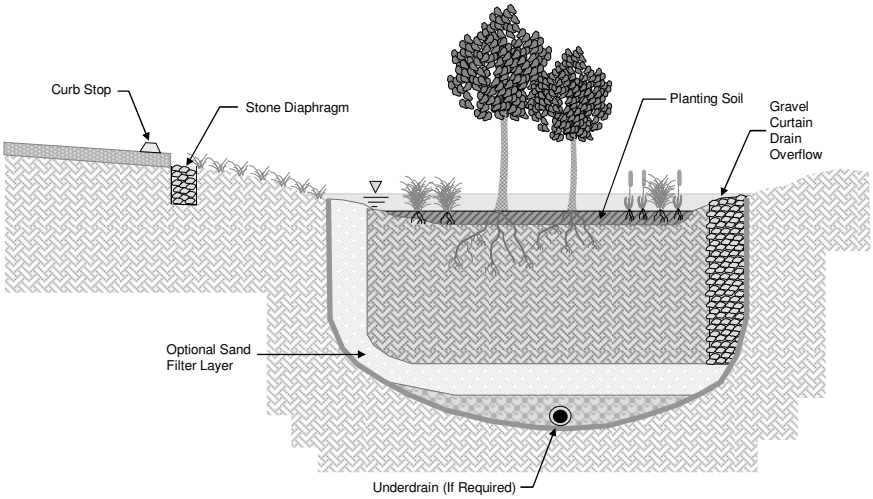
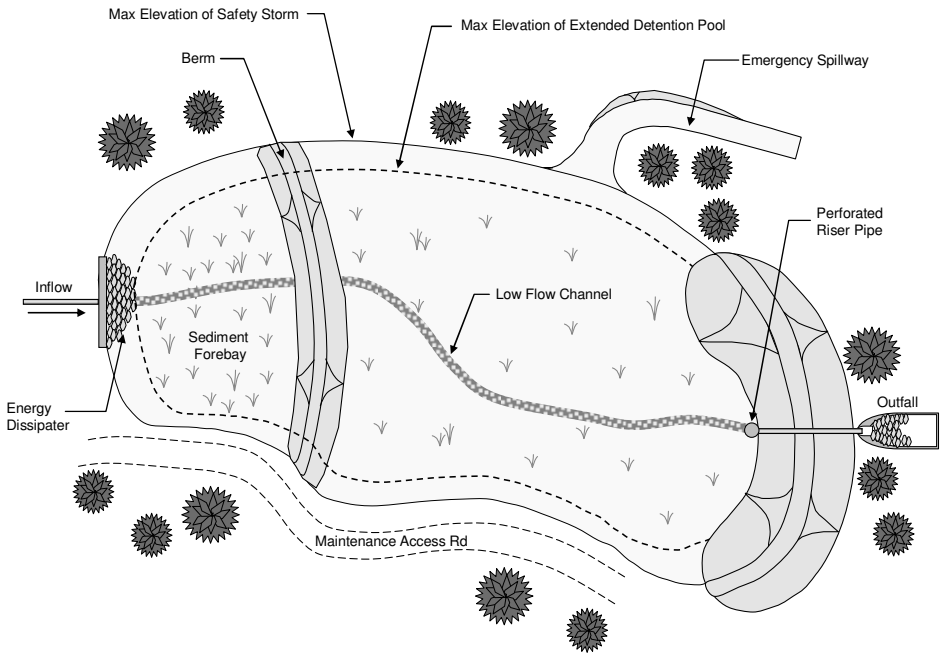


Figure 5-4
Conceptual Illustration of a Bioretention Facility

Figure 5-5
Examples of Bioretention Facilities

December 2007	**Newhall Ranch Specific Plan Subregional Stormwater Mitigation Plan**	Geosyntec consultants

Plan View



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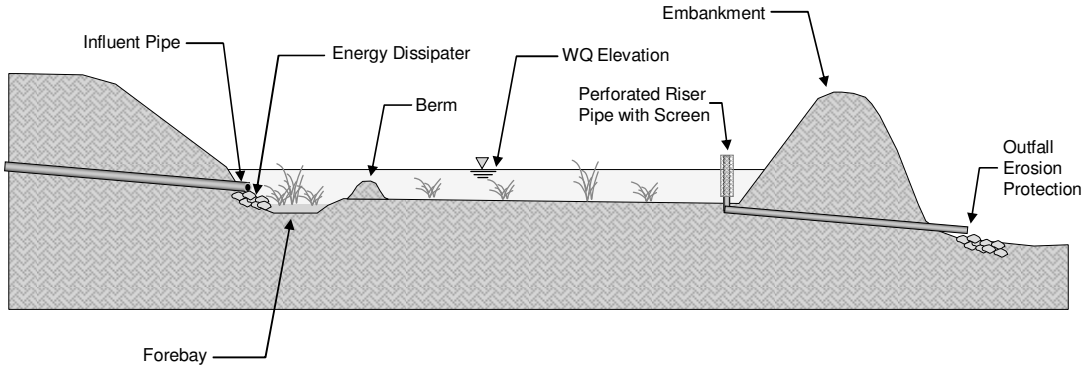
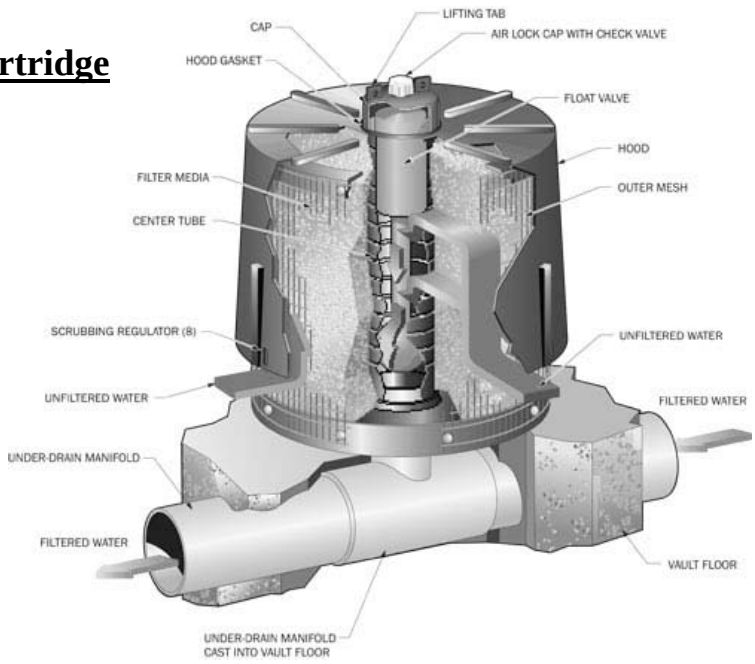


Figure 5-6
Conceptual Illustration of a Dry Extended Detention Basin

Figure 5-7
Examples of Extended Detention Basins

StormFilter Media Cartridge



Example configuration of Catch Basin Storm Filter

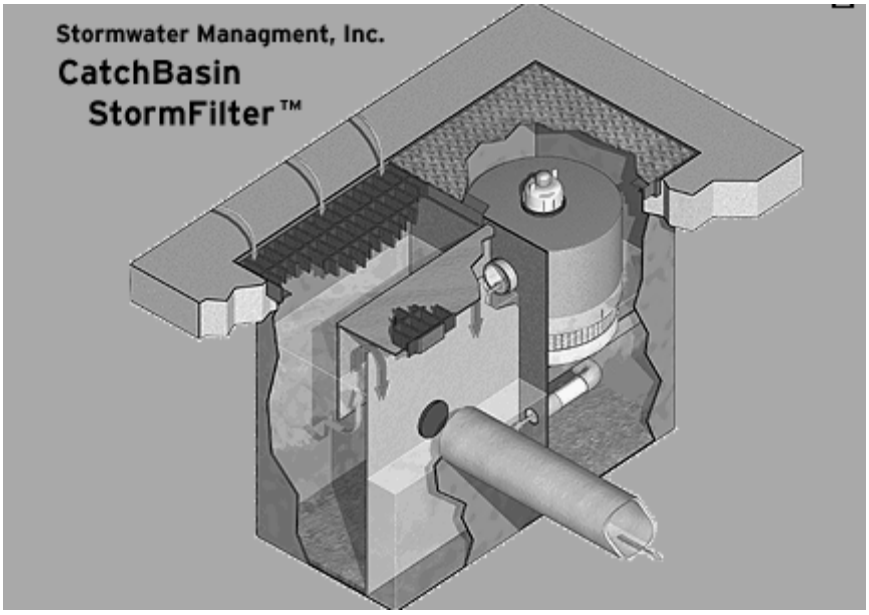


Figure 5-8
Conceptual Illustration of a StormFilter™ Media Filter

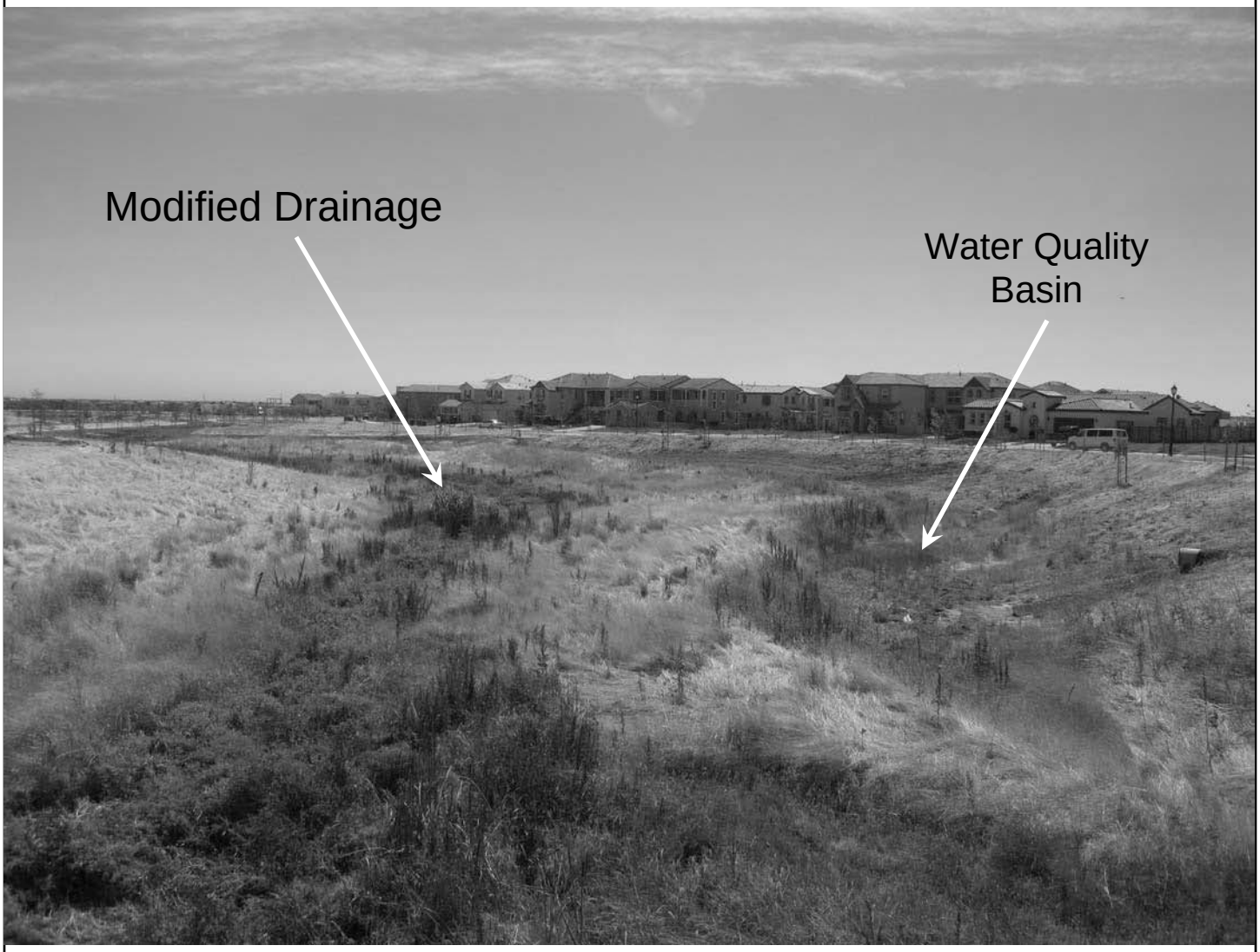


Figure 5-9
Example of Modified Channel/Engineered Natural Channel

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

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: Natural Turbidity — Max Increase 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) 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 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.

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

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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.

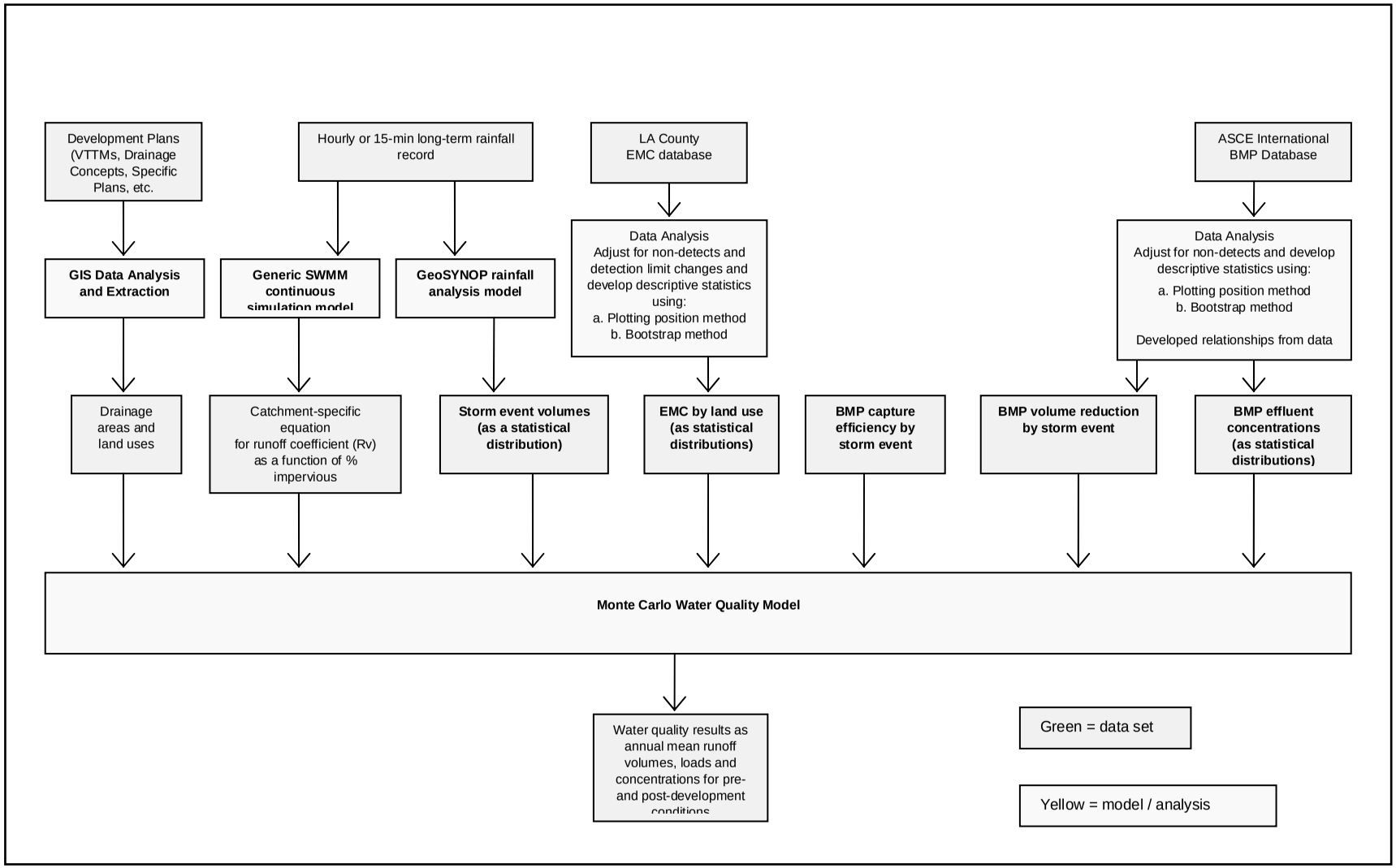

Figure 1-1: Overview of Water Quality Analysis Methodology

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.

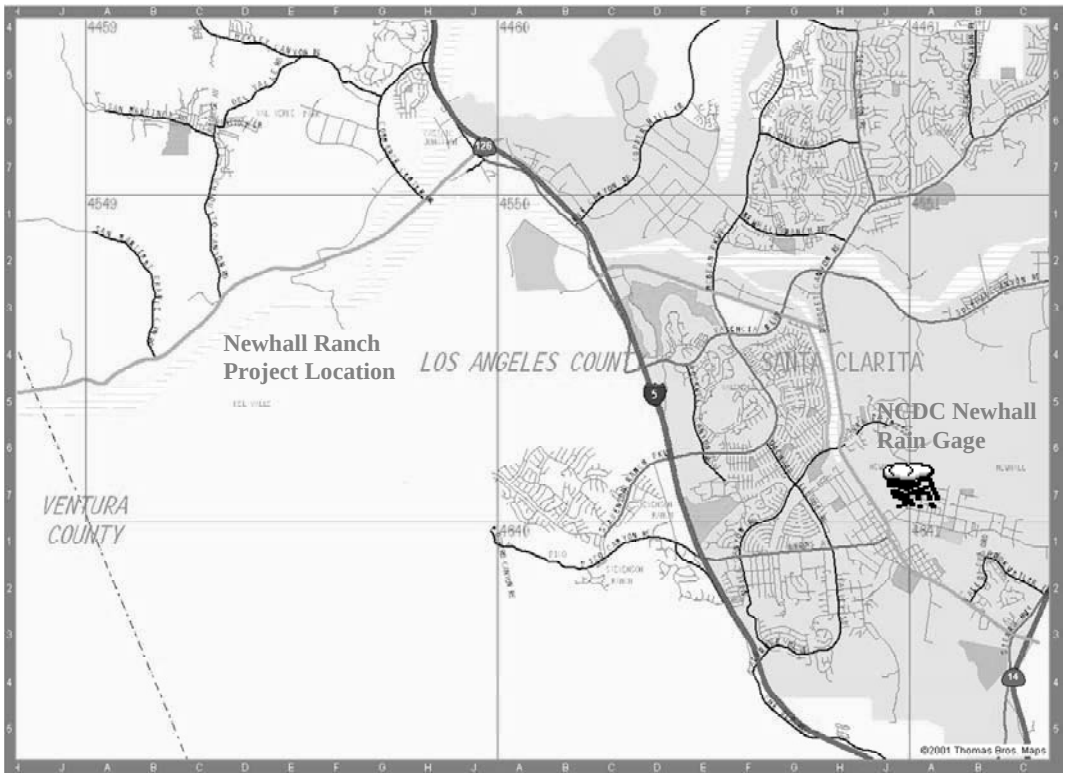

Figure 1-2: Location of Newhall Rain Gauge in the Vicinity of the Project Area

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.

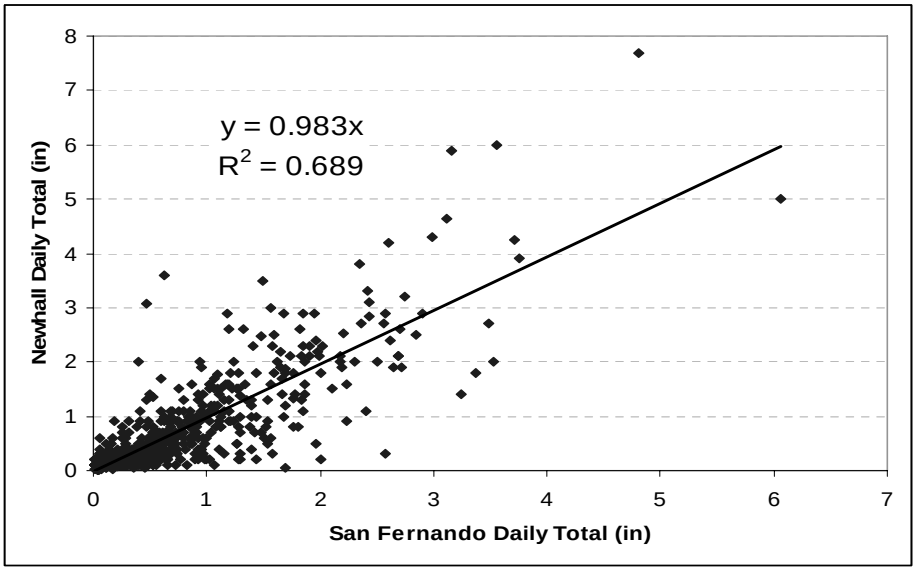

Figure 1-3: Correlation of 24-hour Totals between Newhall & San Fernando Gauges

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.

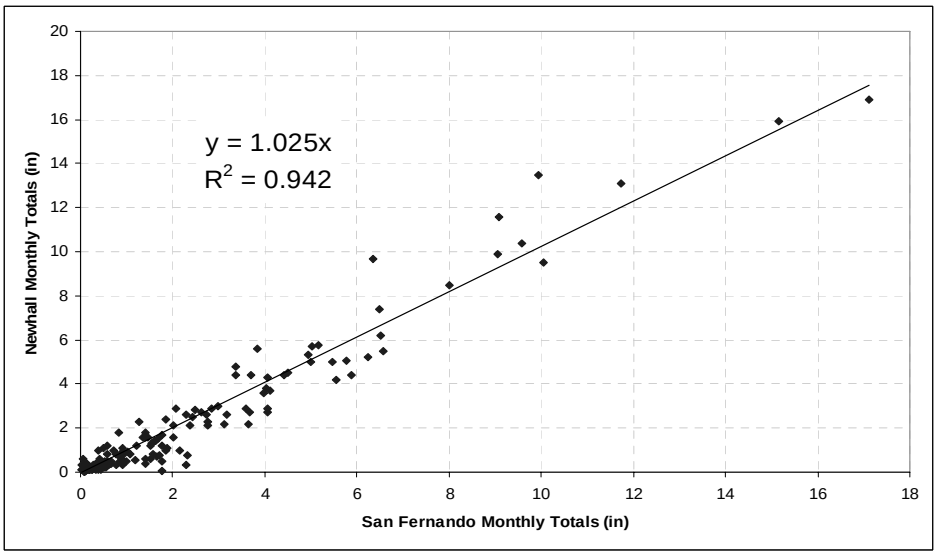

Figure 1-4: Correlation of Monthly Totals Newhall & San Fernando Gauges

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:

Runoff Coefficient = Slope × % Impervious + 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:

Runoff Coefficient = 0.008 × % 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.

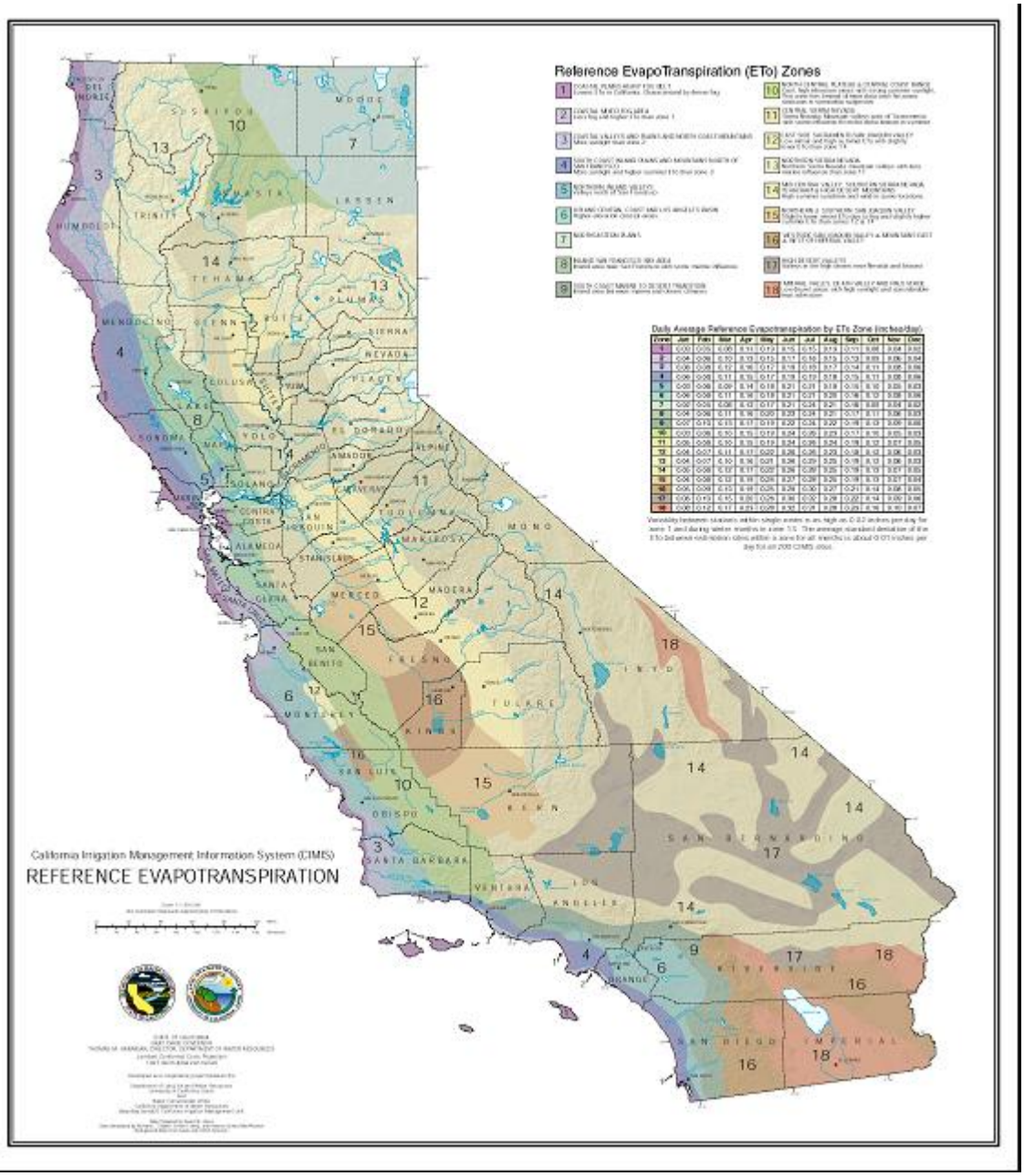

Figure 1-5: Reference ET for CA Zones

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.

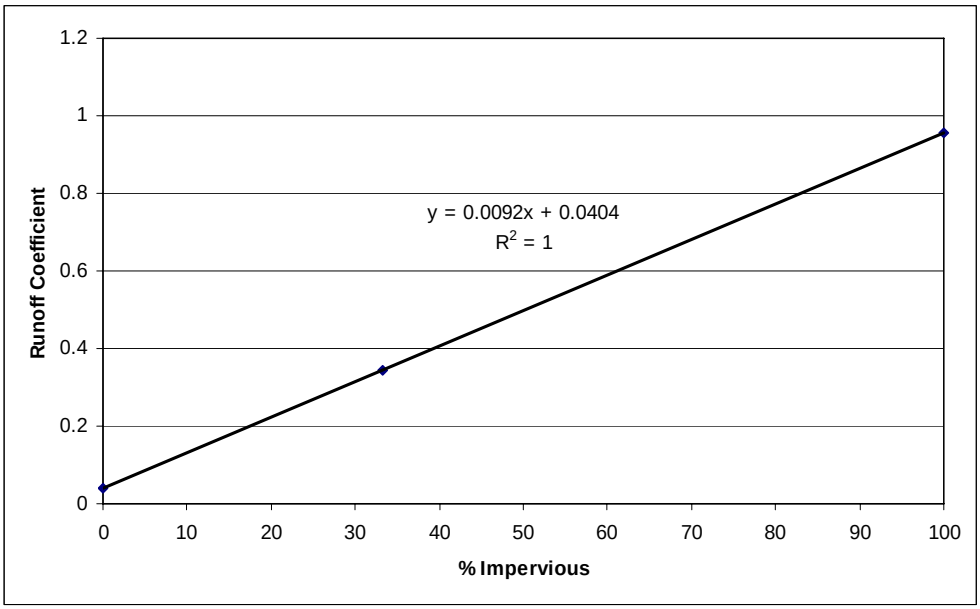

Figure 1-6: Existing Conditions Runoff Coefficient Equation

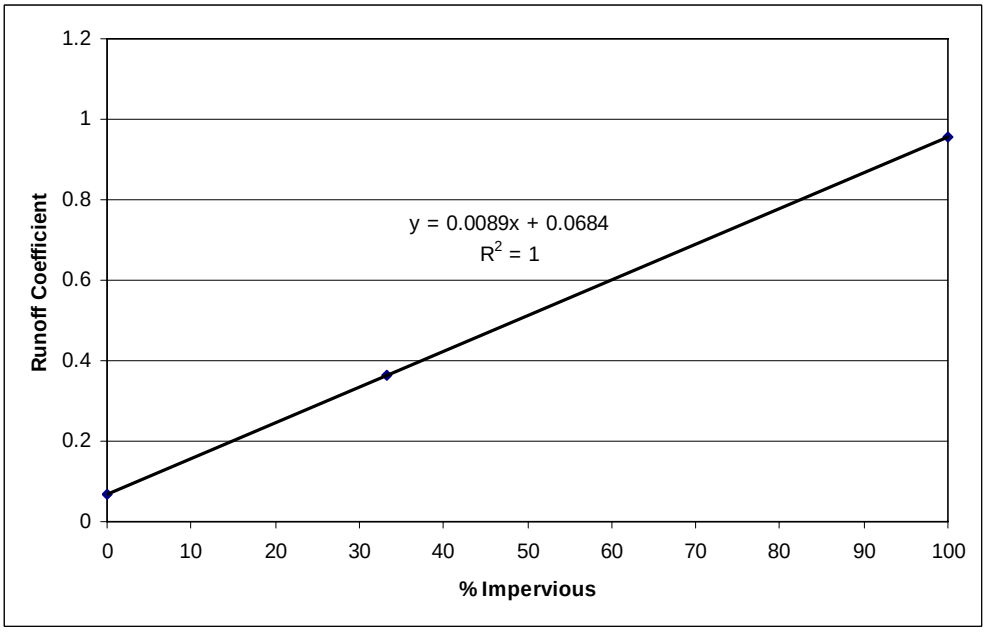

Figure 1-7: Developed Conditions Runoff Coefficient Equation

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.

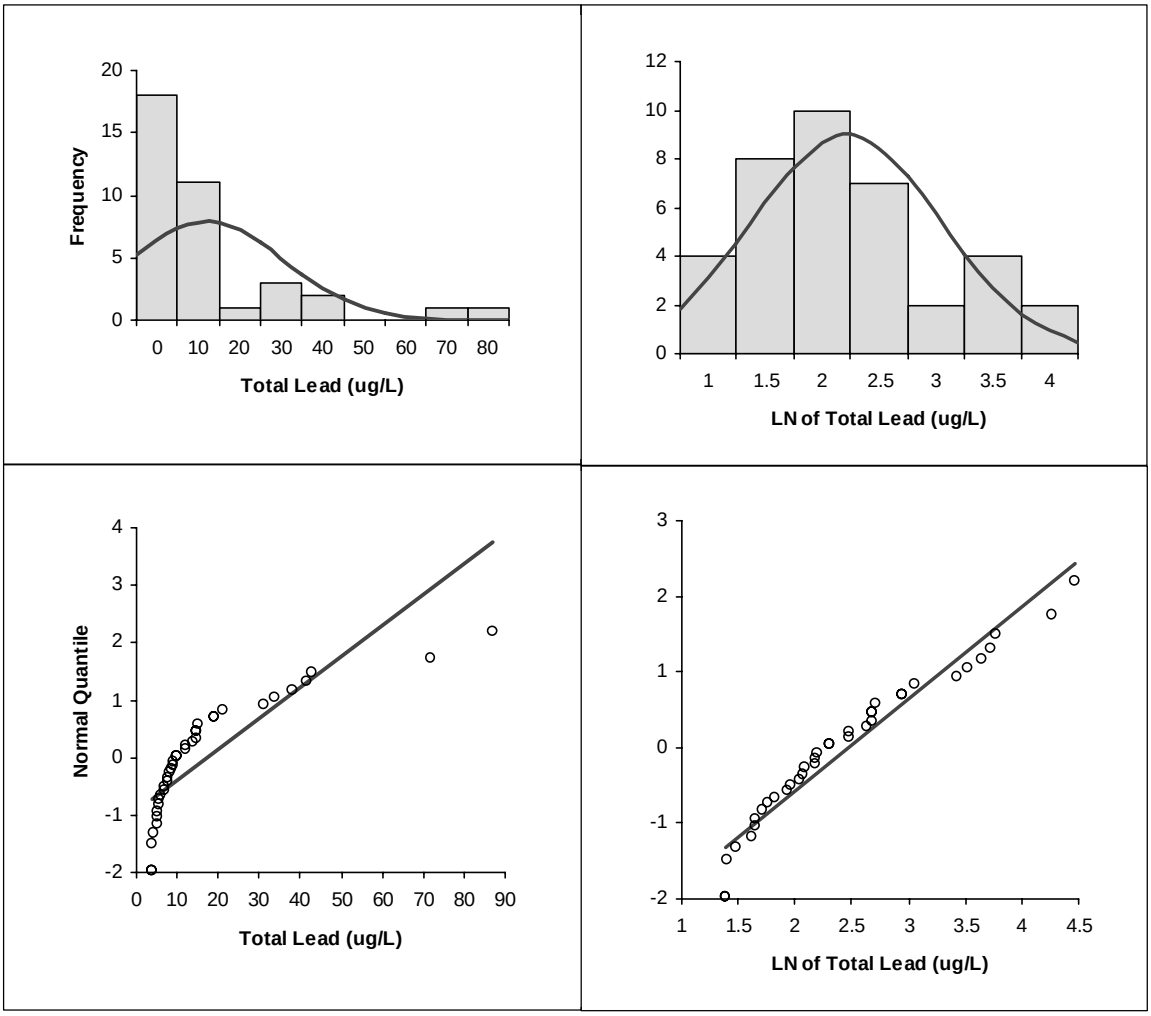

Figure 1-8: Histograms and Probability Plots of Transportation Total Lead Data in Arithmetic and Lognormal Space

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 ith 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 ith observation of the n_j censored values below the j detection limit.

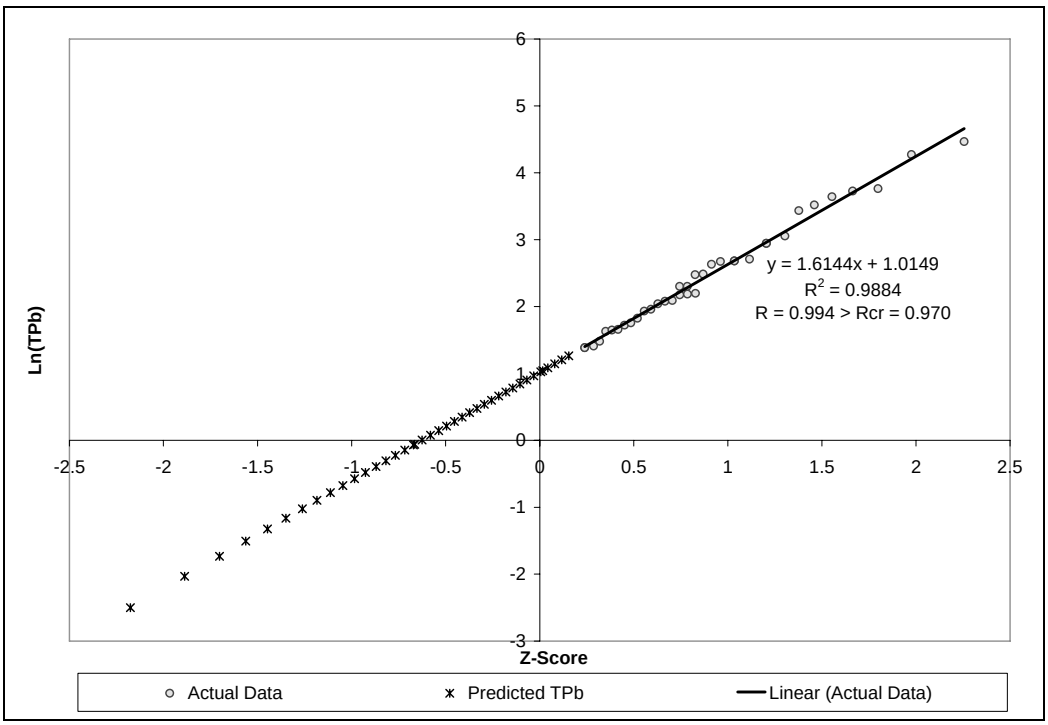

Figure 1-9: Probability Plot of the Uncensored and Predicted (Censored) Total Lead Transportation EMCs

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.

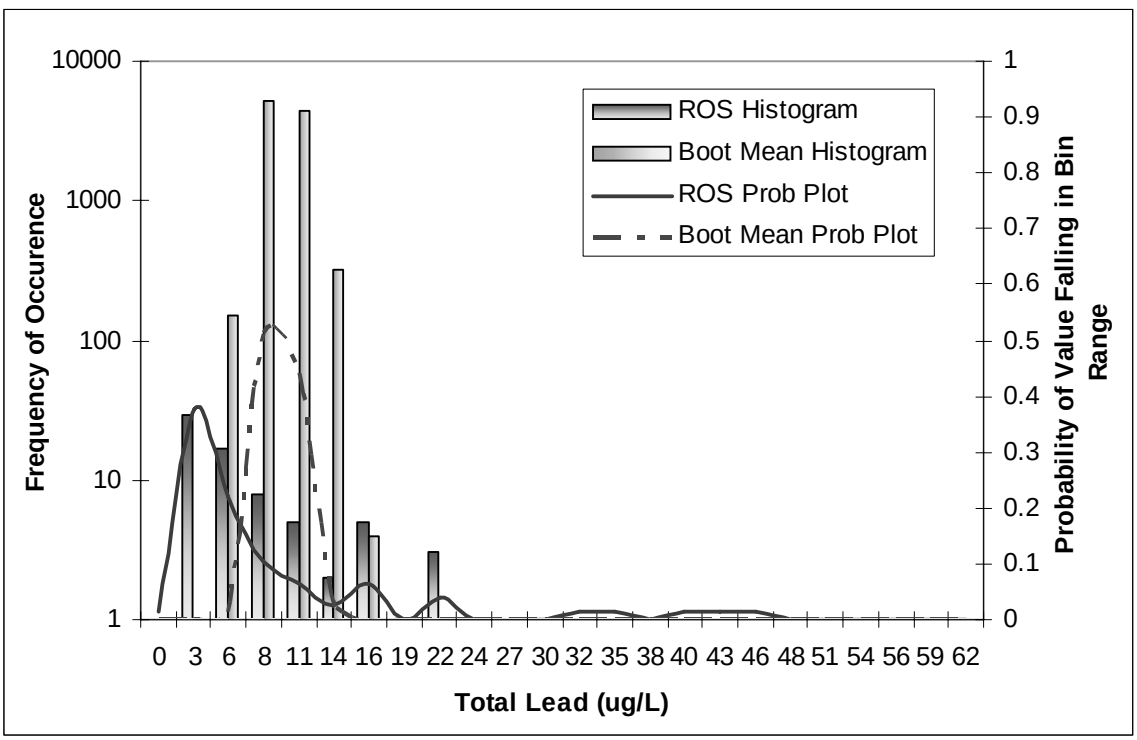

Figure 1-10: Comparison of the Distribution of ROS Method Total Lead Data and the Bootstrap Means of the ROS Data.

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:

<u>Rainfall Data:</u> 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.

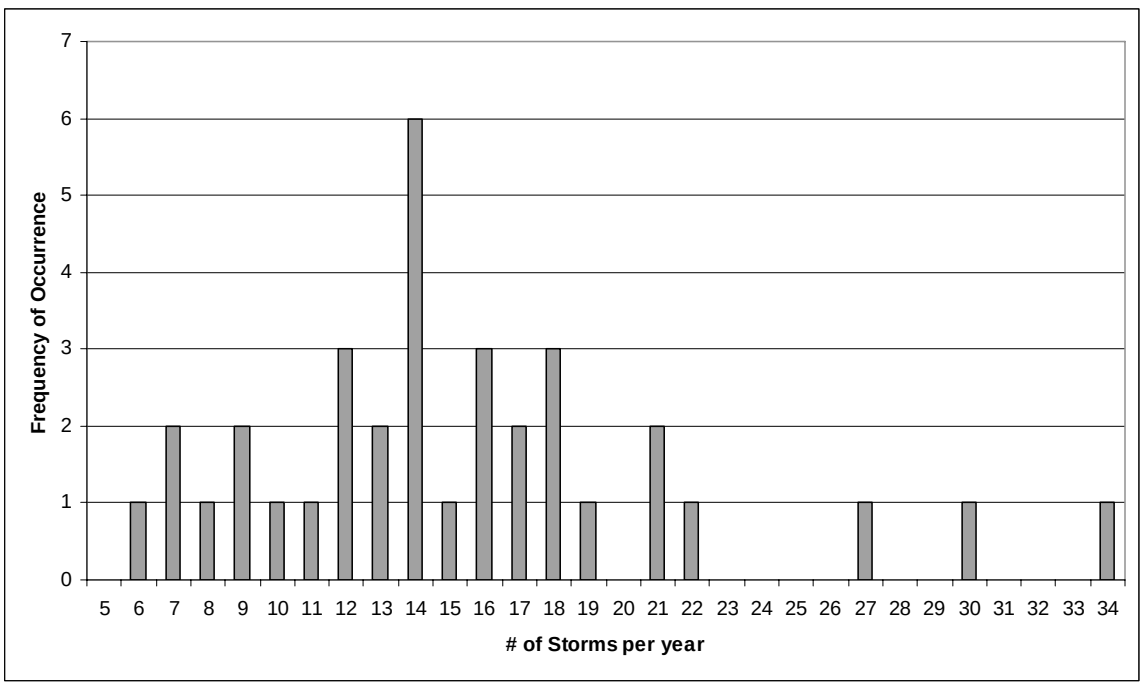

Figure 1-11: Distribution of Storms per Year at the Newhall Gauge

Step 2 – Estimate the Volume of Storm Runoff from a Storm Event.
The runoff volume from each storm was estimated using the following equation:

$$V = R_v P A \qquad (5)$$

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:

$$V_{wshed} = \Sigma_{lu} V_{lu} = \Sigma_{lu} (R_{v\,lu} PA_{lu)} \qquad (6)$$

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:

$$C_{land-use} = \exp\left(\mu_{\ln x} + \sigma_{\ln x} R_N\right) \qquad (7)$$

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:

$$C_{wshed\_BMPs} = L_{wshed\_BMPs} / V_{wshed\_BMPs} \quad (12)$$

where:

$$V_{wshed\_BMPs} = V_{wshed} \times \left[1 - \left(Cap_{\%} \times VR\%\right)\right] \quad (13)$$

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.

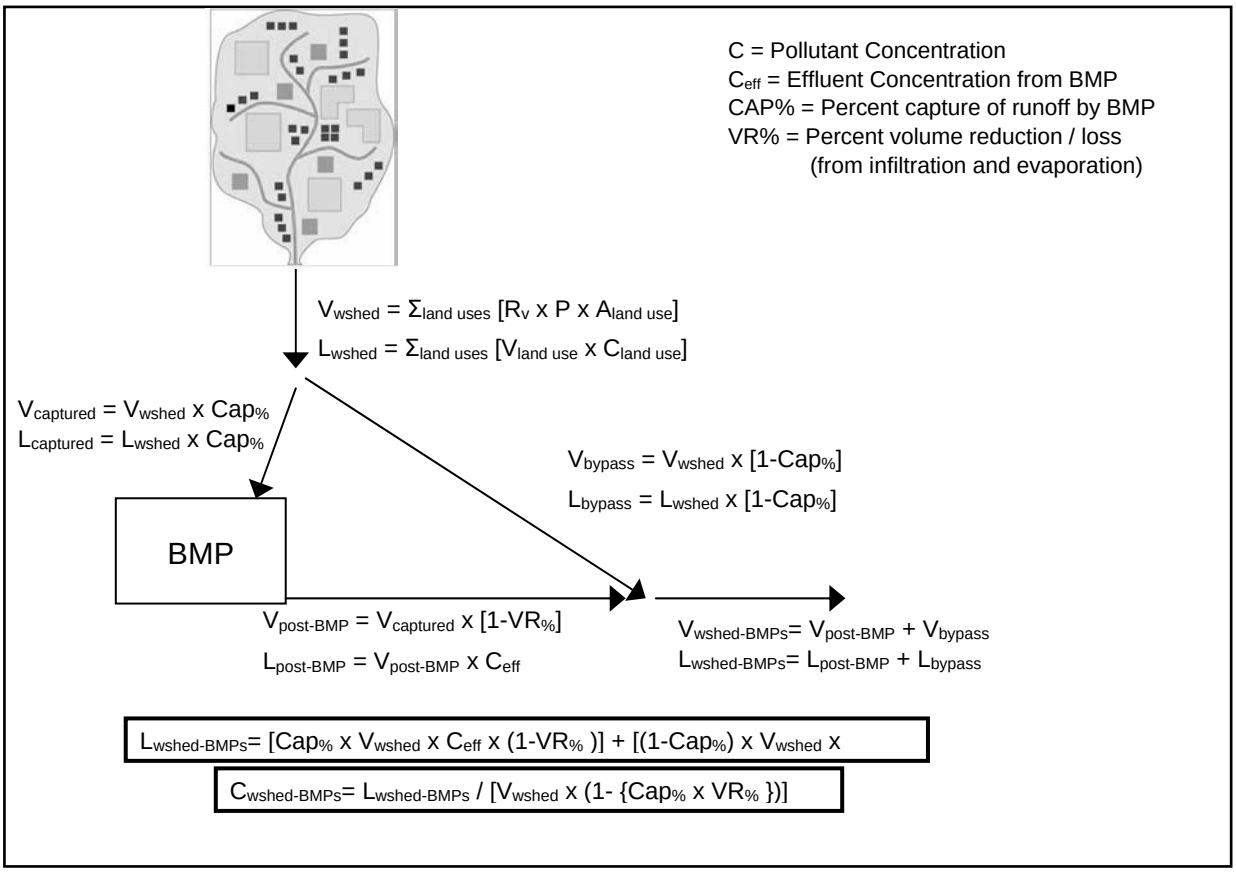

Figure 1-12: Diagrammatic representation of water quality calculations.

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.

<u>1) Distribution Assumptions</u>: 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) <u>Assumption of No Correlation between Model Parameters</u>: 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) <u>BMP Performance – Irreducible Pollutant Effluent Concentrations</u>: 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) <u>BMP Performance – Limiting Pollutant Removal Estimates to Available Data</u>: 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) <u>BMP Performance – BMPs are not a Source of Pollutants</u>: 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.

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APPENDIX C

NEWHALL RANCH STORMWATER MONITORING DATA

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		10	1290	350	30	2230		136	0.4	0.4	2
E-Top of Chiquito Canyon		40	11700	970	150	6280	3	210	1.4	1	10

	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
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		170	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		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”

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REVIEW OF BACTERIA DATA FROM SOUTHERN CALIFORNIA WATERSHEDS

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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

[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.

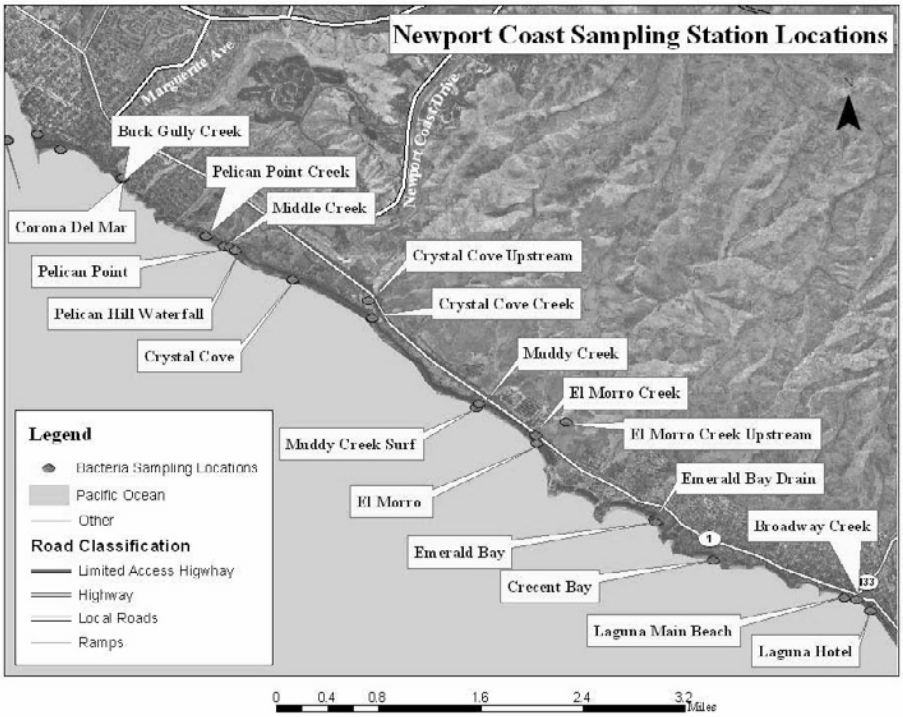


Figure A 2: Additional detail on the catchment areas (information collated from the PBS&J report, 1999 and updated by The Irvine Company, 2005).

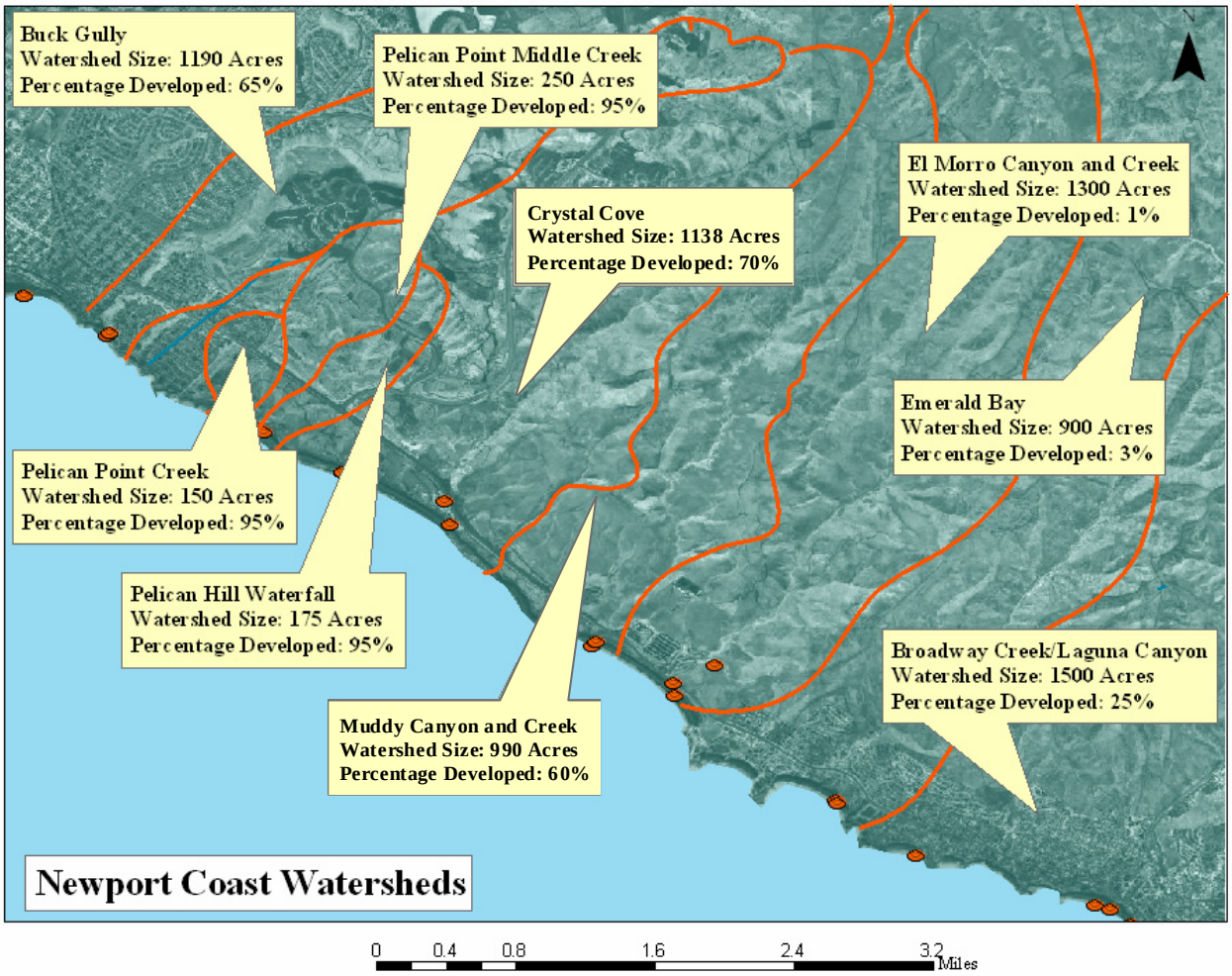


Figure A 3: Long-term geometric mean concentration for enterococci (data from 3/30/99 to 12/21/04). Dashed line represents EPA's suggested 30-day geometric mean water quality criterion for enterococci corresponding to a 1.0% risk level.

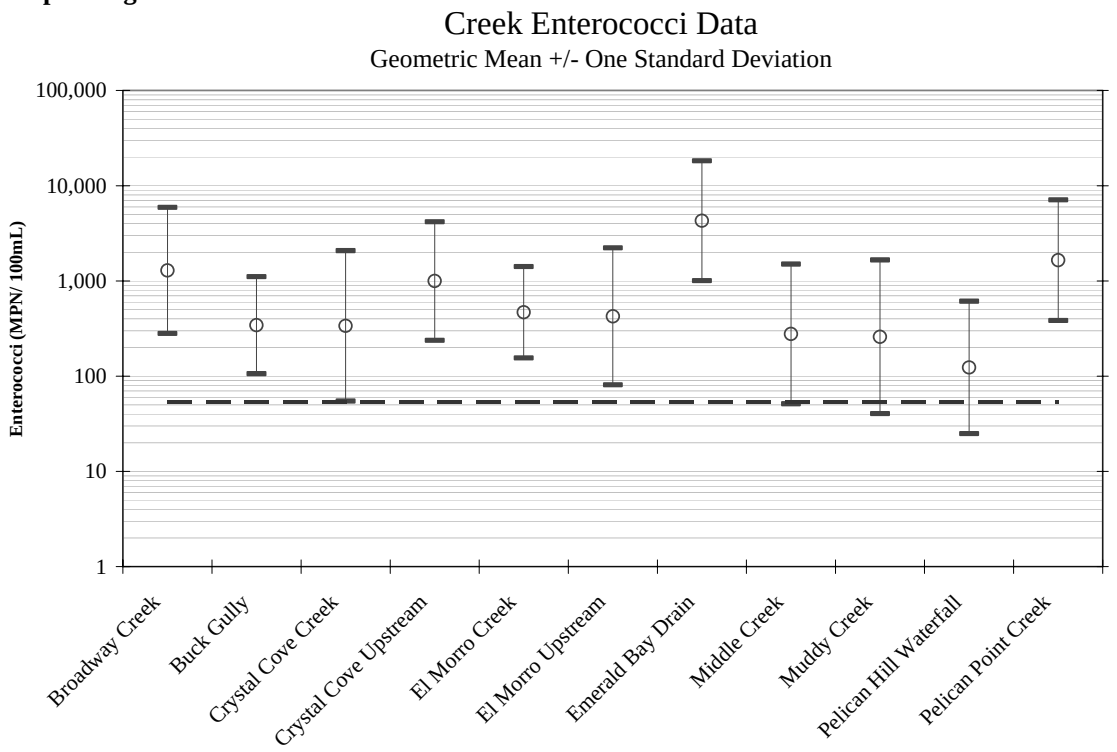


Figure A 4: Long-term geometric mean fecal coliform concentrations (data from 1/7/86 to 12/21/04). Dashed line corresponds to the current Santa Ana Basin Plan water quality criterion for 30-day log mean (geometric mean) fecal coliform concentrations.

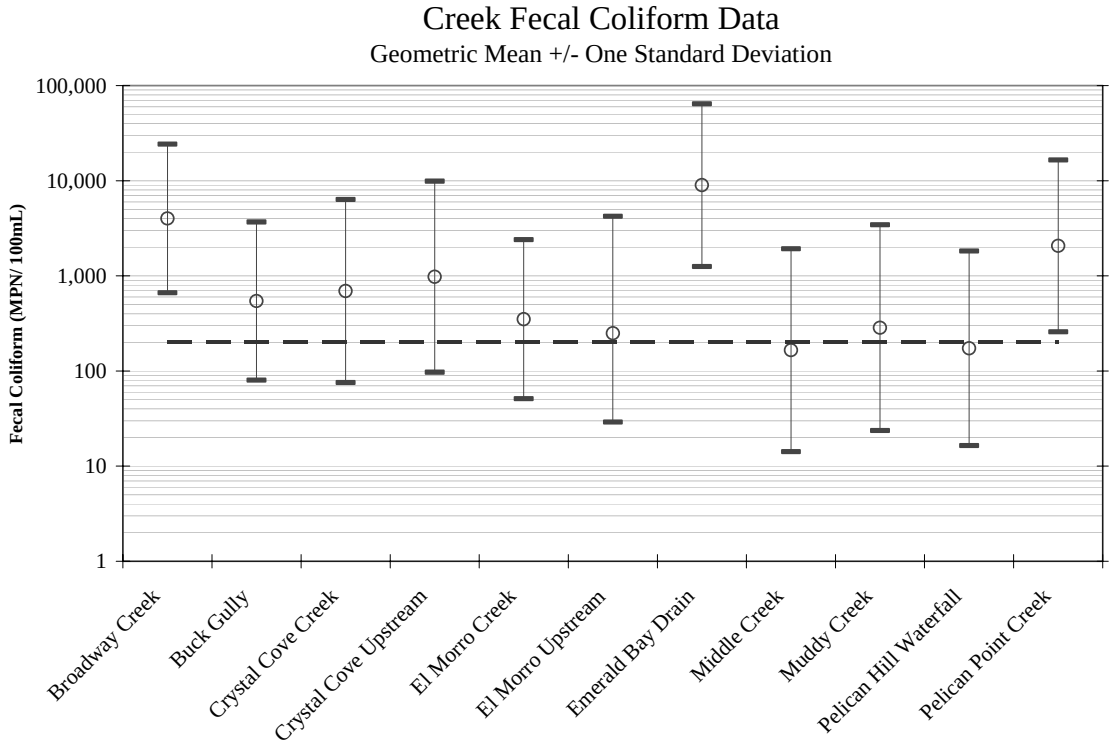


Figure A 5: Long-term geometric mean concentrations for total coliform (data from 1/7/86 to 12/21/04)

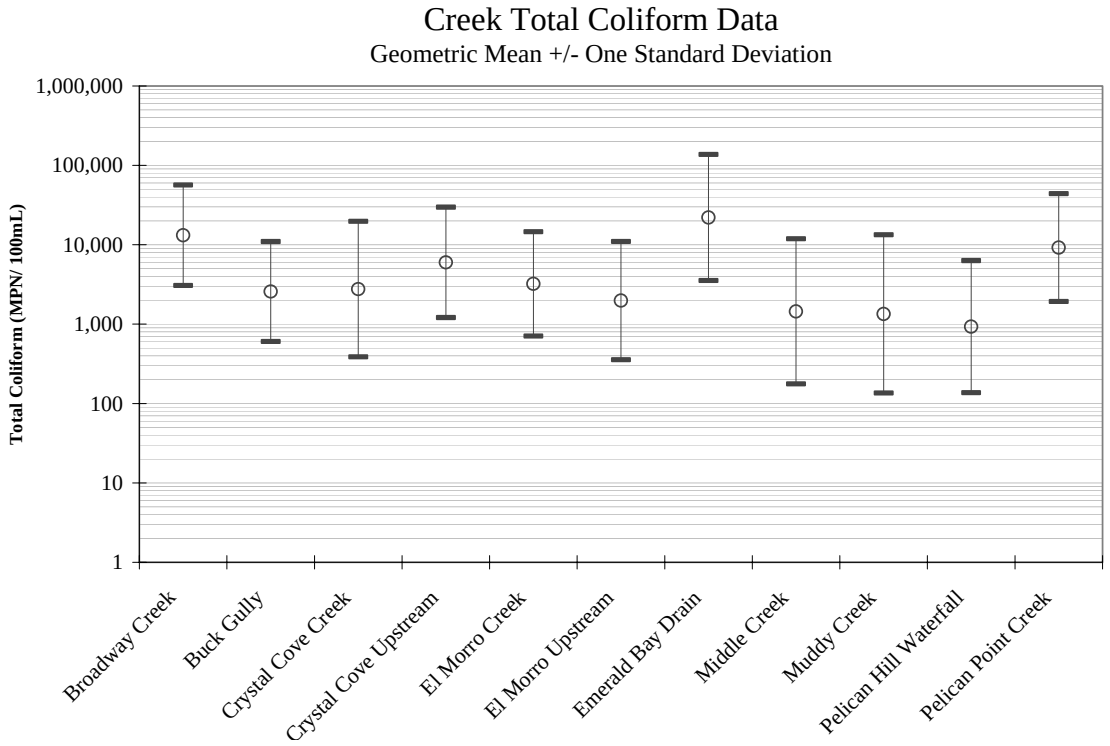


Figure A 6: Relationship between % developed and the long-term geometric mean enterococci concentration (data from 3/30/99 to 12/21/04). Dashed line represents EPA's suggested 30-day geometric mean water quality criterion for enterococci corresponding to a 1.0% risk level.

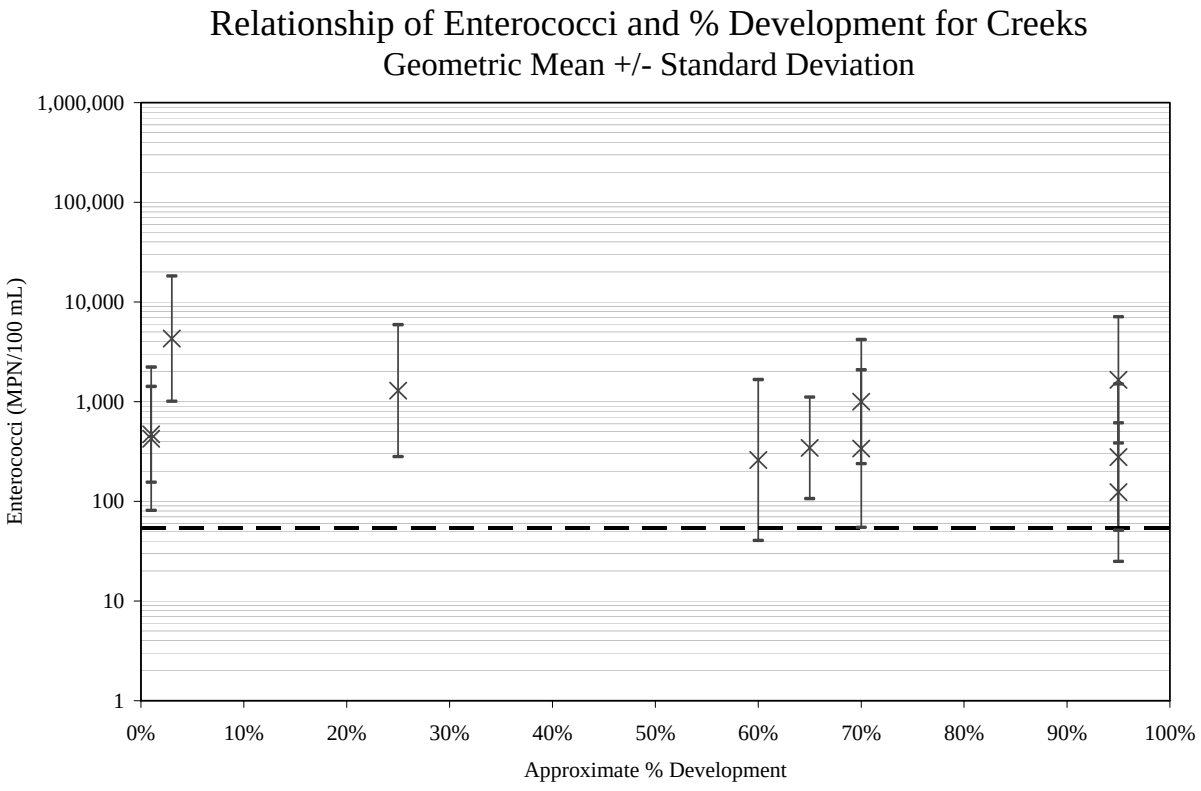


Figure A 7: Relationship between % developed and the long-term geometric mean fecal coliform concentration (data from 1/7/86 to 12/21/04). Dashed line corresponds to the current Santa Ana Basin Plan water quality criterion for 30-day log mean (geometric mean) fecal coliform concentrations.

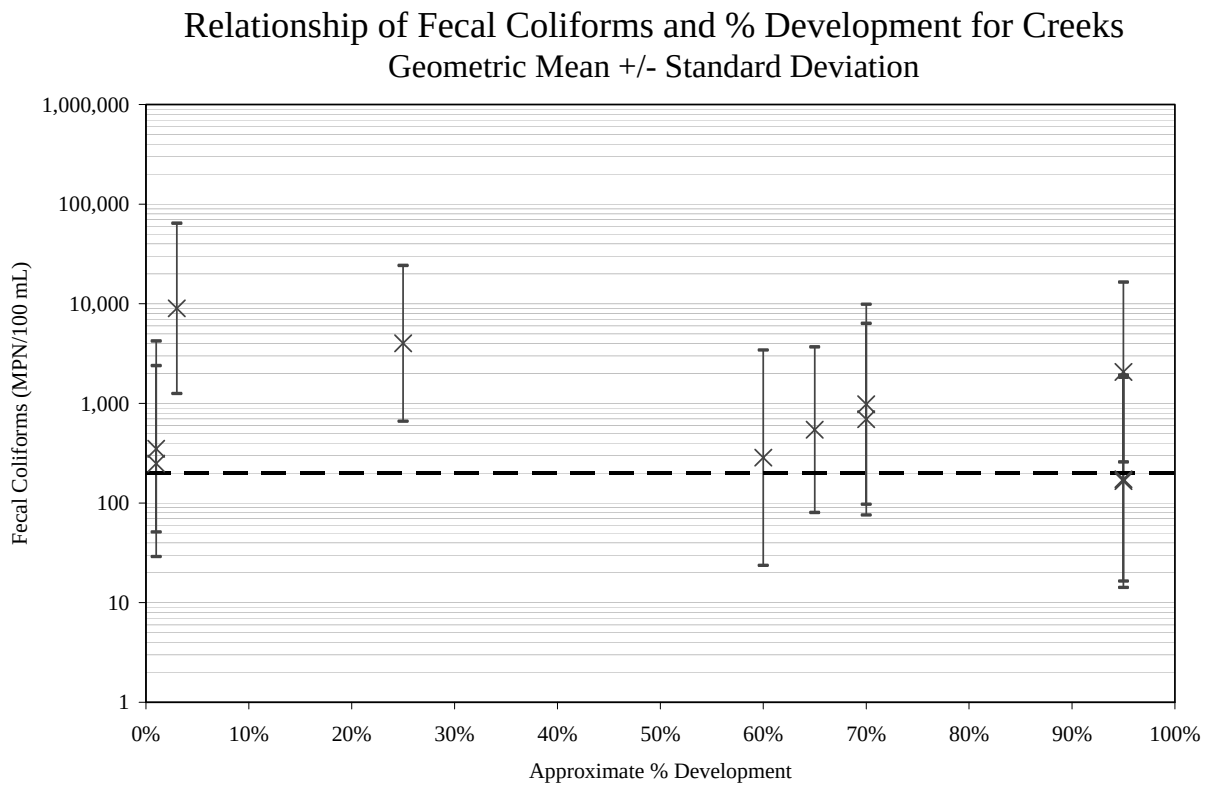


Figure A 8: Relationship between % developed and the long-term geometric mean total coliform concentration (data from 1/7/86 to 12/21/04).

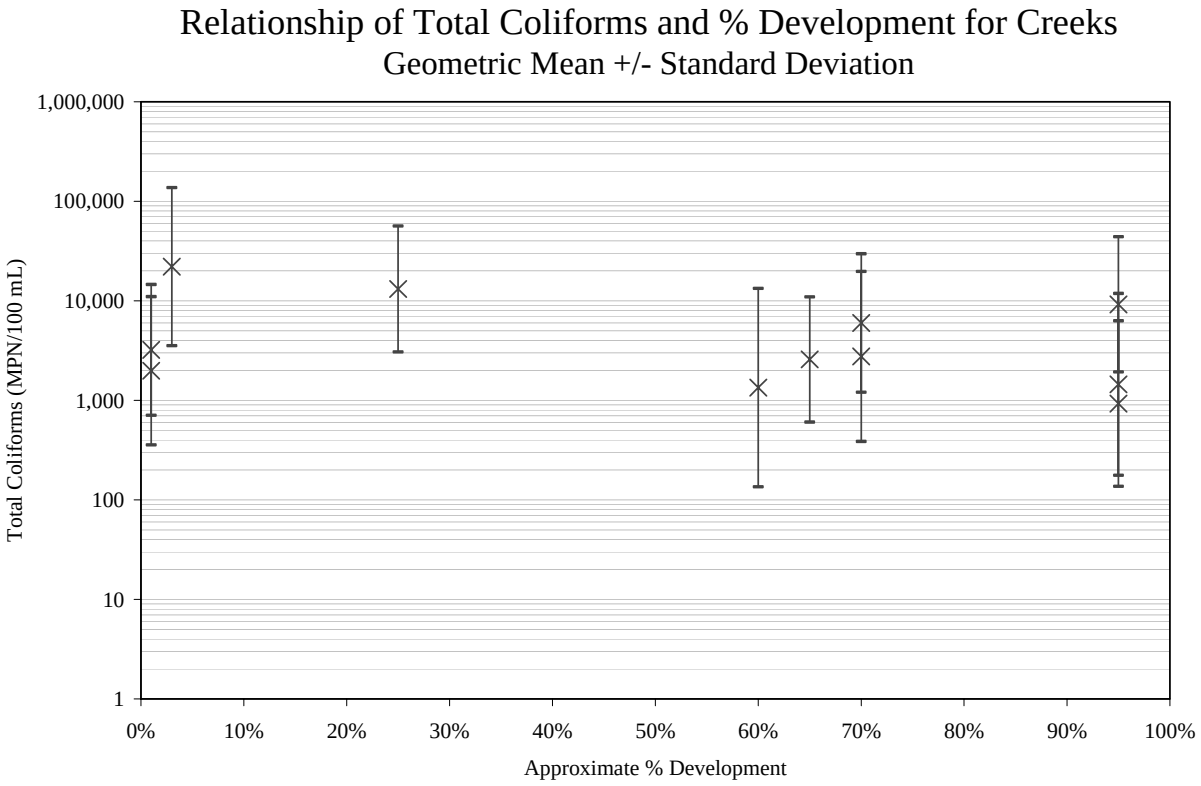


Figure A 9: Percent of samples in exceedance of thresholds by weather type (data from 1/7/86 to 12/21/04 for total and fecal coliform and from 3/30/1999 to 12/21/04 for enterococci). "Wet" data are those within two days of rainfall totaling 0.1" or greater at Newport Harbor. "Summer Dry" samples were 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.

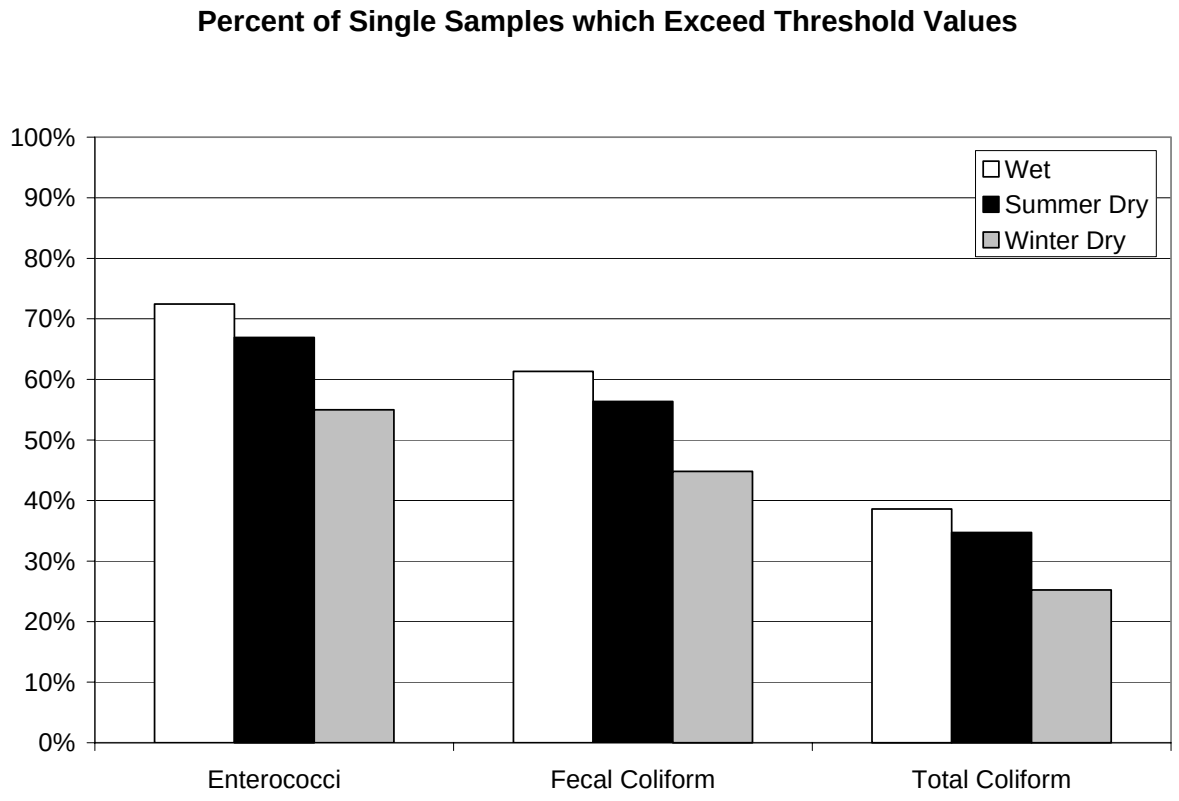
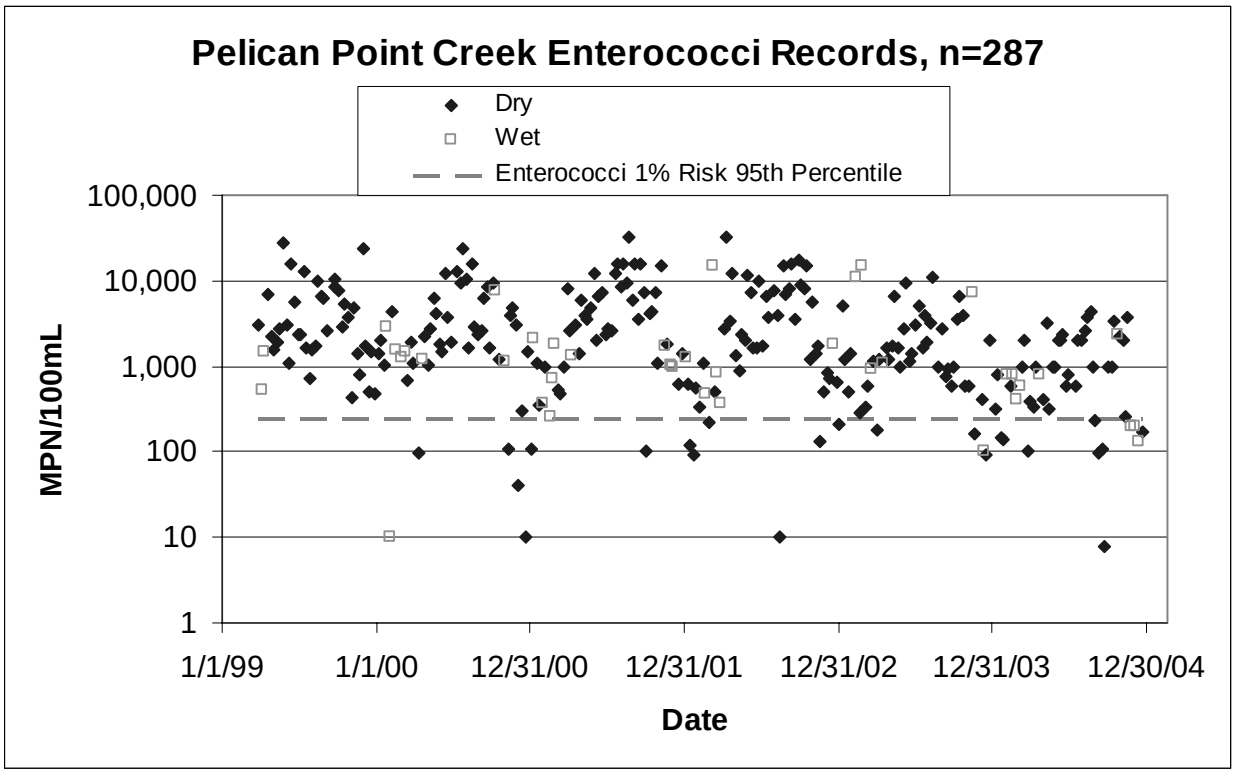


Figure A 10: Pelican Point Creek enterococci data and corresponding cumulative frequency distribution



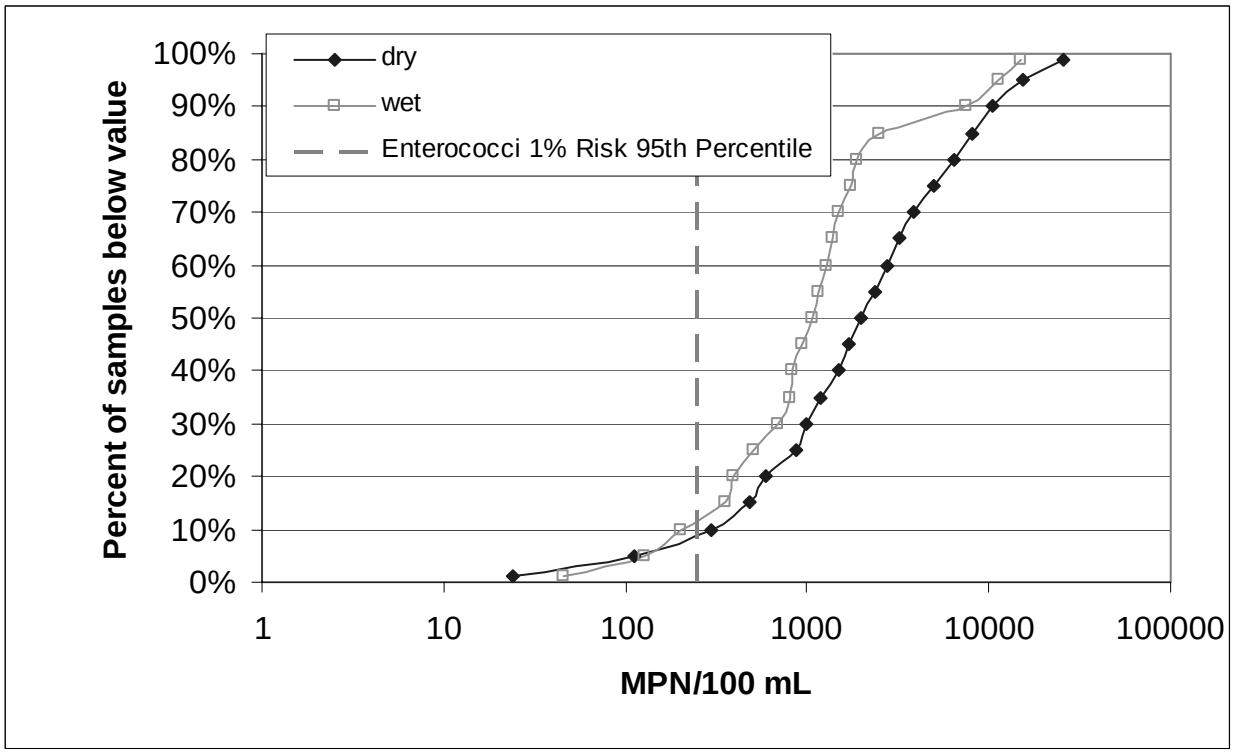
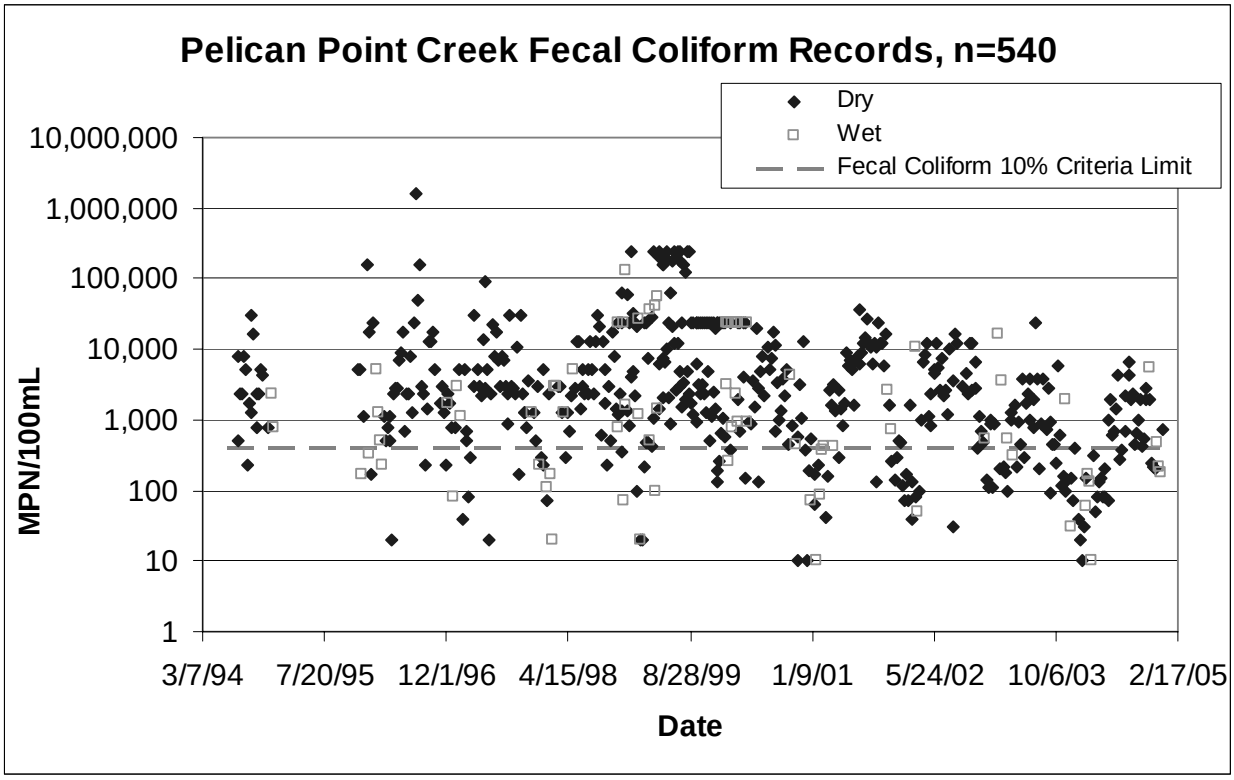


Figure A 11: Pelican Point Creek fecal coliform data and corresponding cumulative frequency distribution



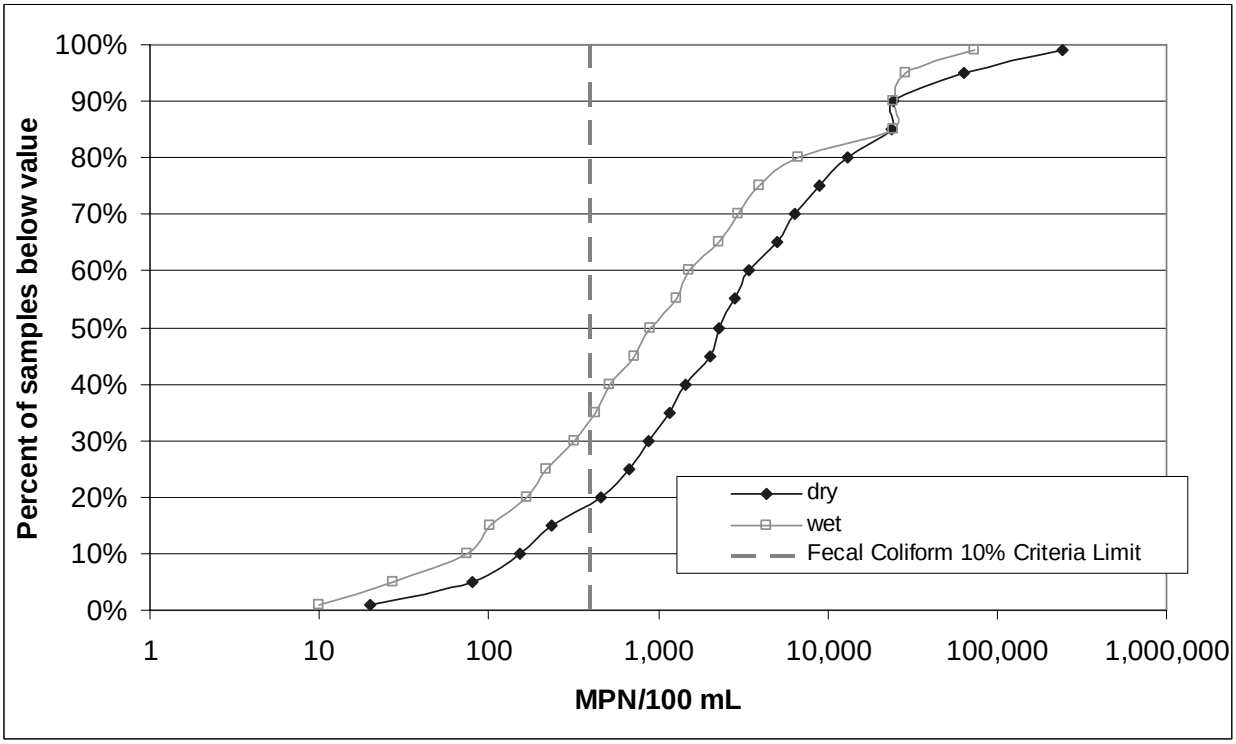
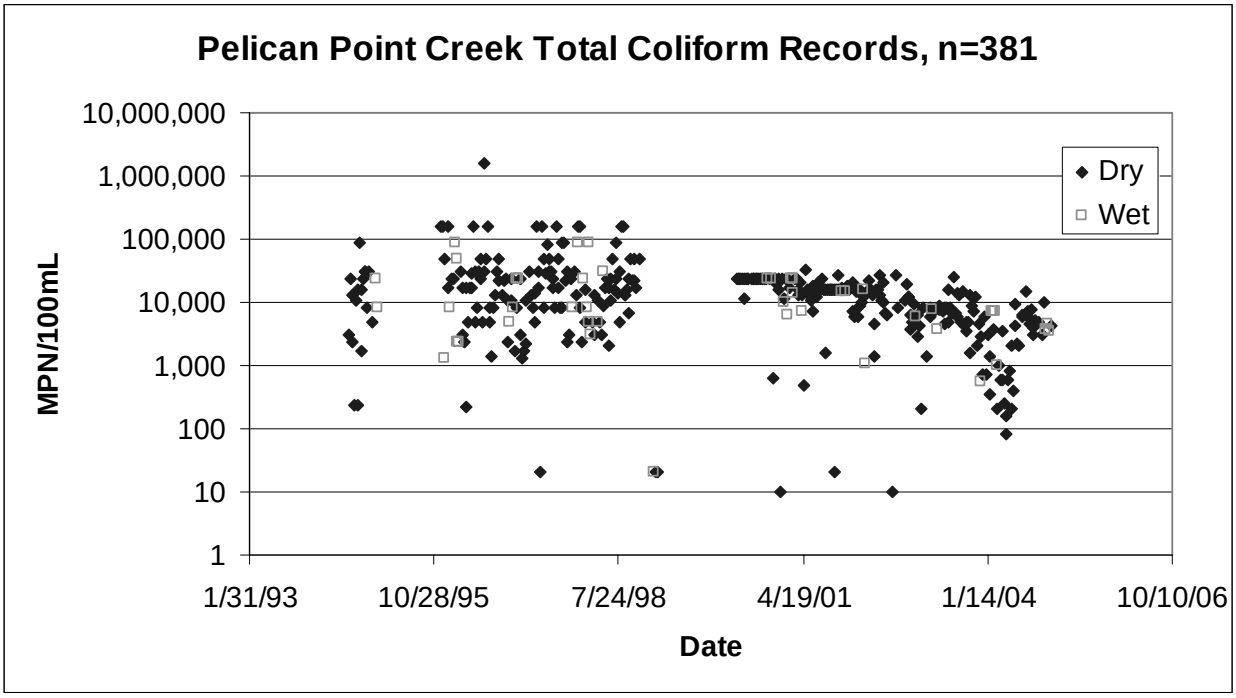


Figure A 12: Pelican Point Creek total coliform data and corresponding cumulative frequency distribution



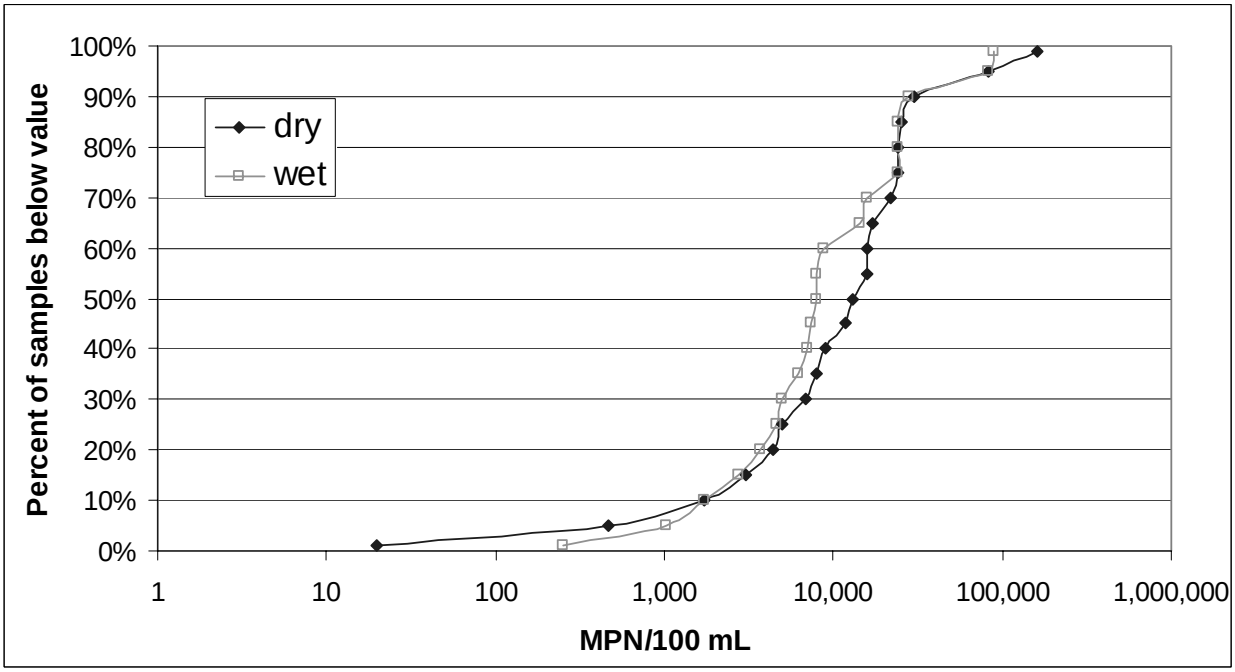


Figure A 13: Percentage of samples from Pelican Point Creek which exceed thresholds, by month

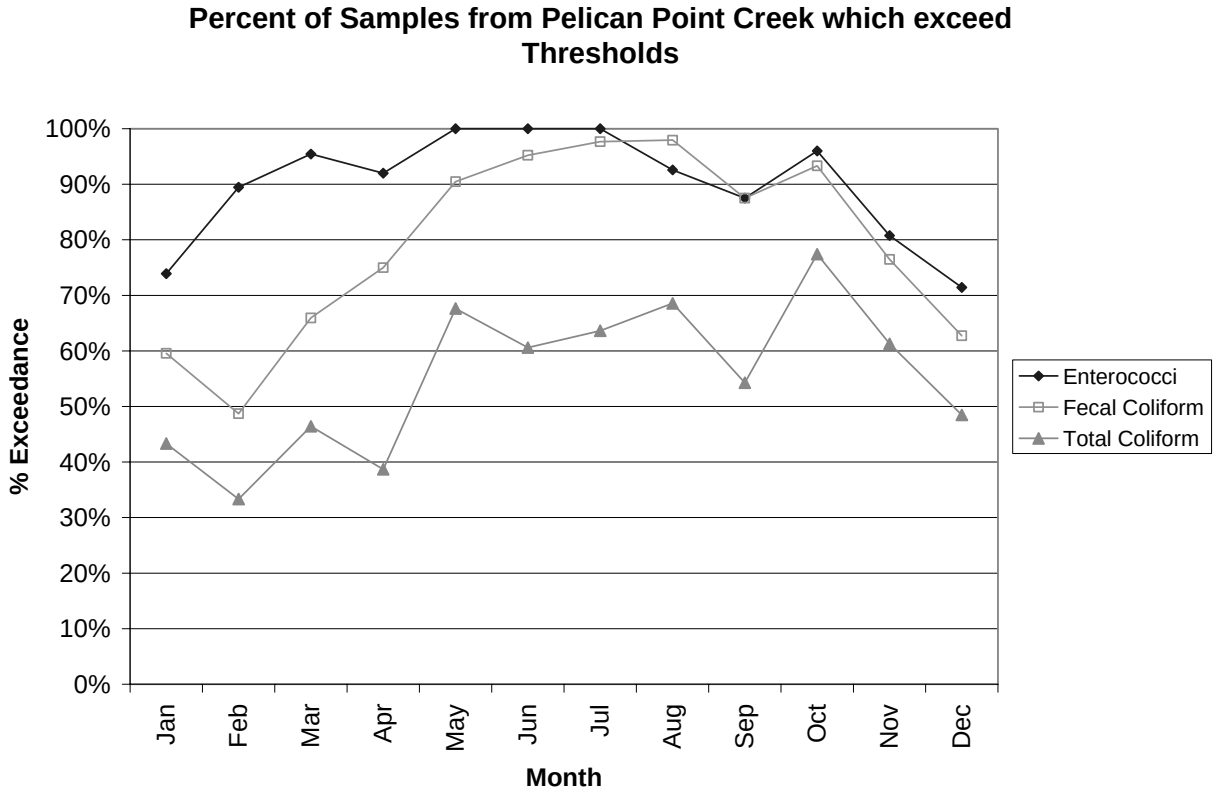
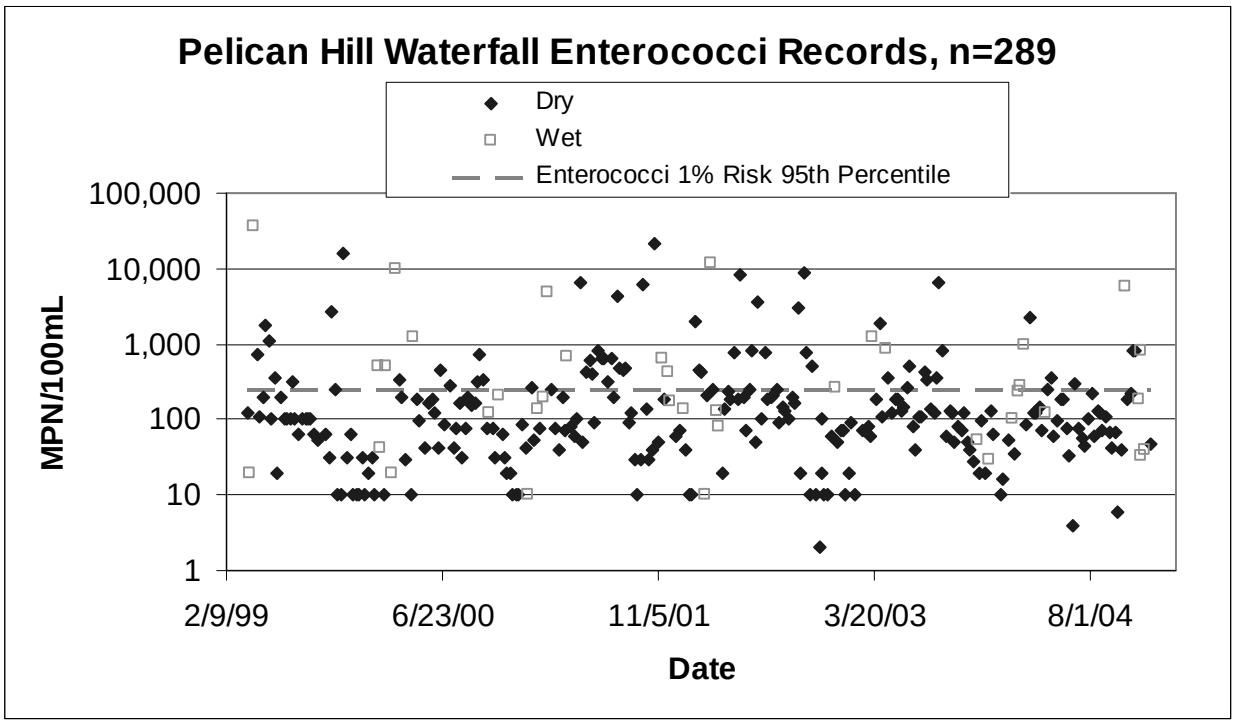


Figure A 14: Pelican Hill Waterfall enterococci data and corresponding cumulative frequency distribution



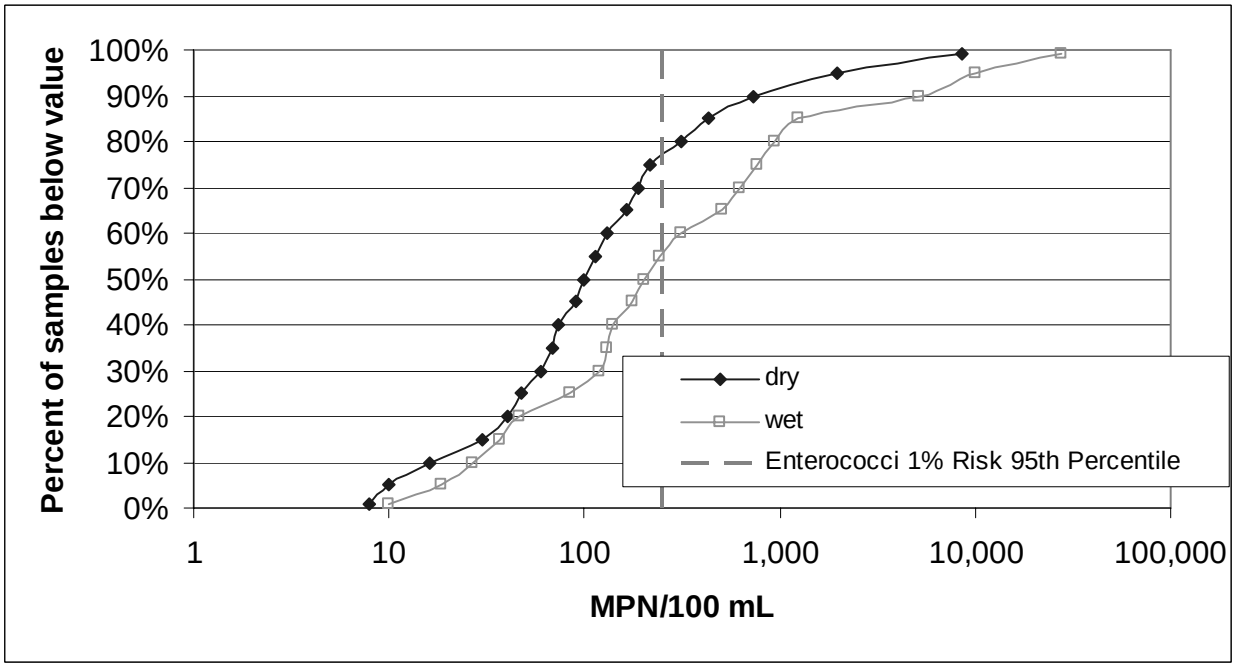
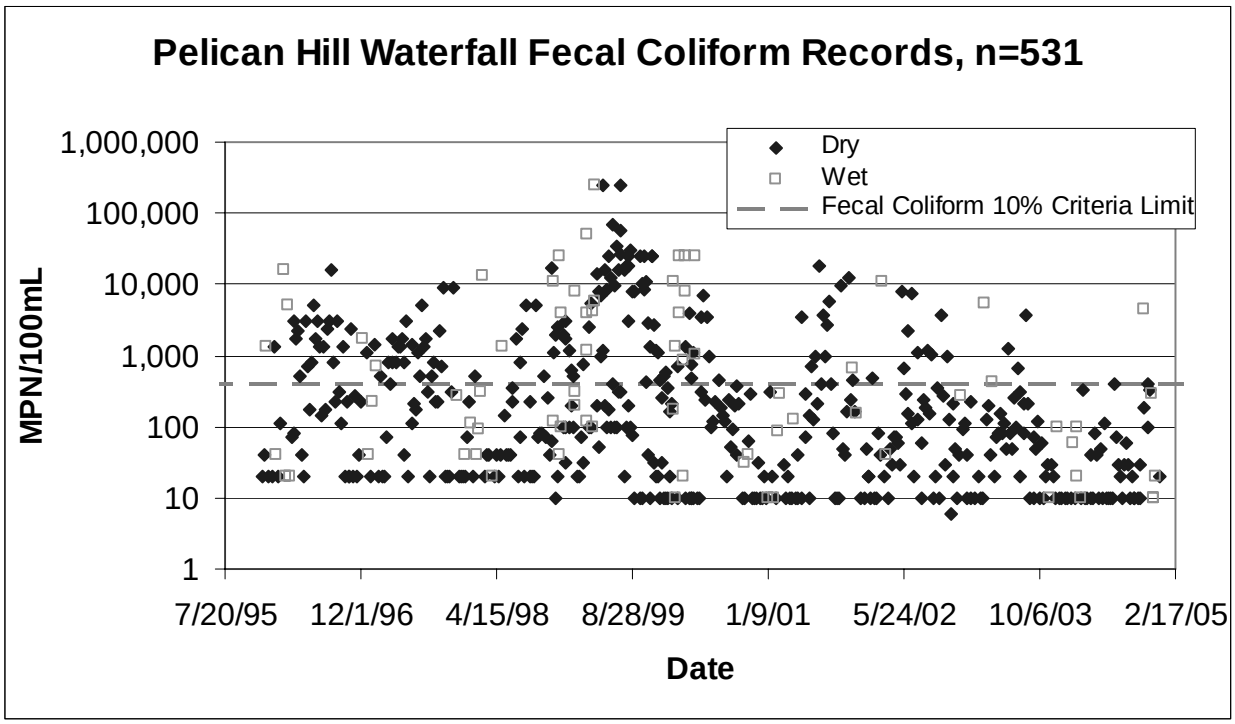


Figure A 15: Pelican Hill Waterfall fecal coliform data and corresponding cumulative frequency distribution



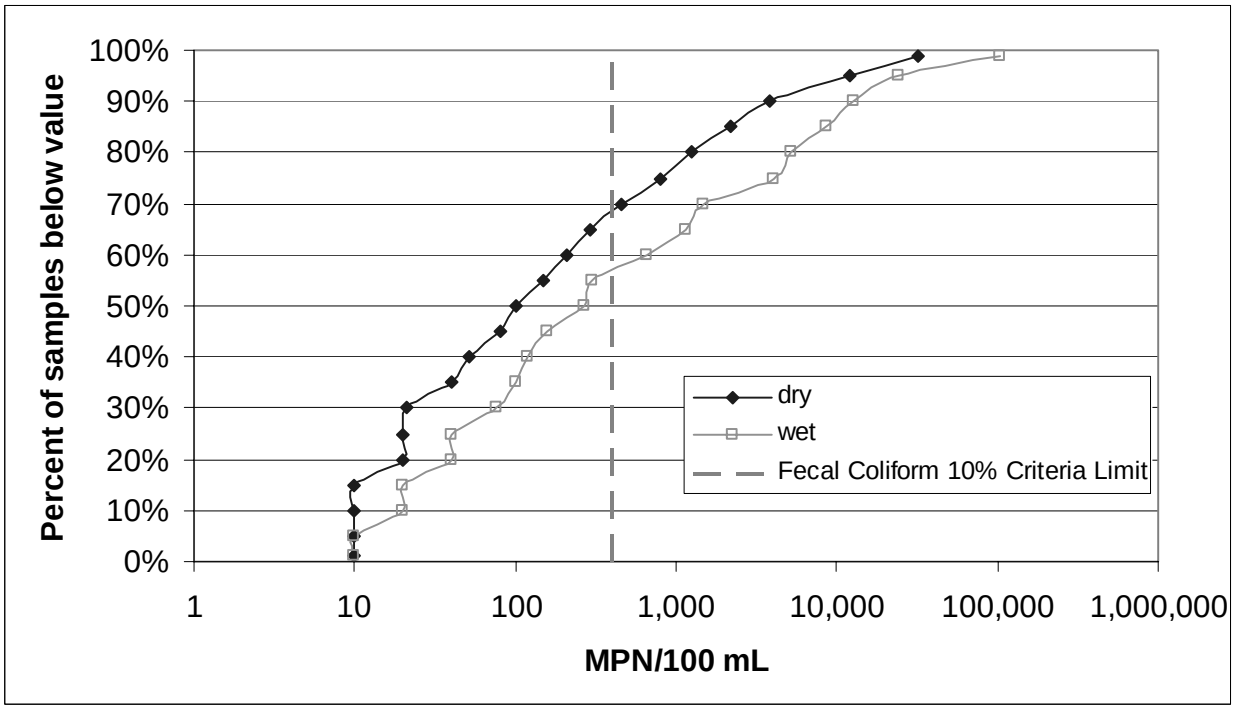
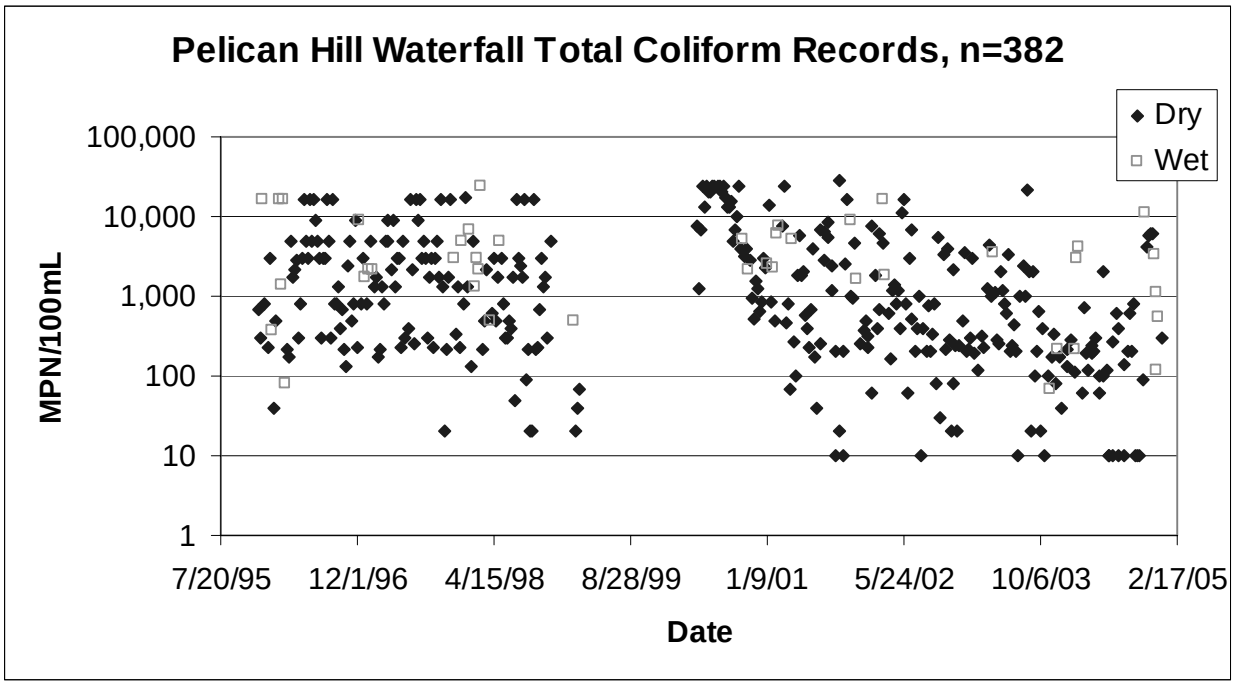


Figure A 16: Pelican Hill Waterfall total coliform data and corresponding cumulative frequency distribution



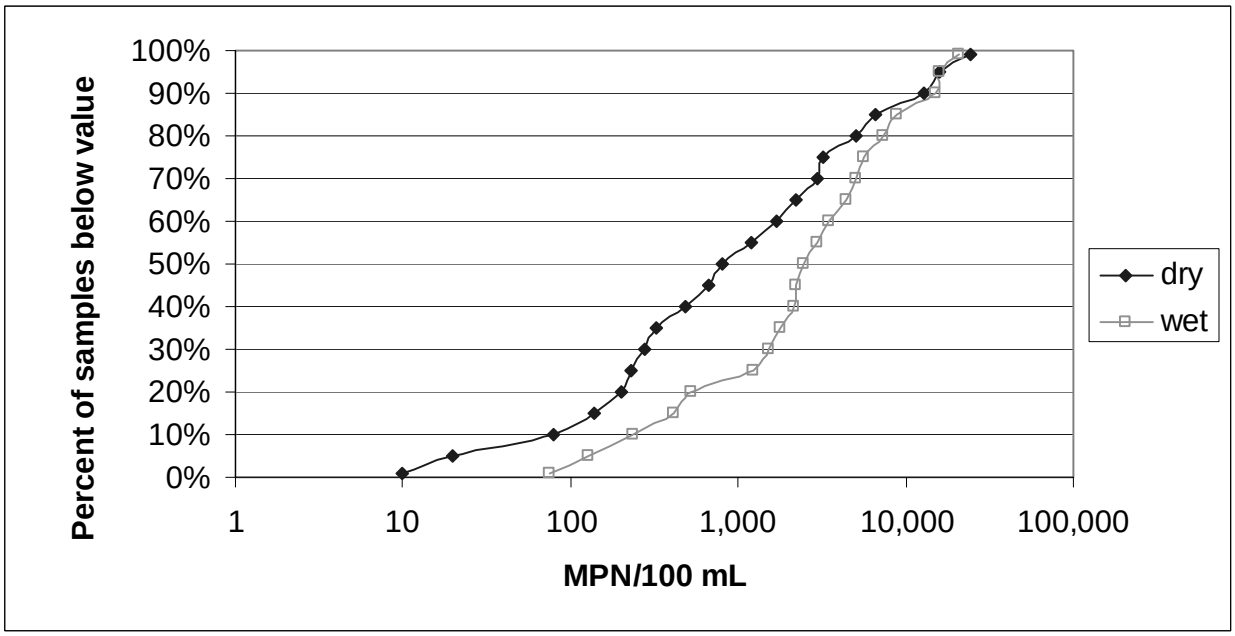


Figure A 17: Percentage of samples from Pelican Hill Waterfall which exceed thresholds, by month

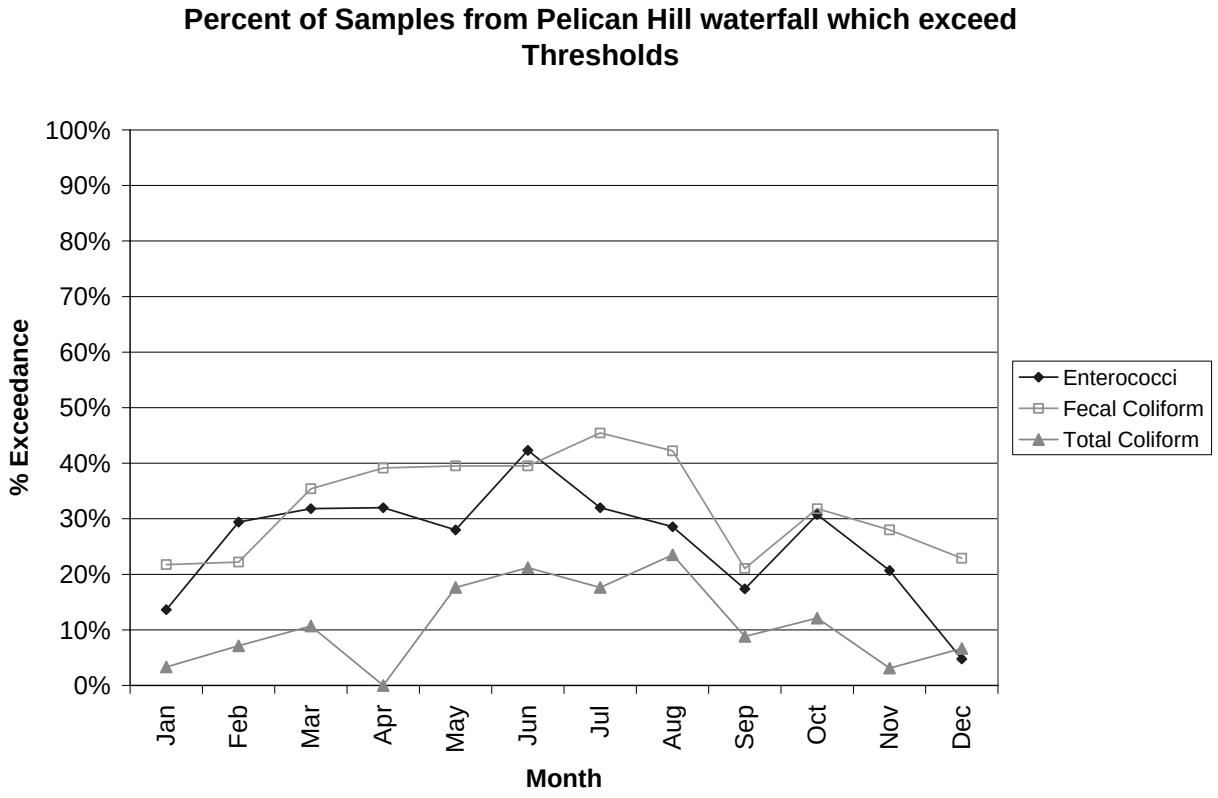
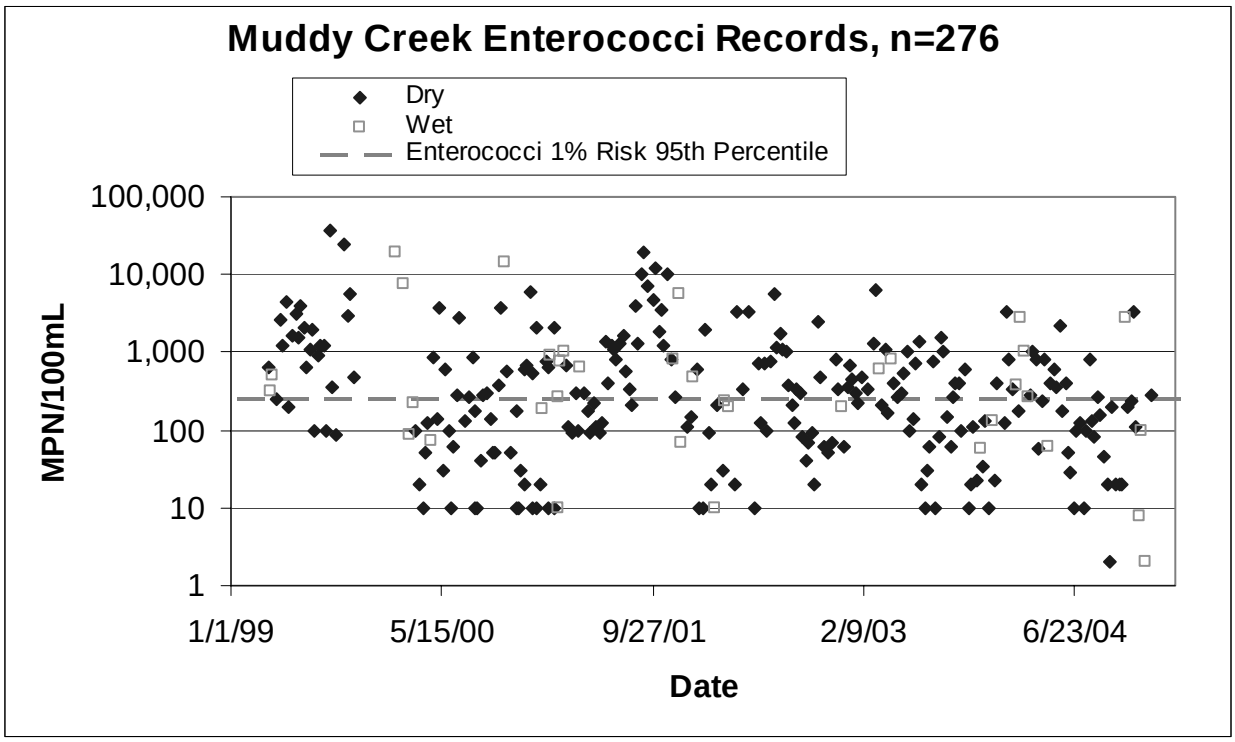


Figure A 18: Muddy Creek enterococci data and corresponding cumulative frequency distribution



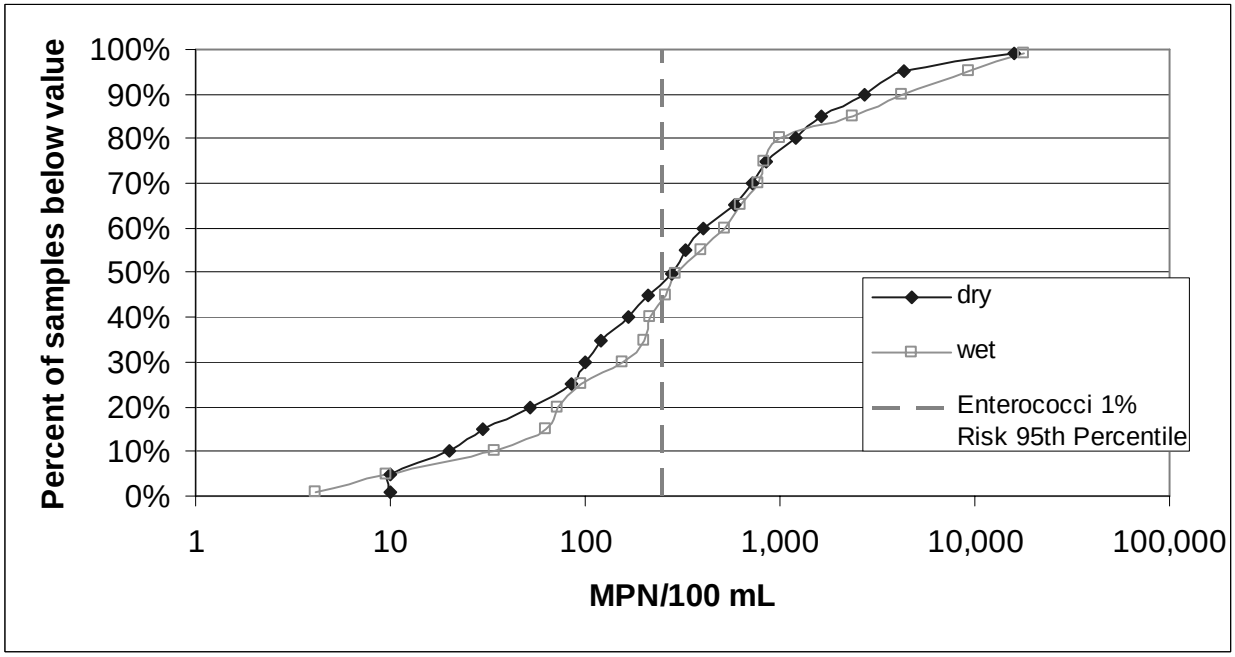
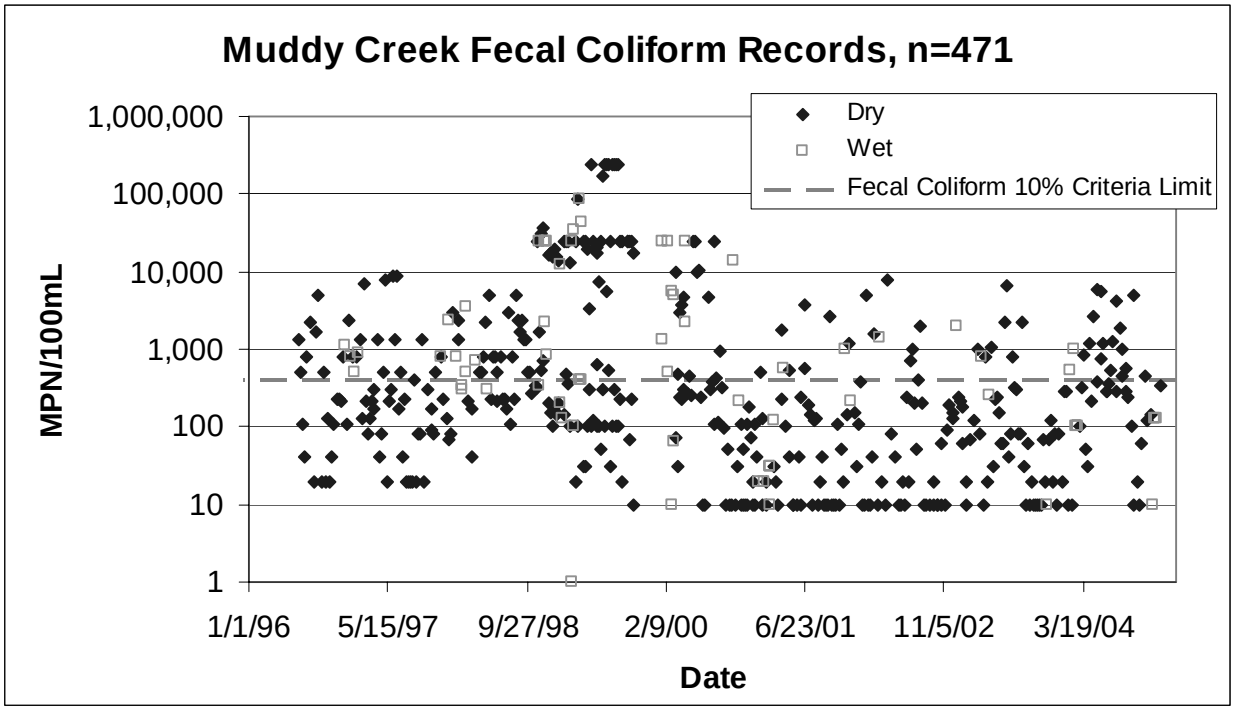


Figure A 19: Muddy Creek fecal coliform data and corresponding cumulative frequency distribution



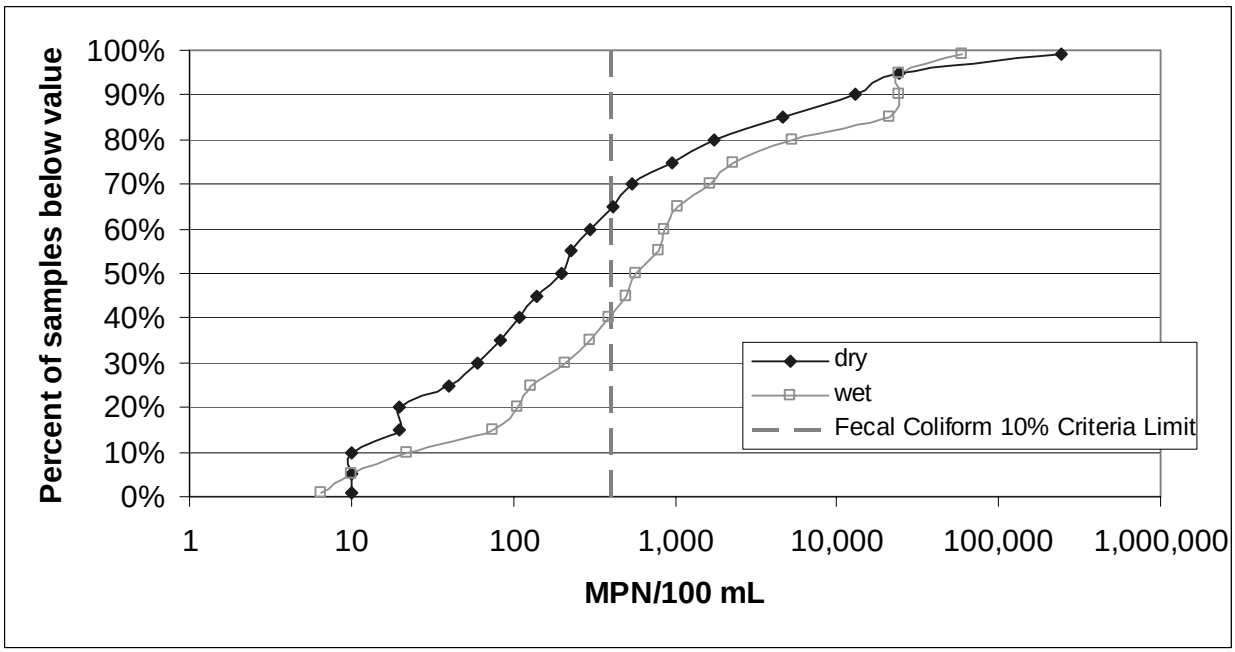
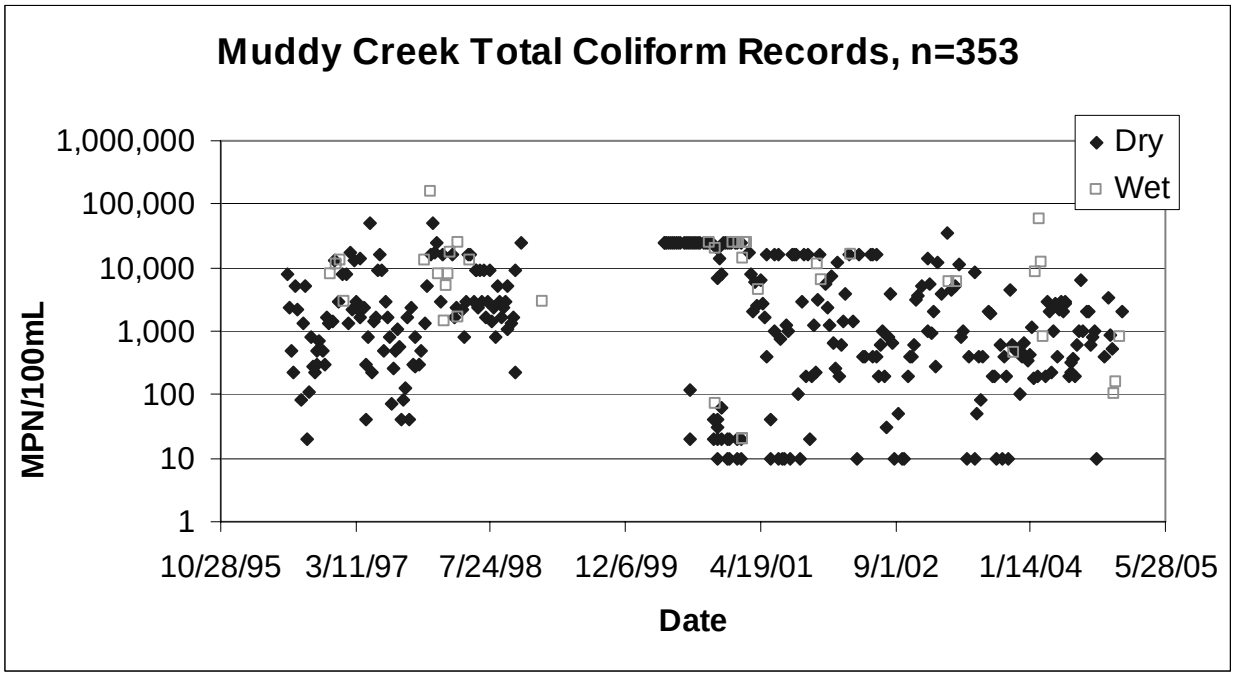


Figure A 20: Muddy Creek total coliform data and corresponding cumulative frequency distribution



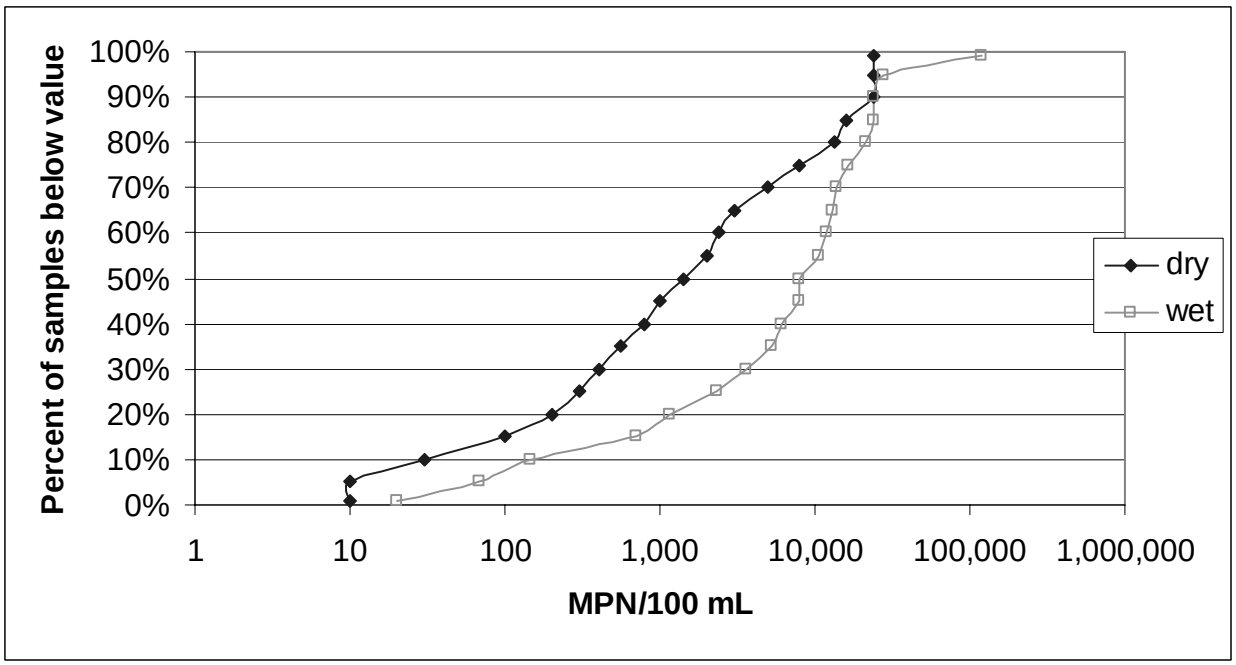


Figure A 21: Percentage of samples from Muddy Creek which exceed thresholds, by month

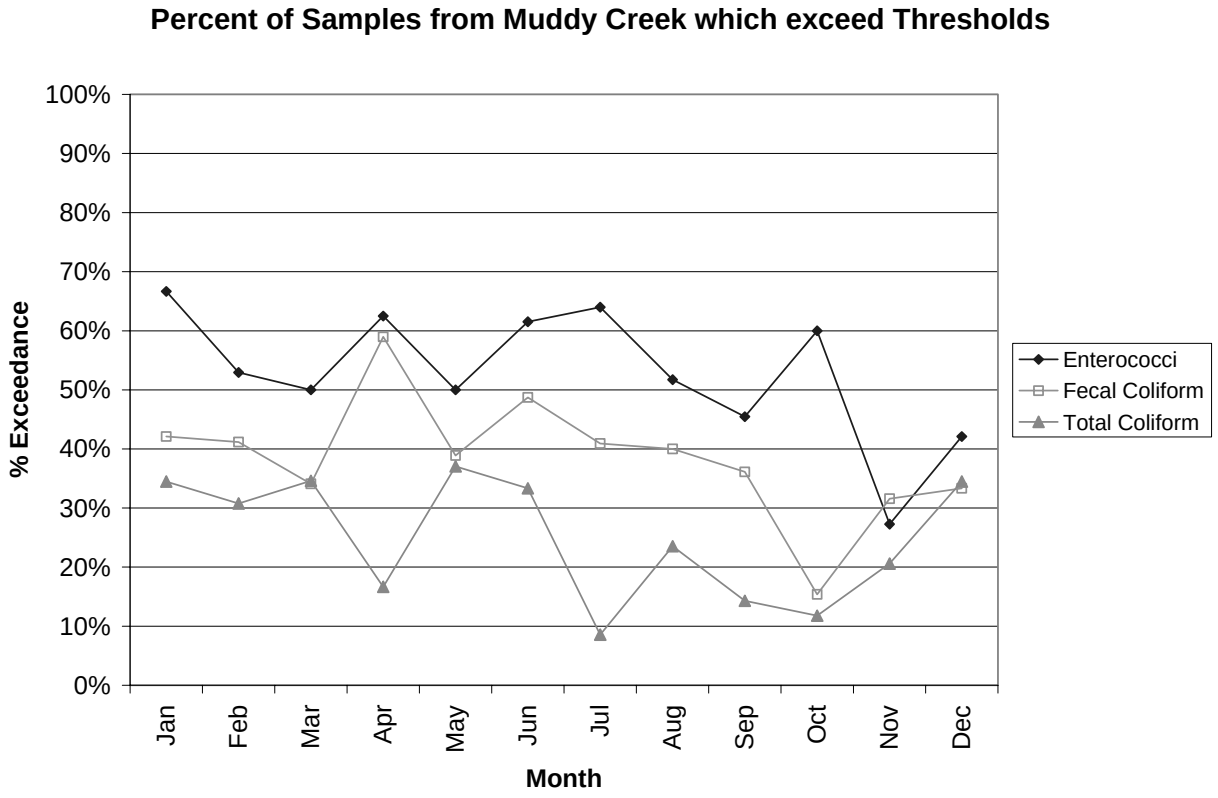
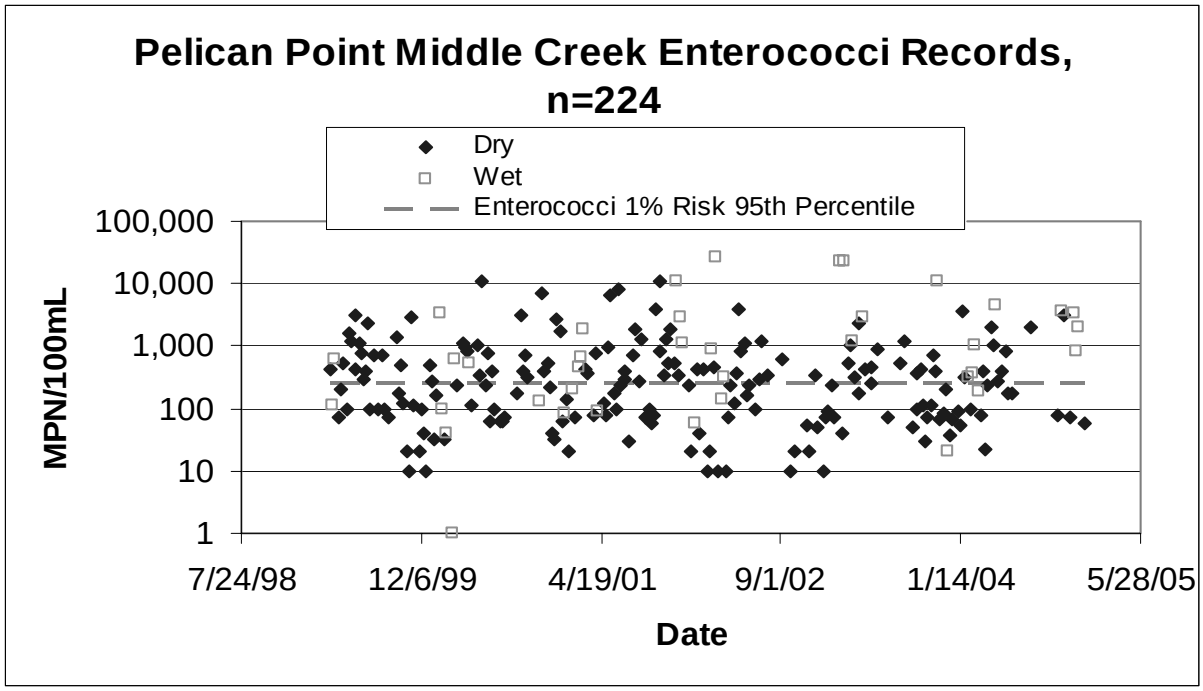


Figure A 22: Pelican Point Middle Creek enterococci data and corresponding cumulative frequency distribution



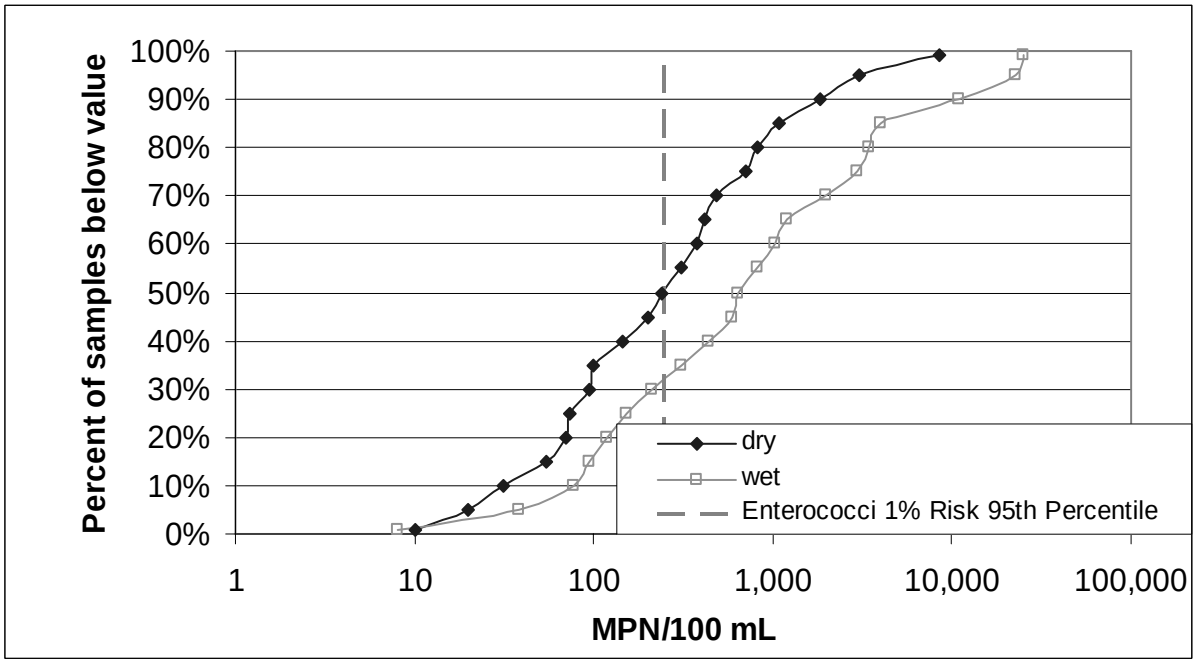
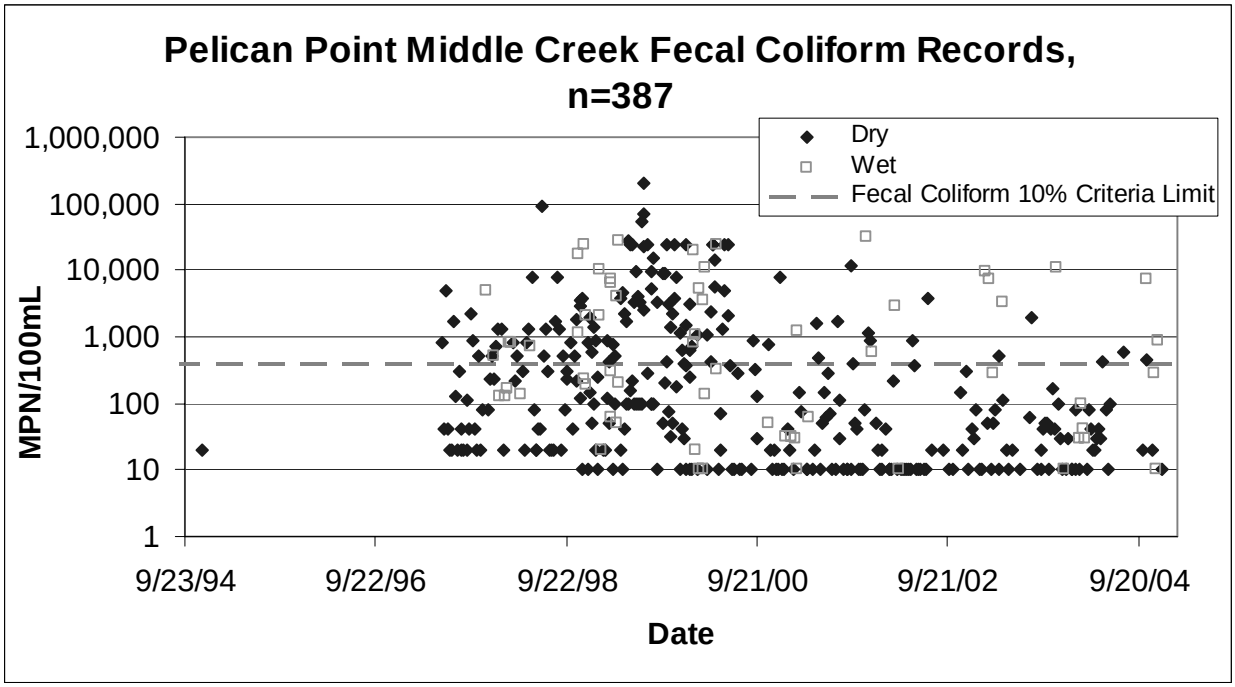


Figure A 23: Pelican Point Middle Creek fecal coliform data and corresponding cumulative frequency distribution



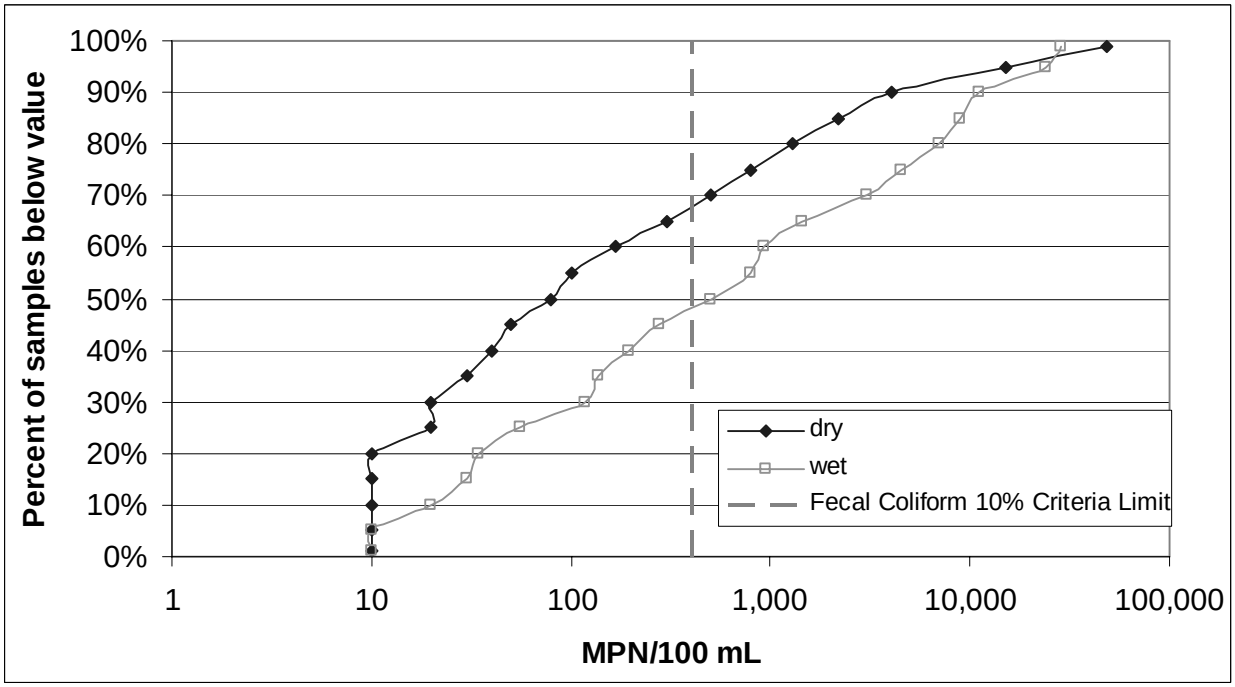
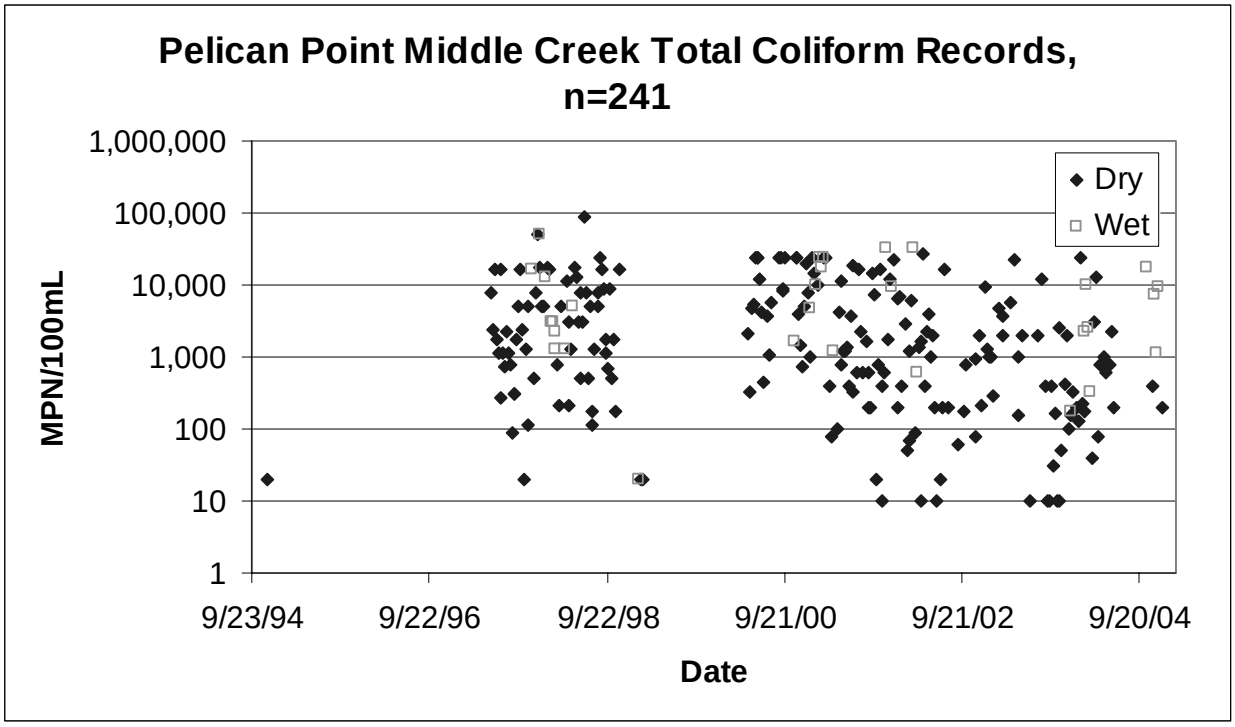


Figure A 24: Pelican Point Middle Creek total coliform data and corresponding cumulative frequency distribution



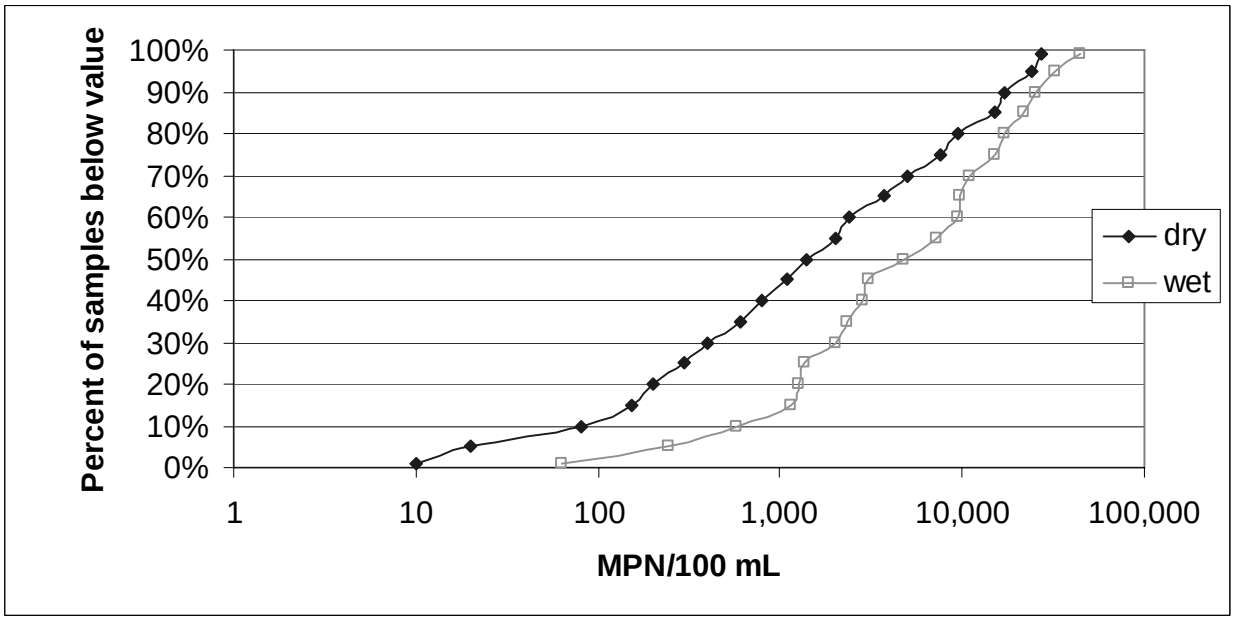


Figure A 25: Percentage of samples from Pelican Point Middle Creek which exceed thresholds, by month

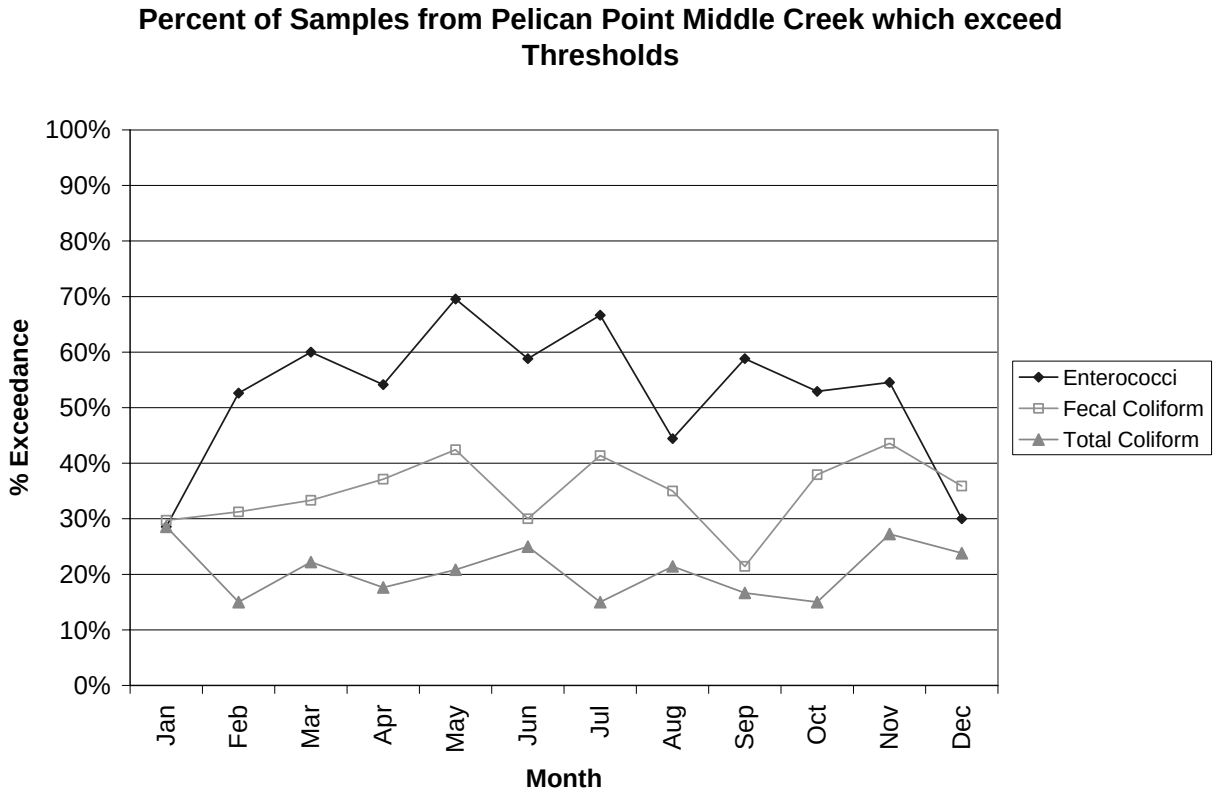
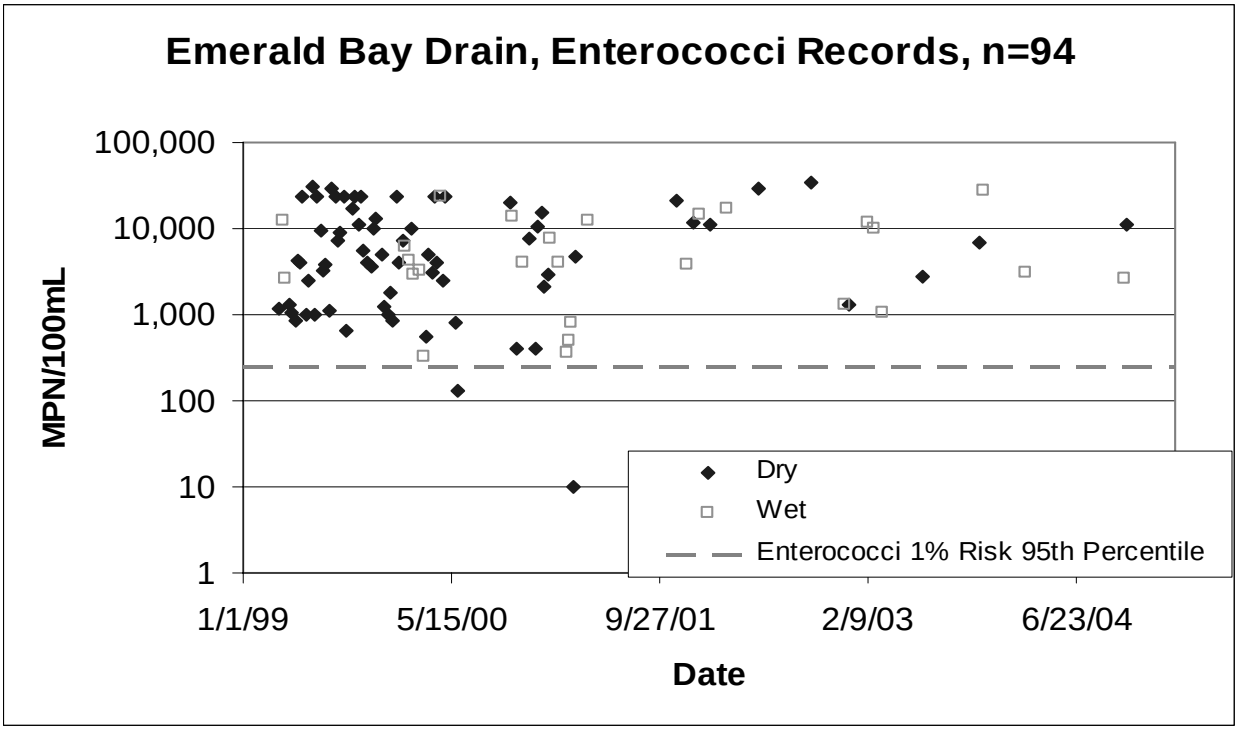


Figure A 26: Emerald Bay Drain enterococci data and corresponding cumulative frequency distribution



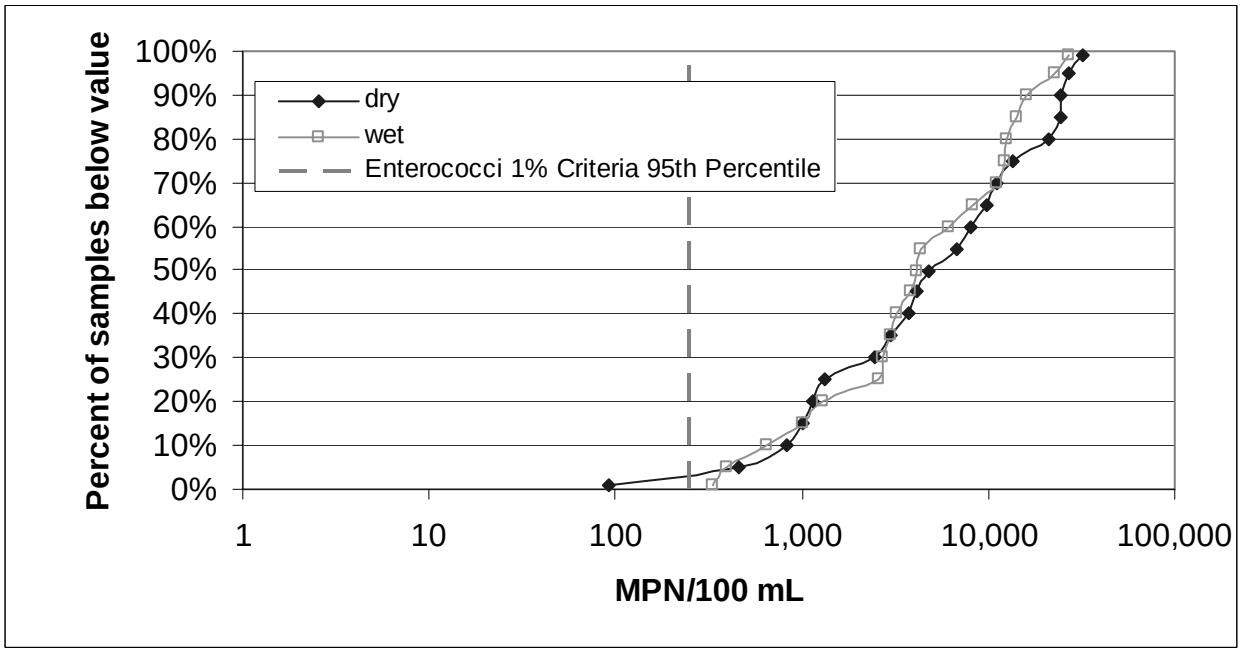
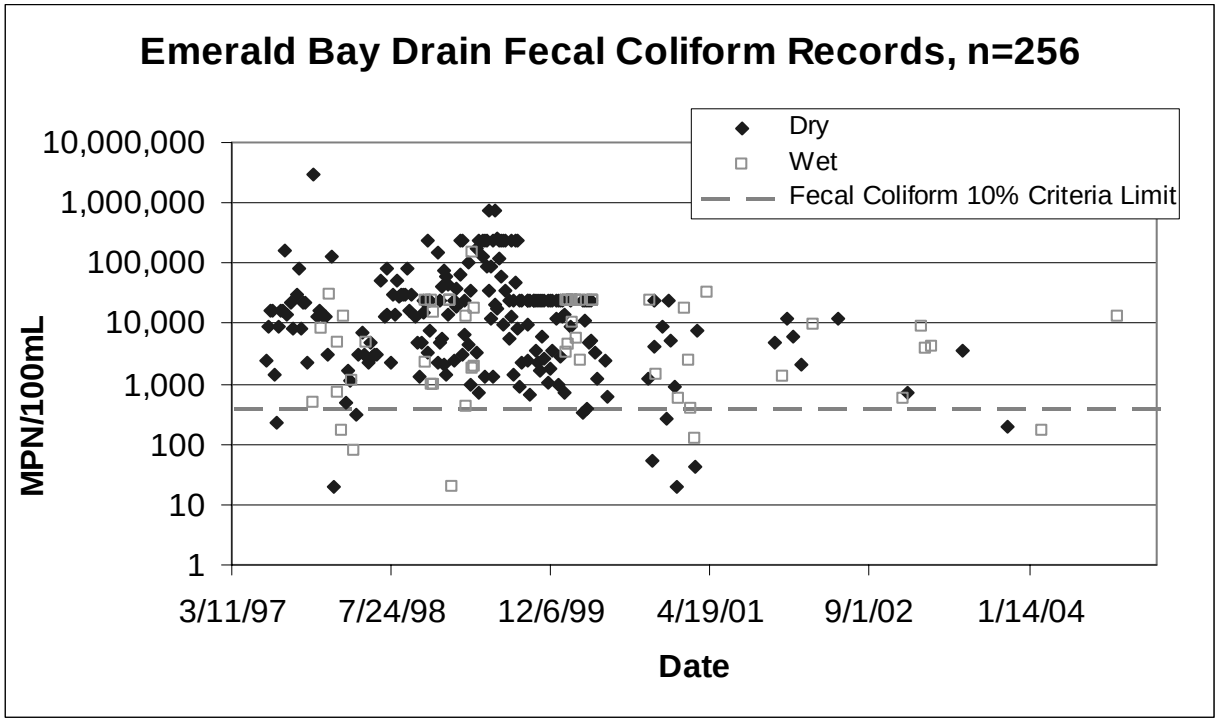


Figure A 27: Emerald Bay Drain fecal coliform data and corresponding cumulative frequency distribution



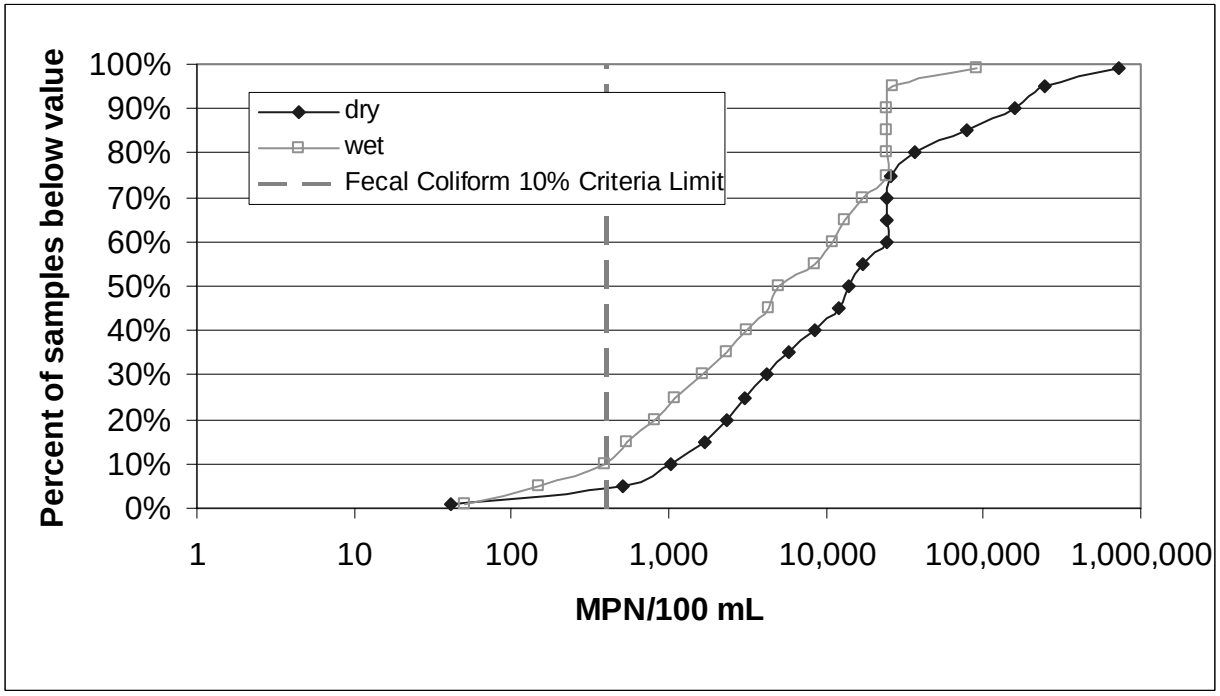
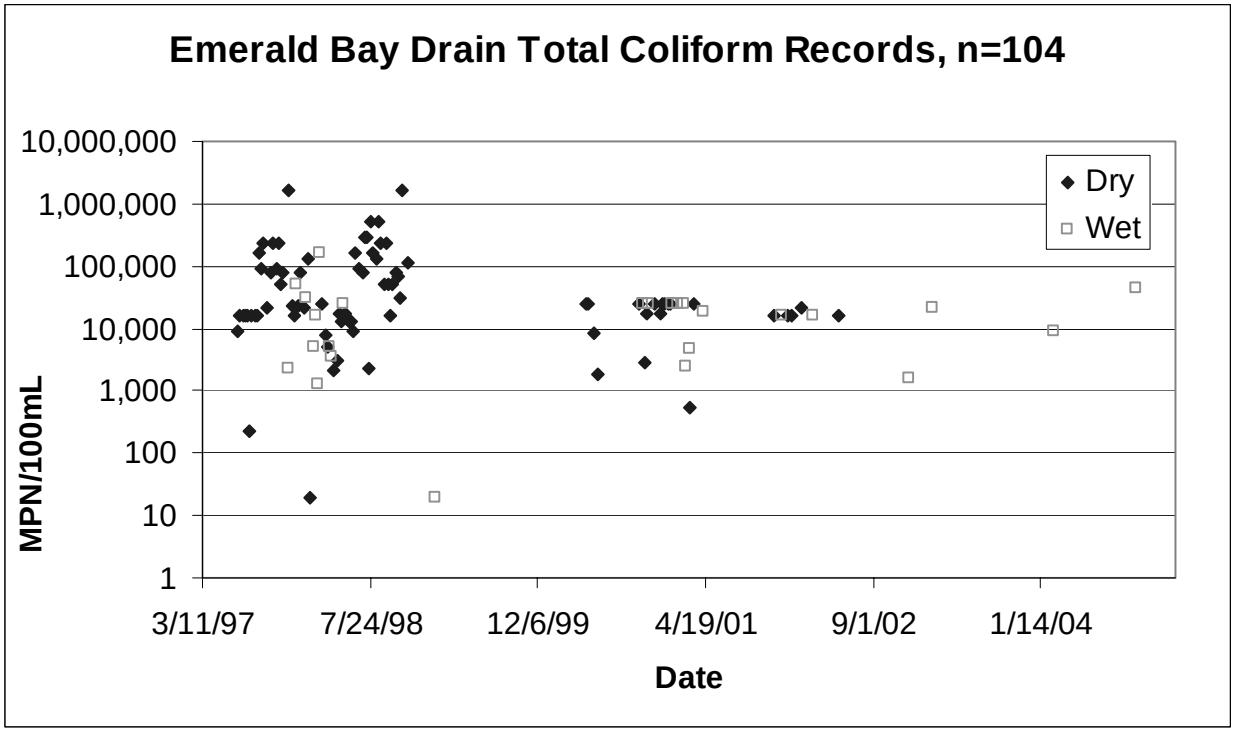


Figure A 28: Emerald Bay Drain total coliform data and corresponding cumulative frequency distribution



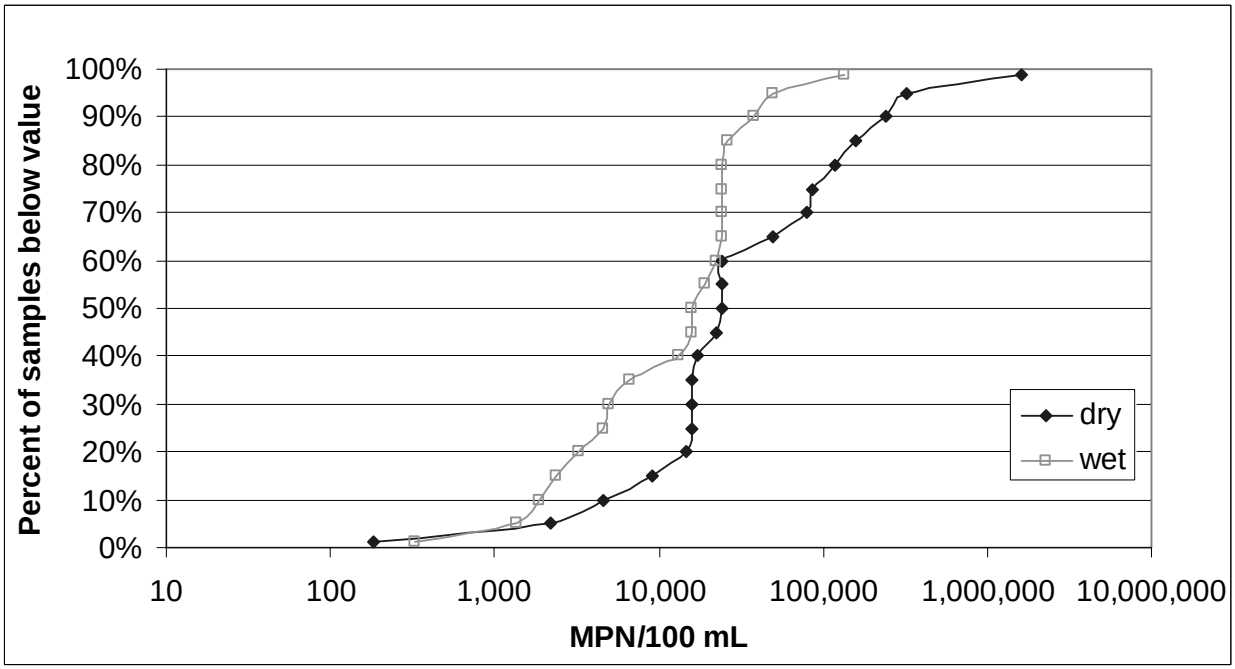


Figure A 29: Percentage of samples from the Emerald Bay Drain which exceed thresholds, by month

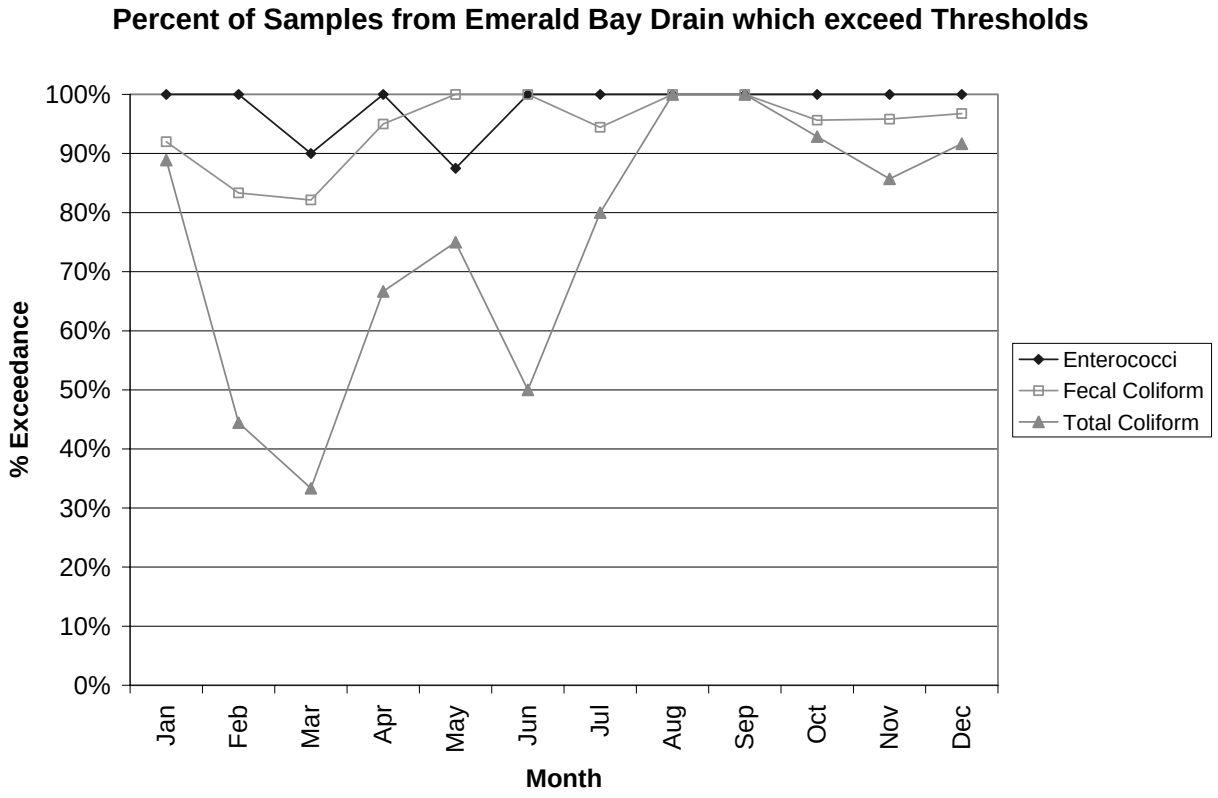
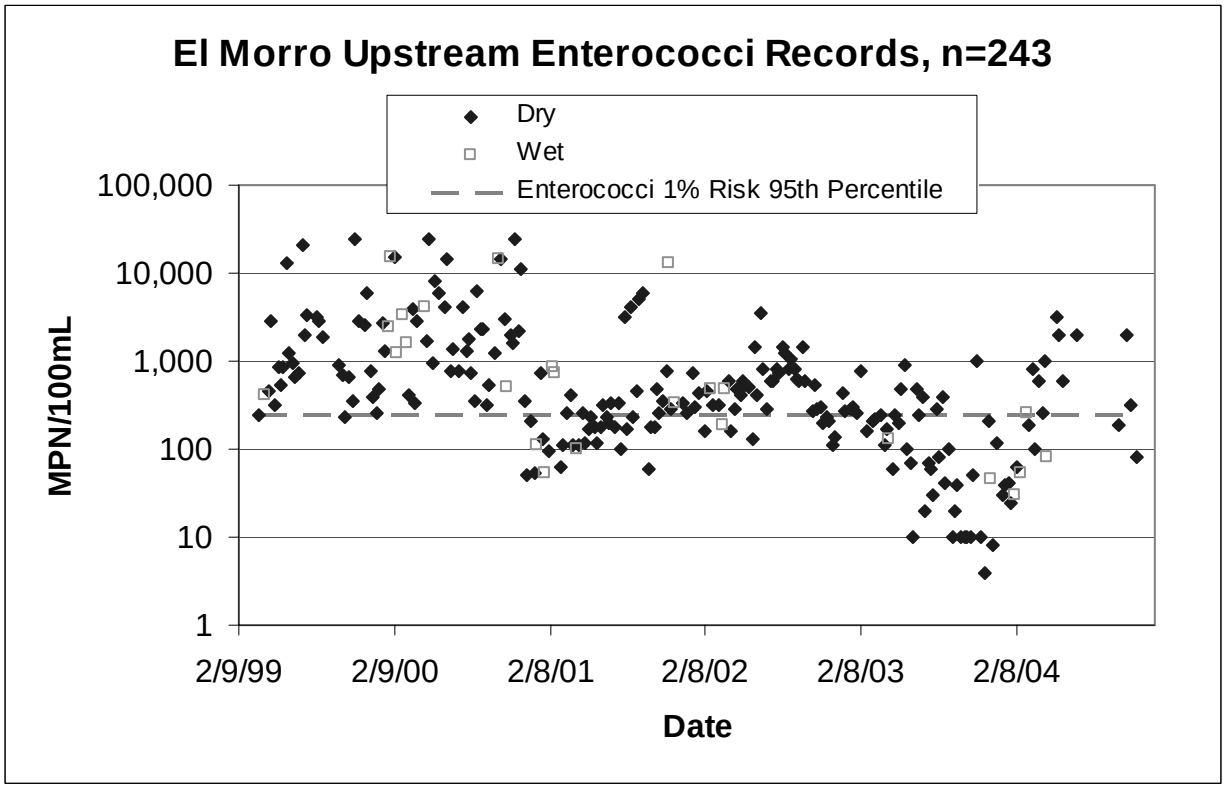


Figure A 30: El Morro Creek Upstream enterococci data and corresponding cumulative frequency distribution



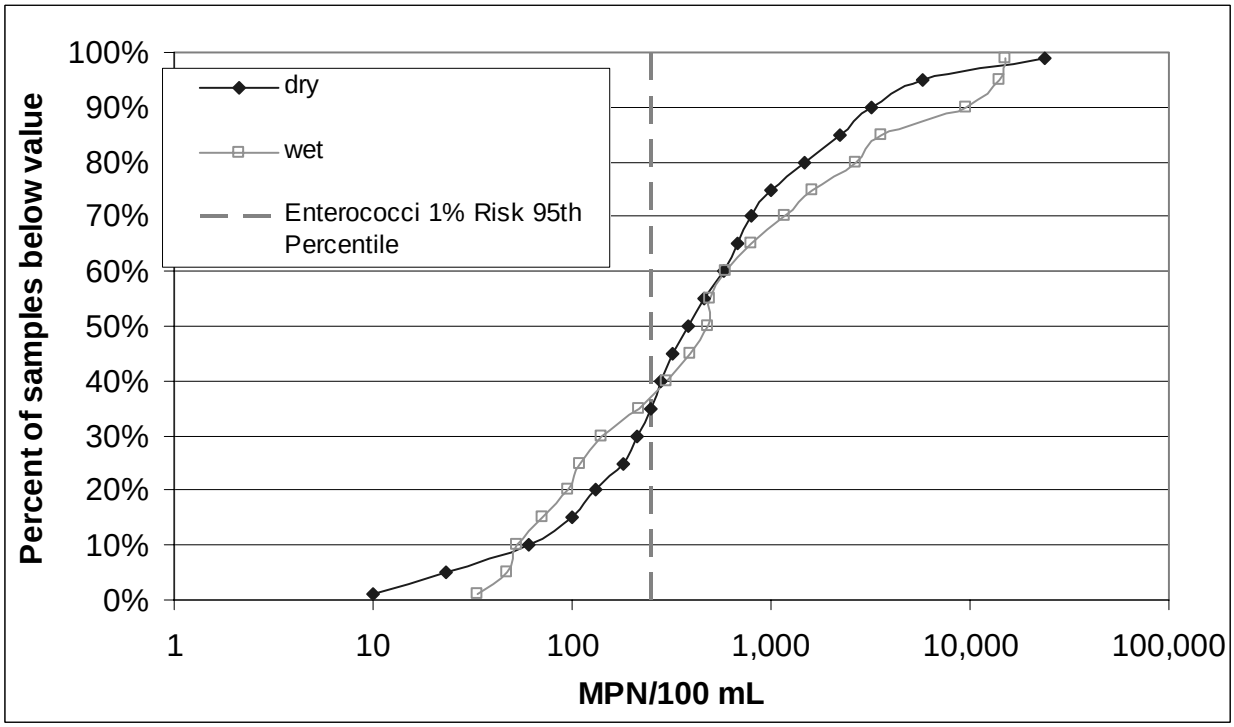
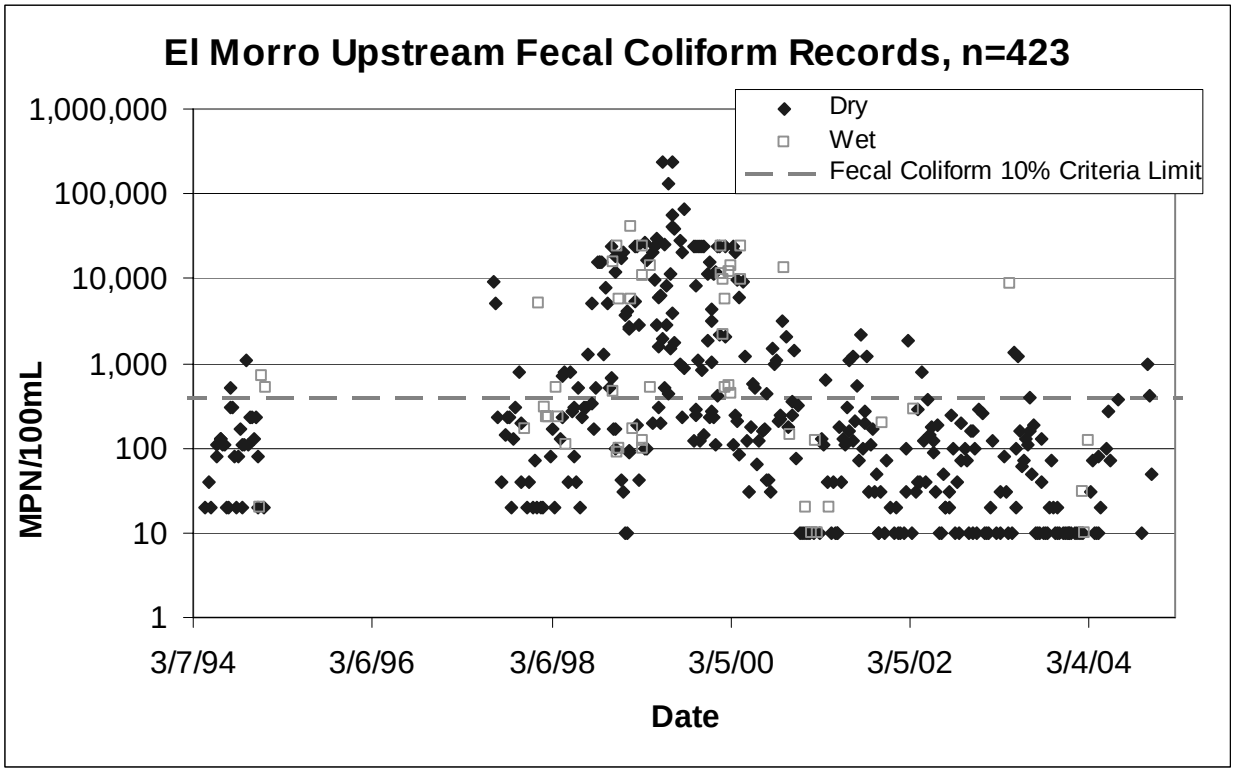


Figure A 31: El Morro Creek Upstream fecal coliform data and corresponding cumulative frequency distribution



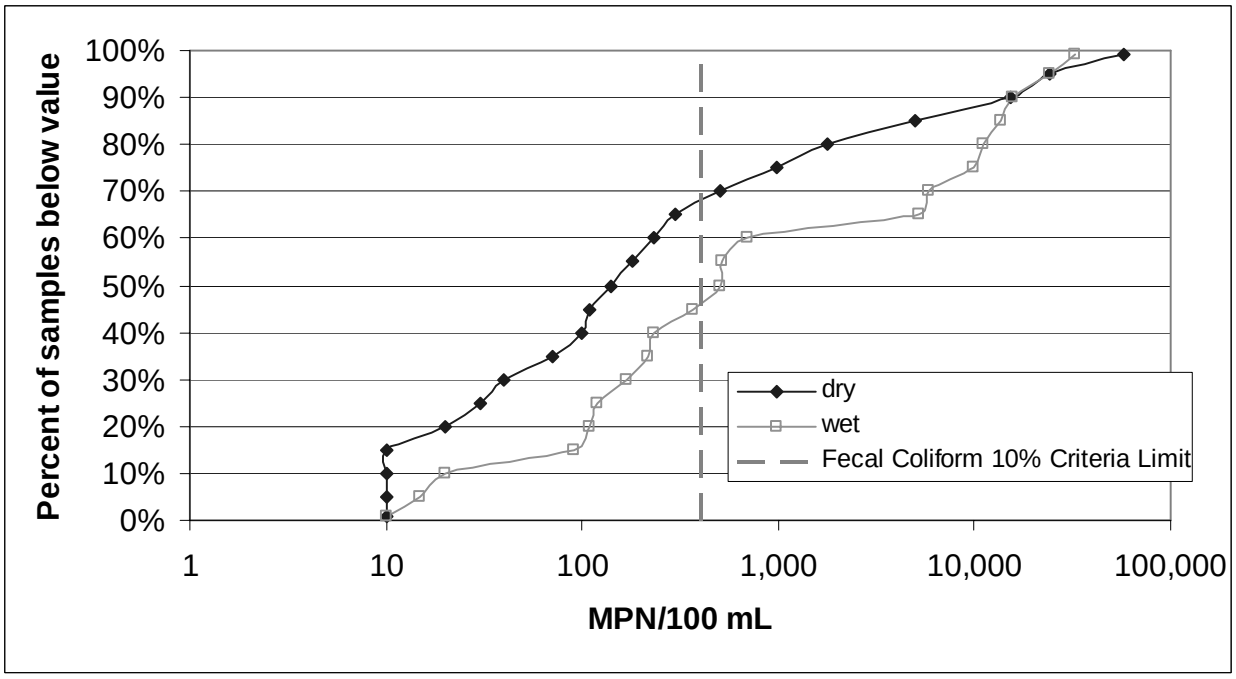
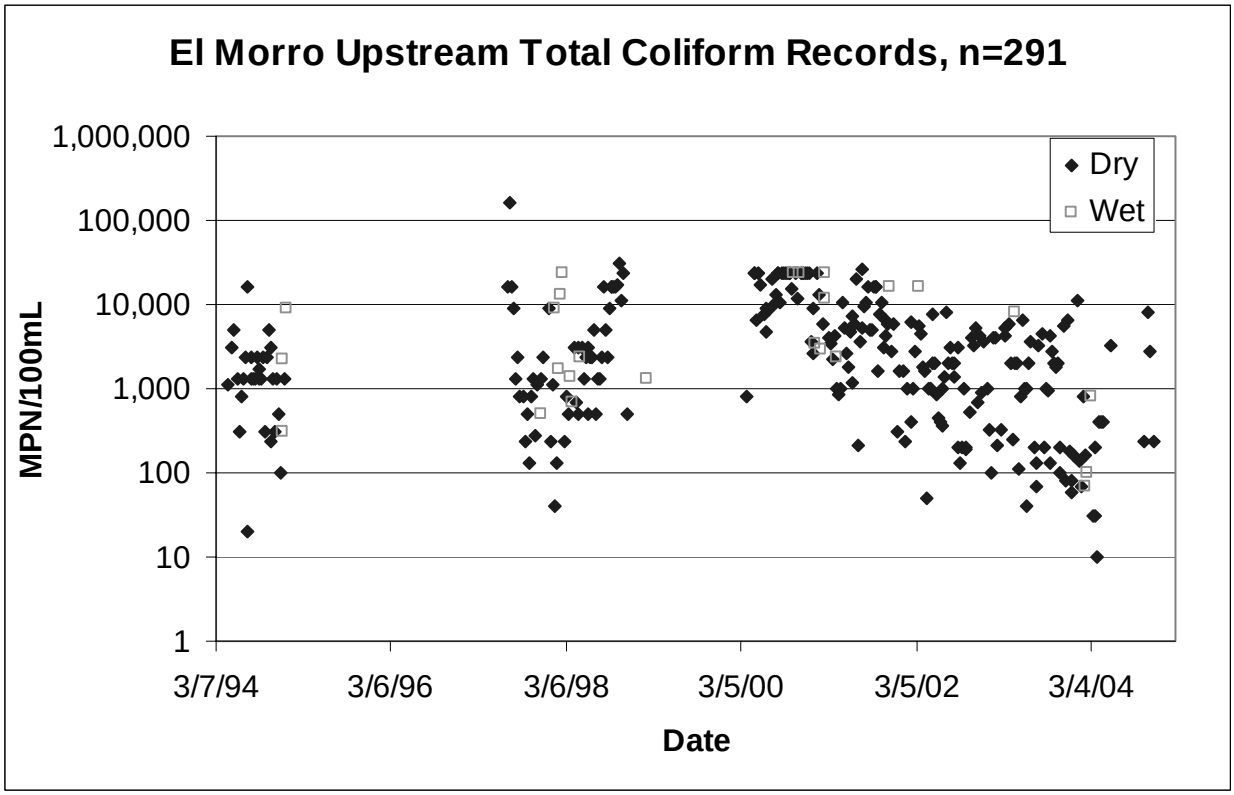


Figure A 32: El Morro Creek Upstream total coliform data and corresponding cumulative frequency distribution



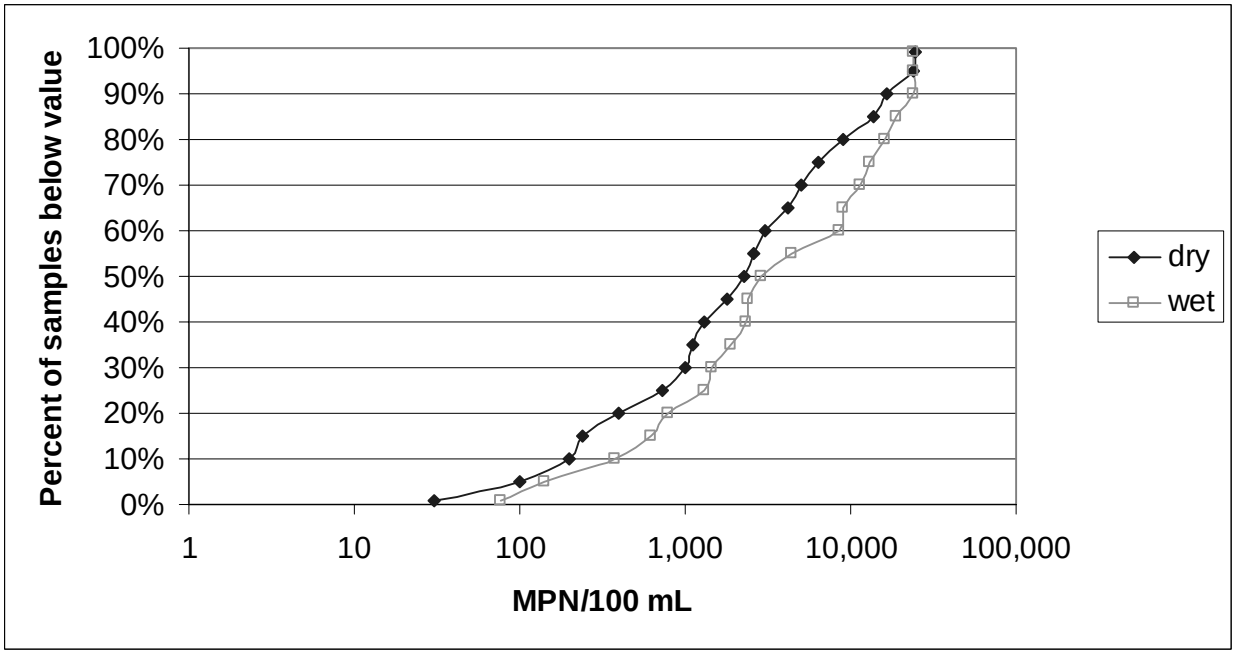


Figure A 33: Percentage of samples from El Morro Creek Upstream which exceed thresholds, by month

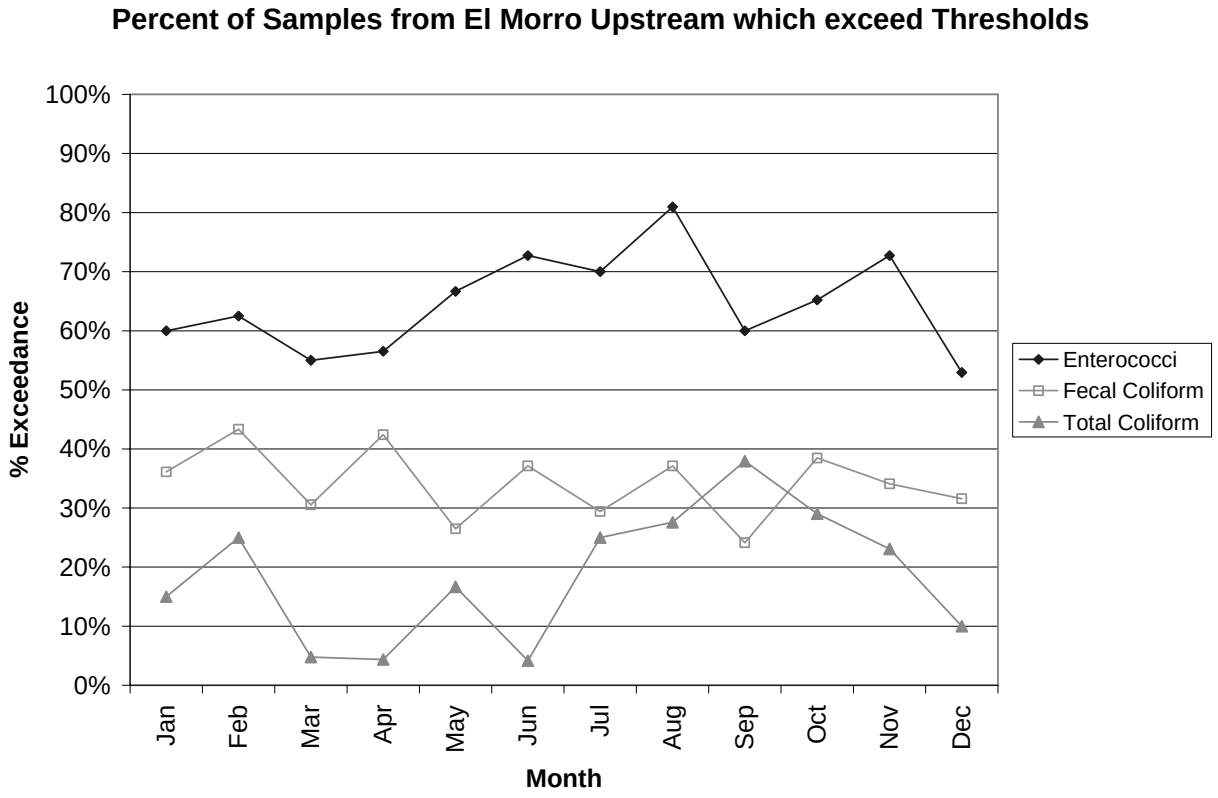
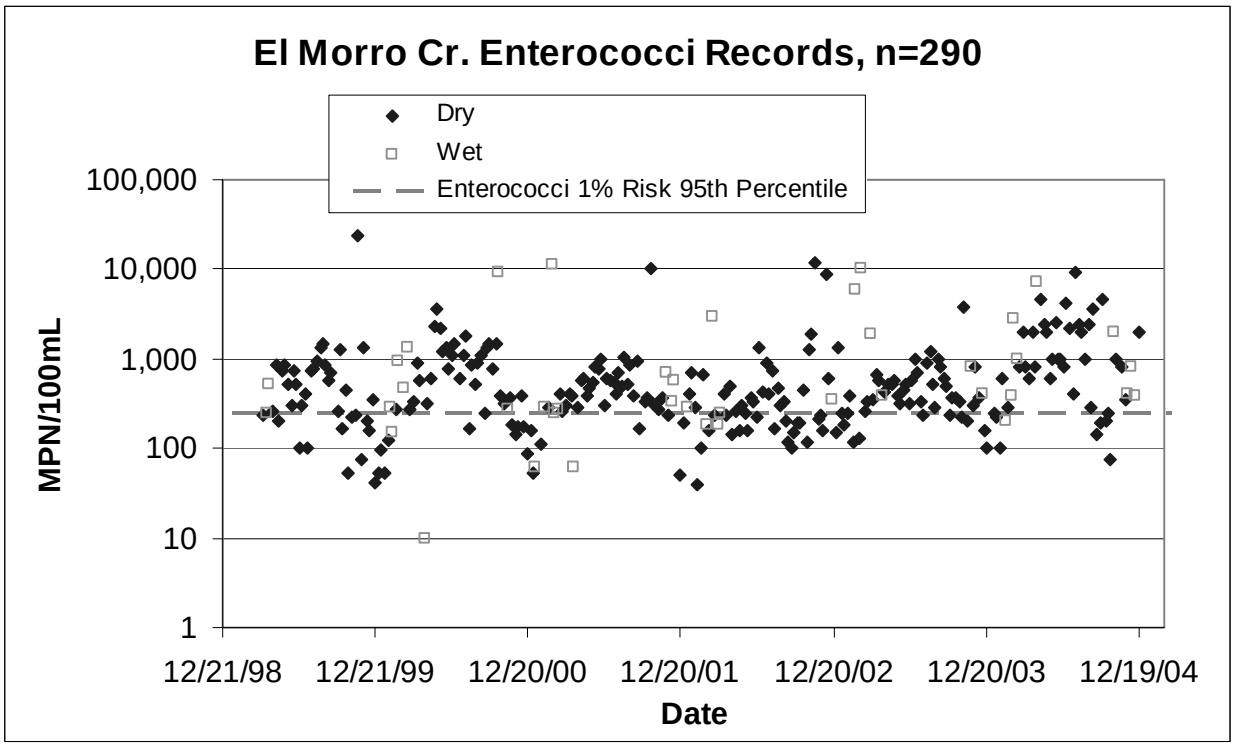


Figure A 34: El Morro Creek enterococci data and corresponding cumulative frequency distribution



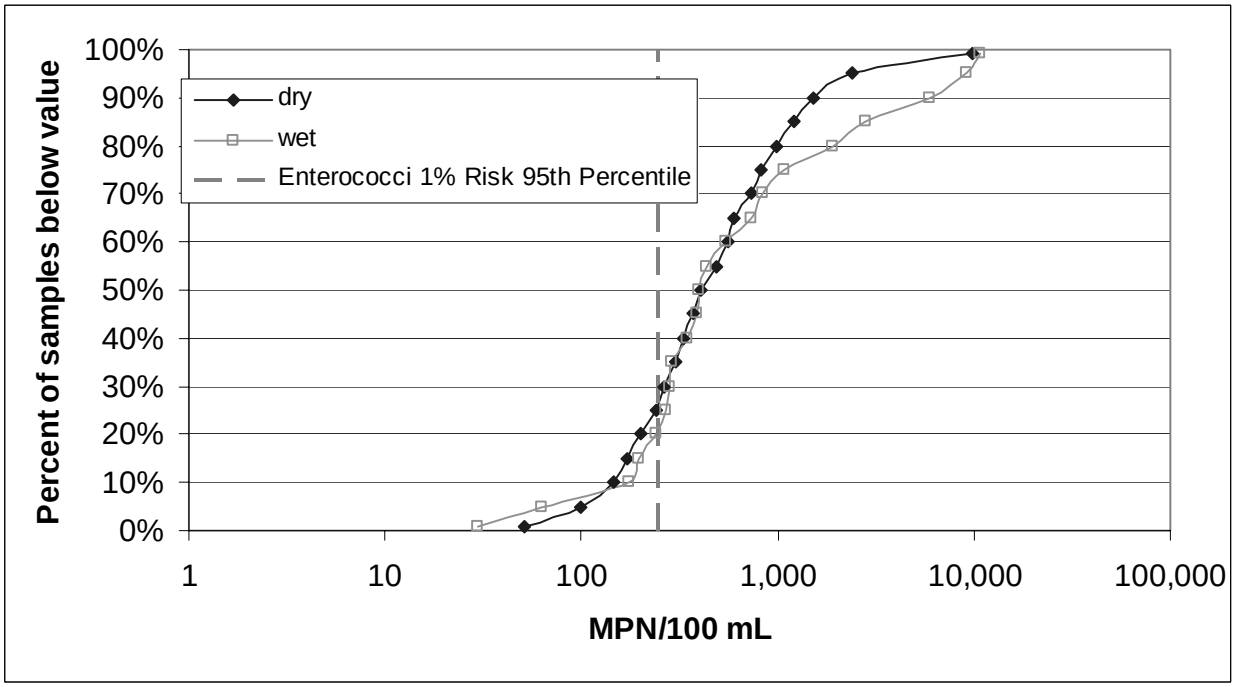
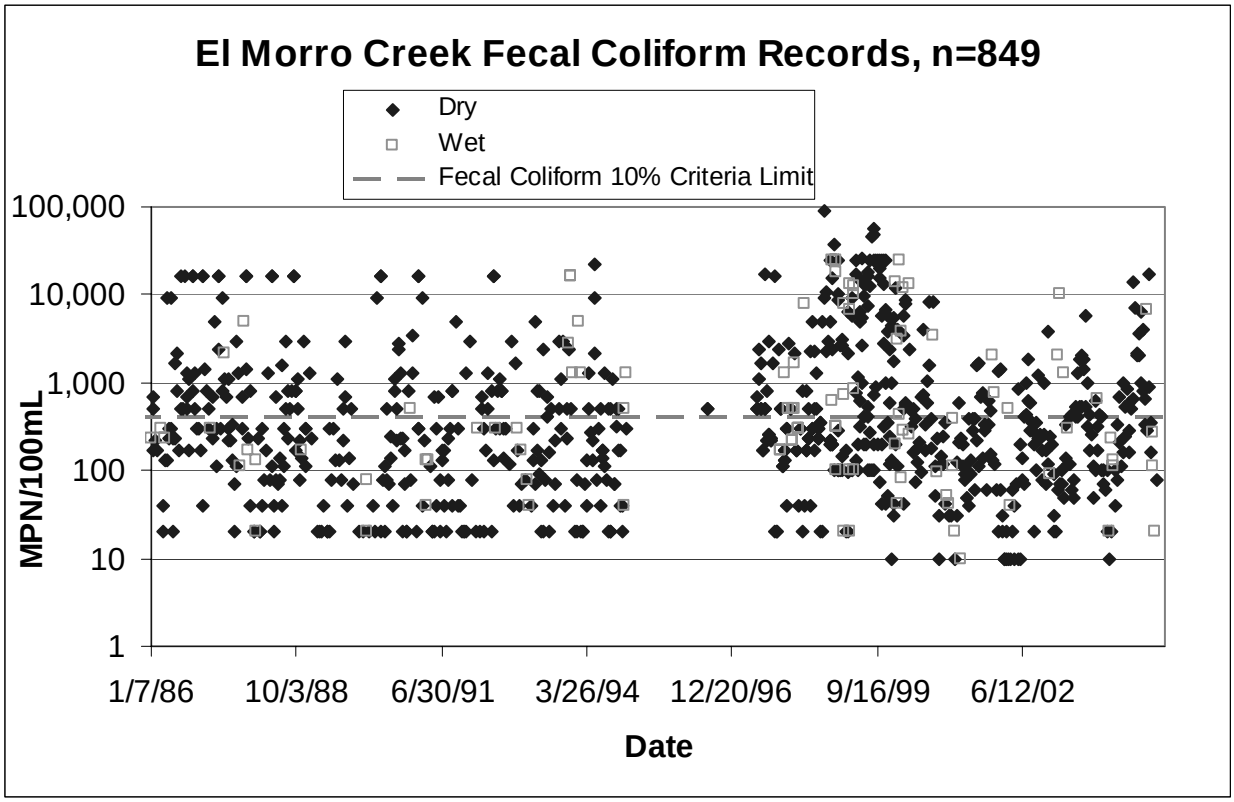


Figure A 35: El Morro Creek fecal coliform data and corresponding cumulative frequency distribution



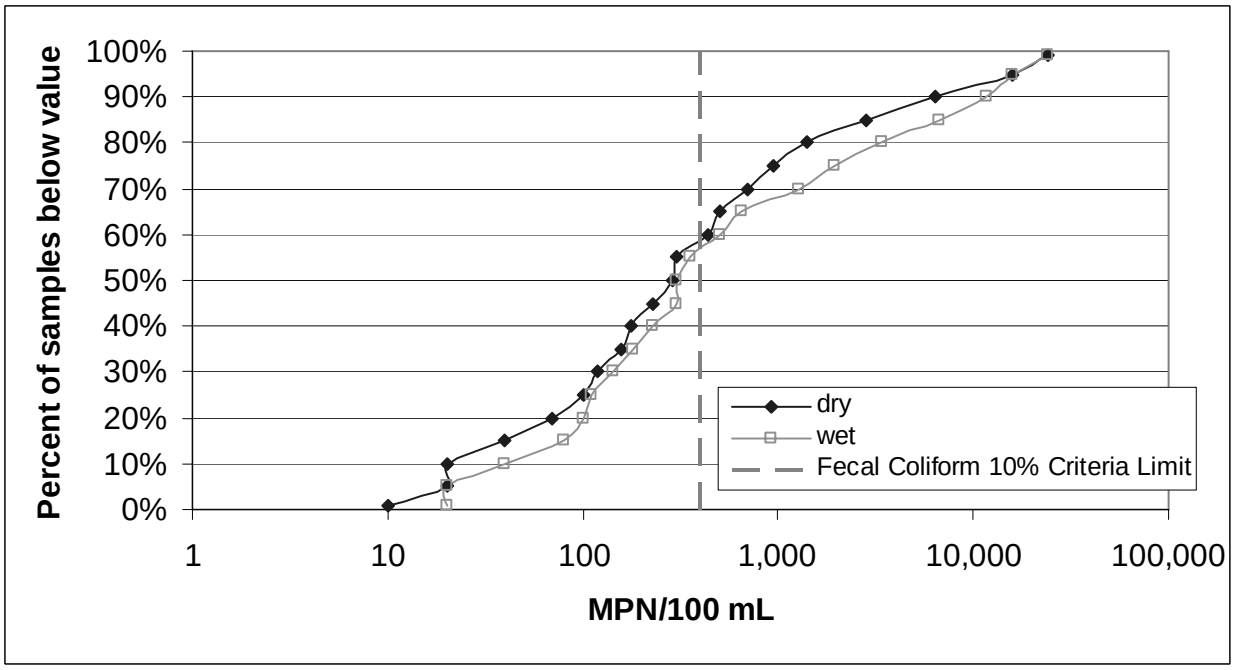
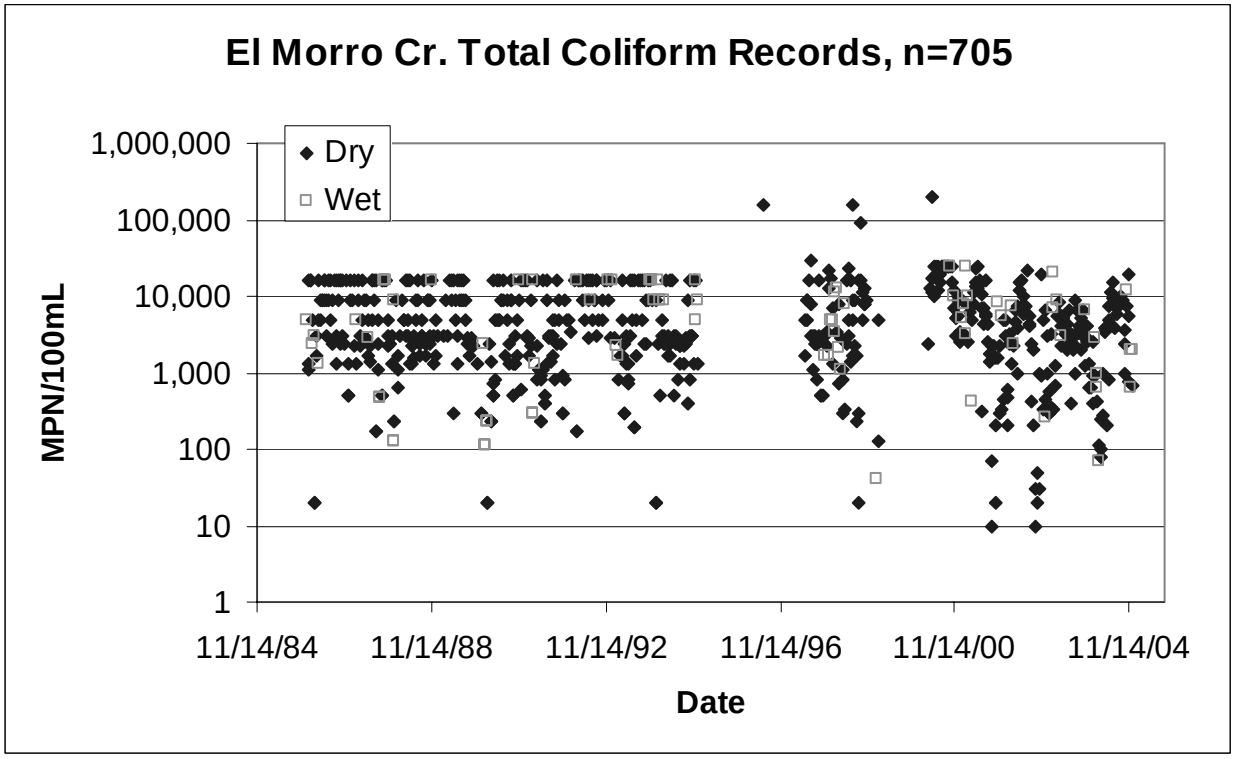


Figure A 36: El Morro Creek total coliform data and corresponding cumulative frequency distribution



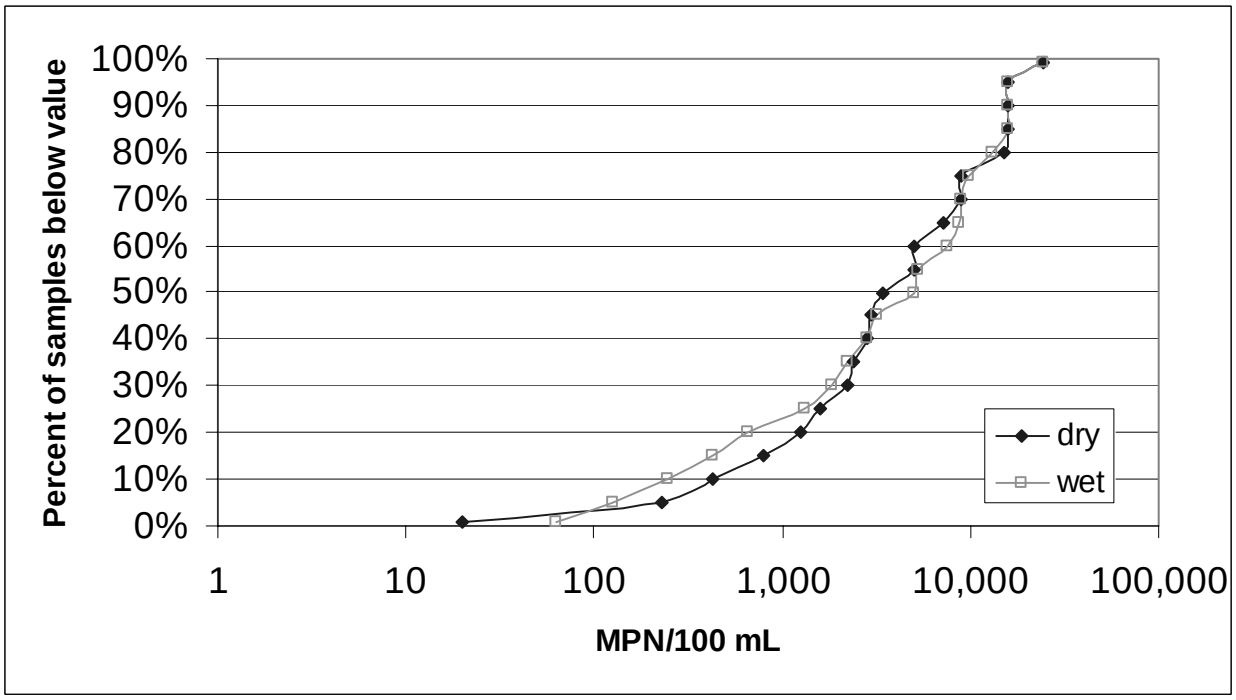


Figure A 37: Percentage of samples from El Morro Creek which exceed thresholds, by month

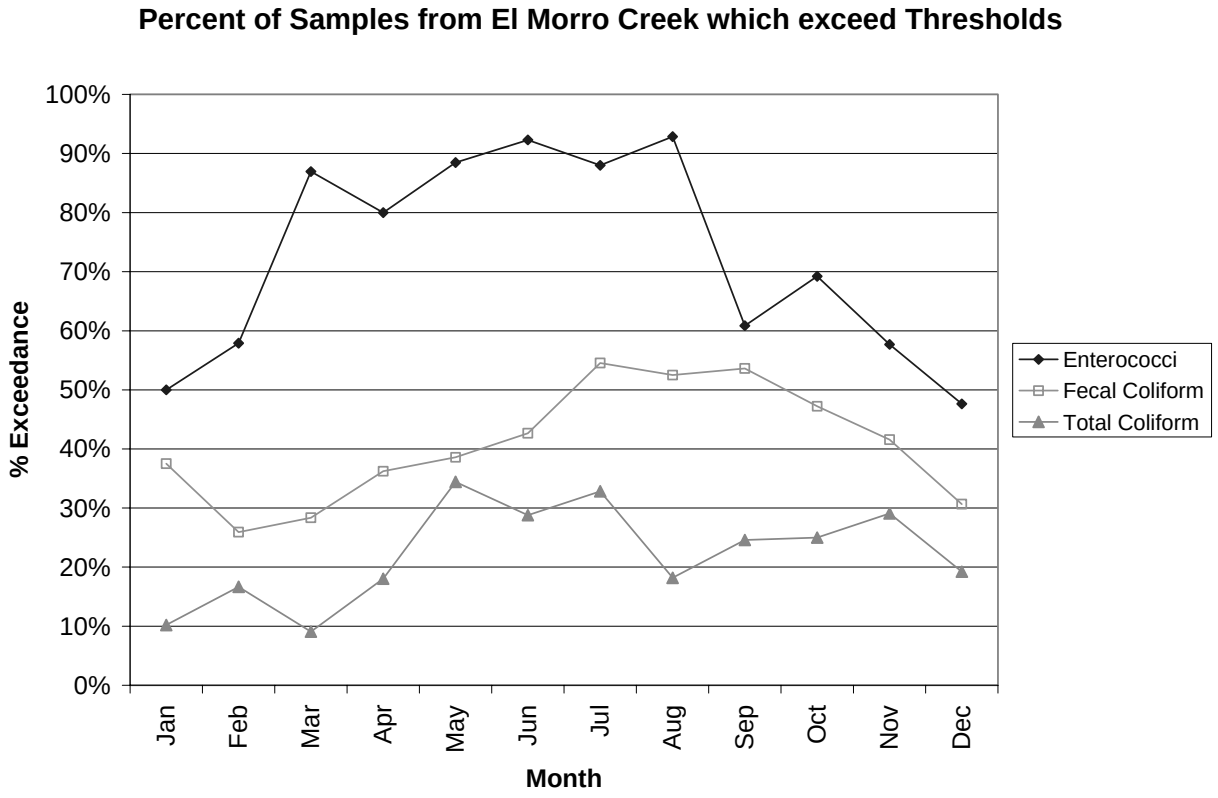
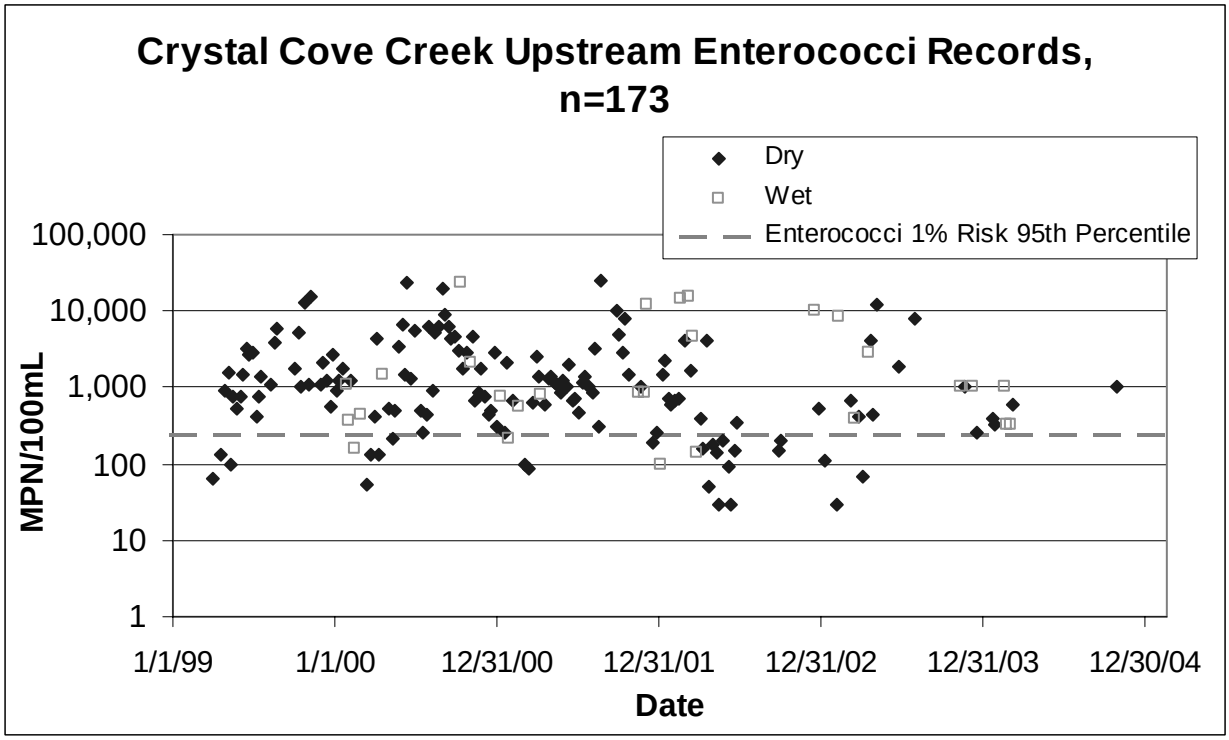


Figure A 38: Crystal Cove Creek Upstream enterococci data and corresponding cumulative frequency distribution



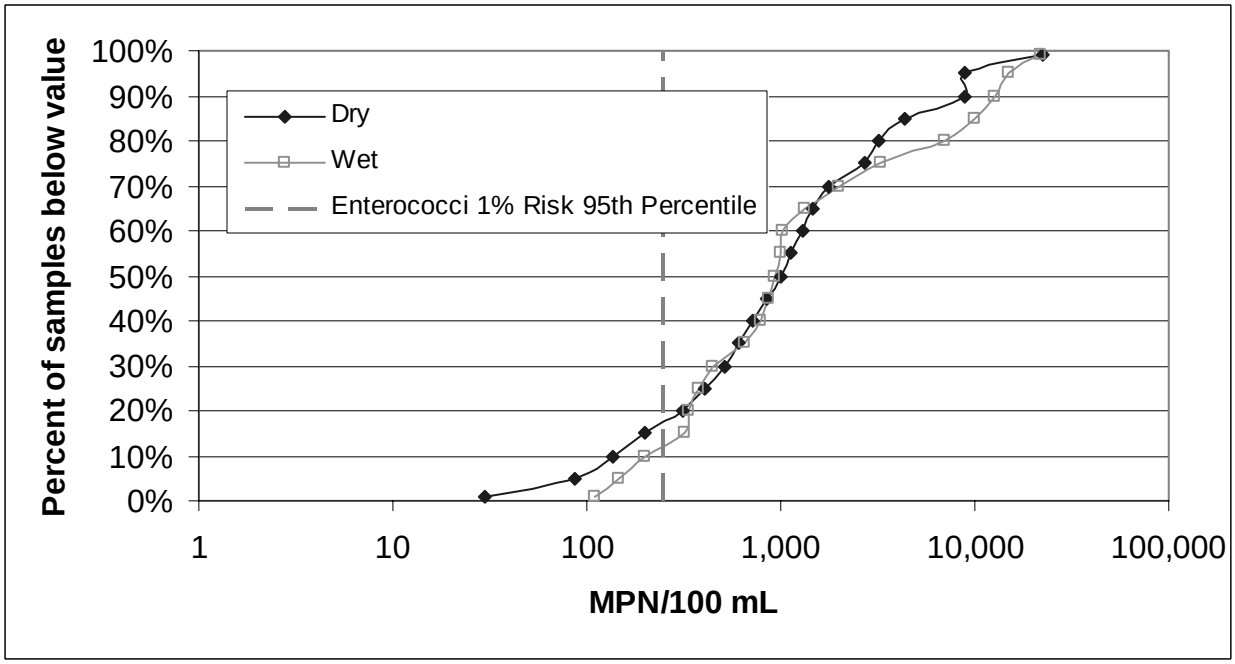
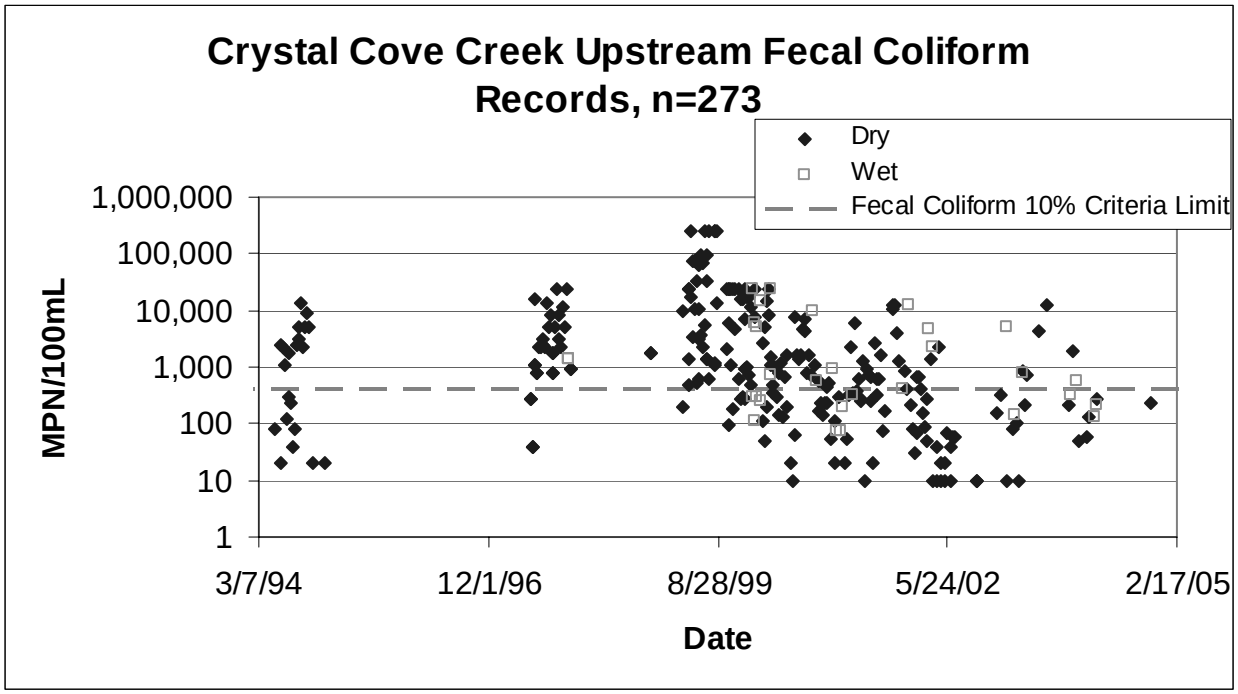


Figure A 39: Crystal Cove Creek Upstream fecal coliform data and corresponding cumulative frequency distribution



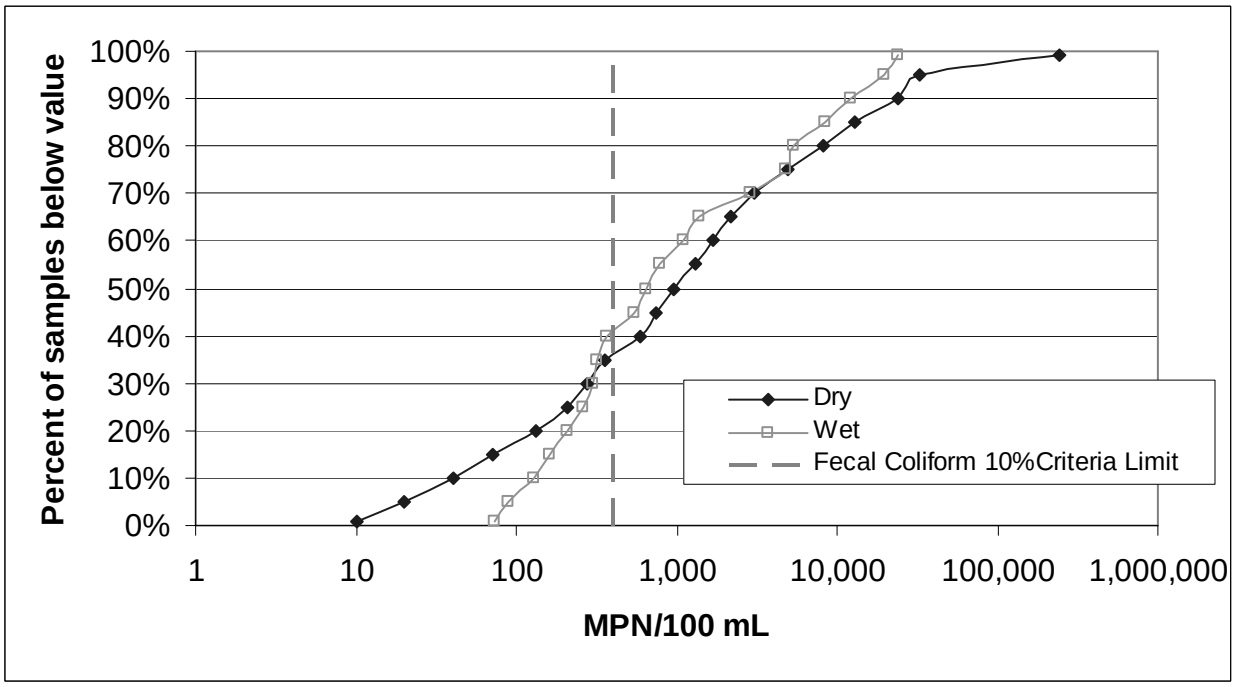
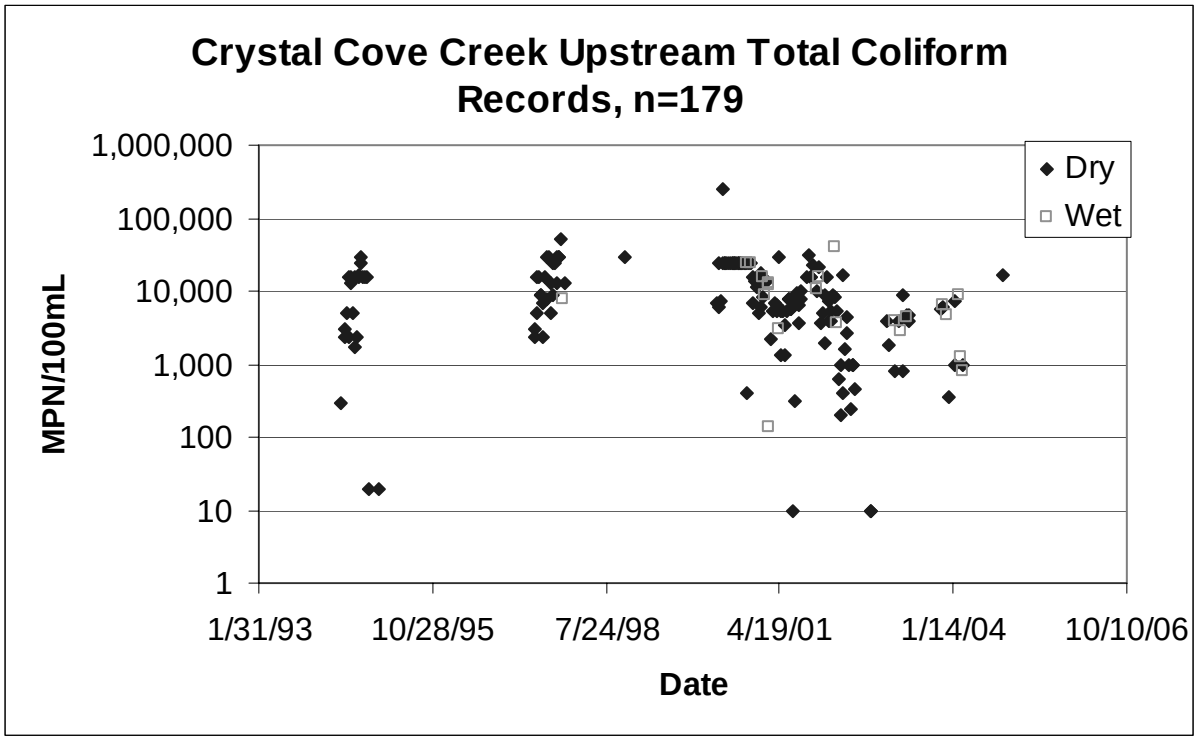


Figure A 40: Crystal Cove Creek Upstream total coliform data and corresponding cumulative frequency distribution



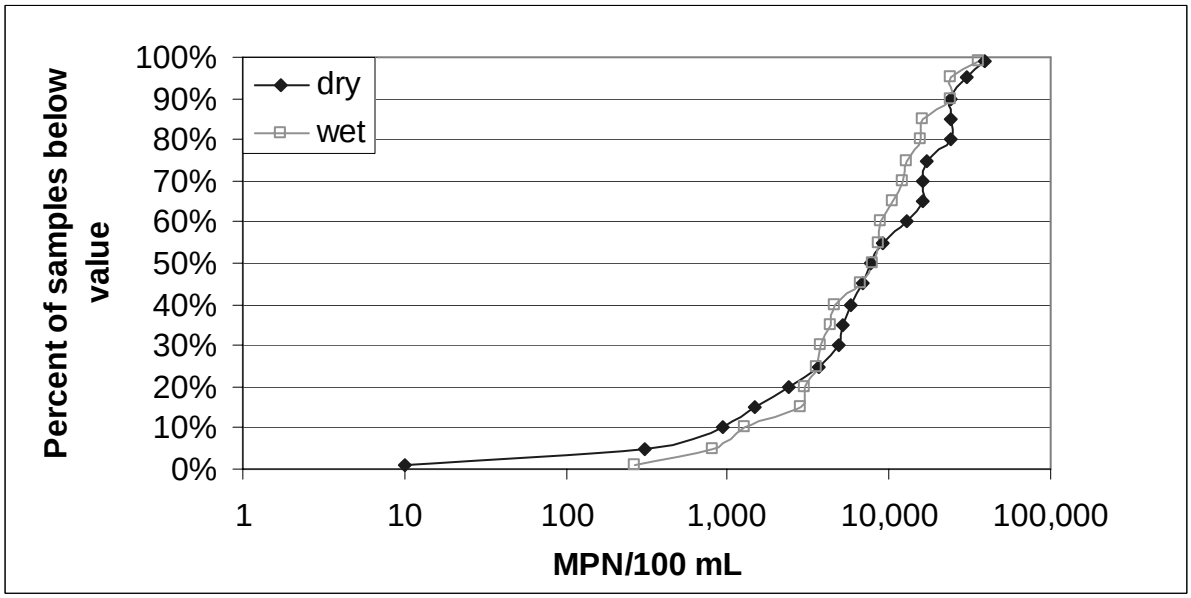


Figure A 41: Percentage of samples from Crystal Cove Creek Upstream which exceed thresholds, by month

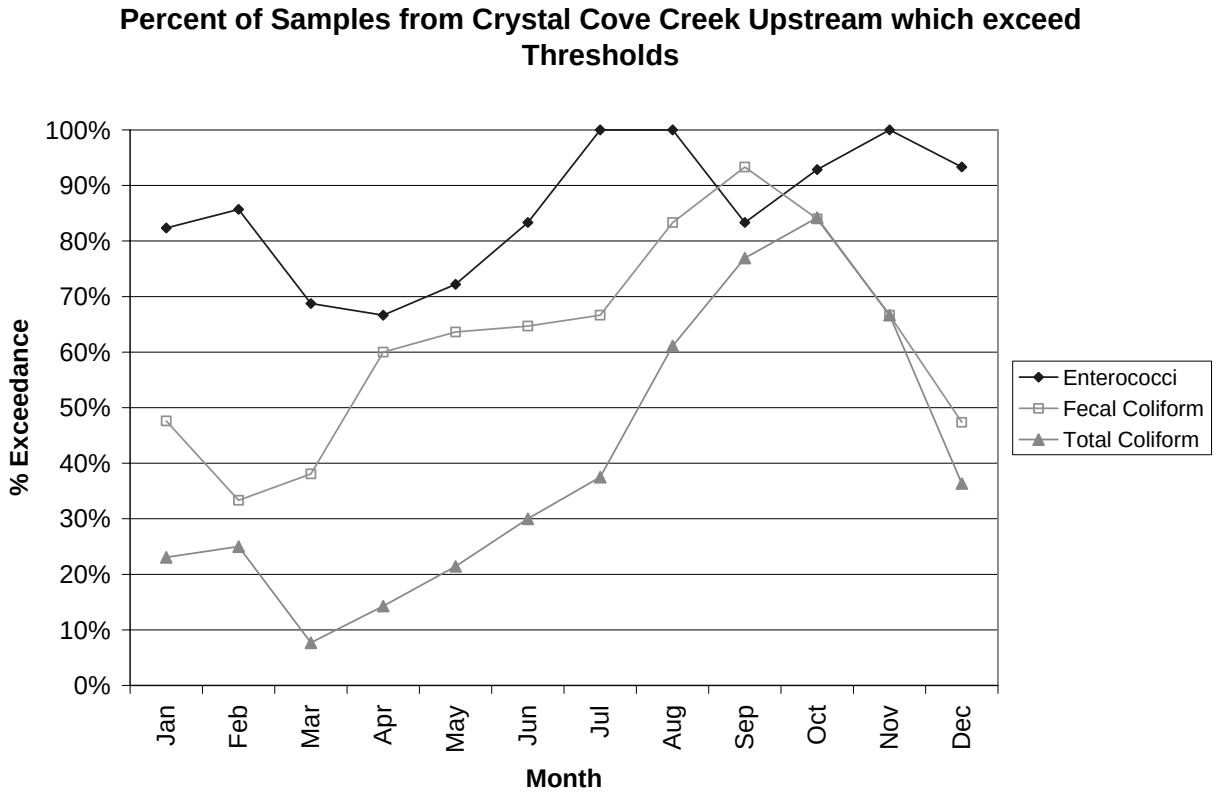
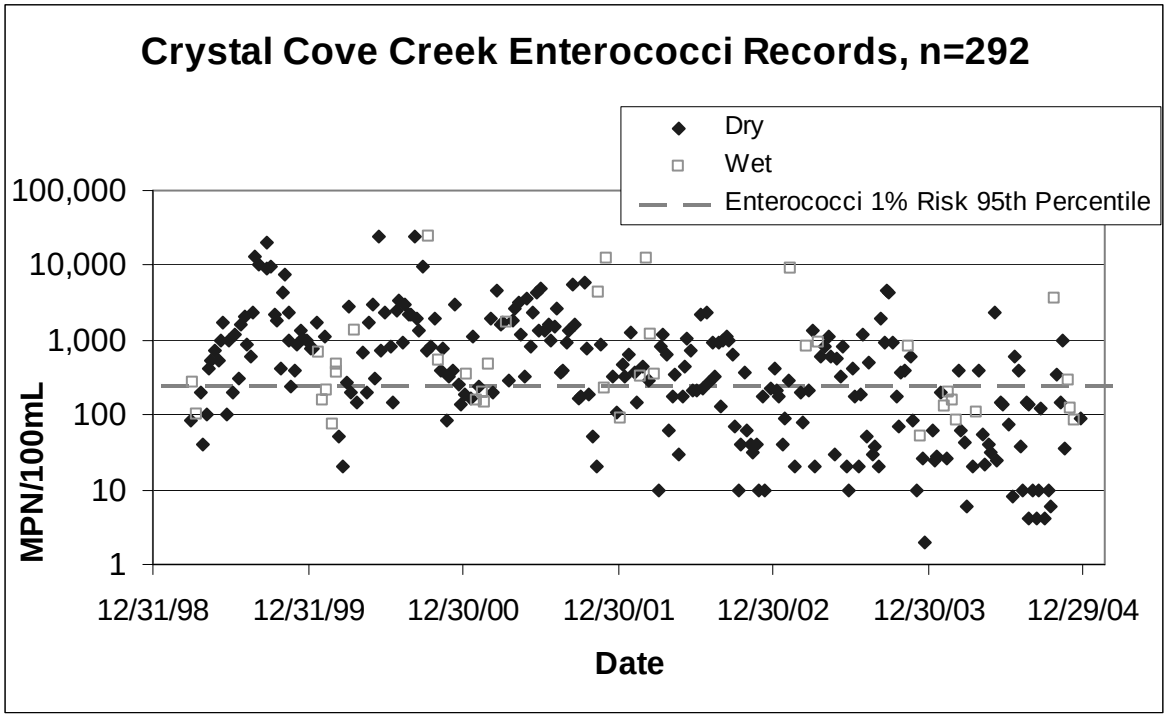


Figure A 42: Crystal Cove Creek enterococci data and corresponding cumulative frequency distribution



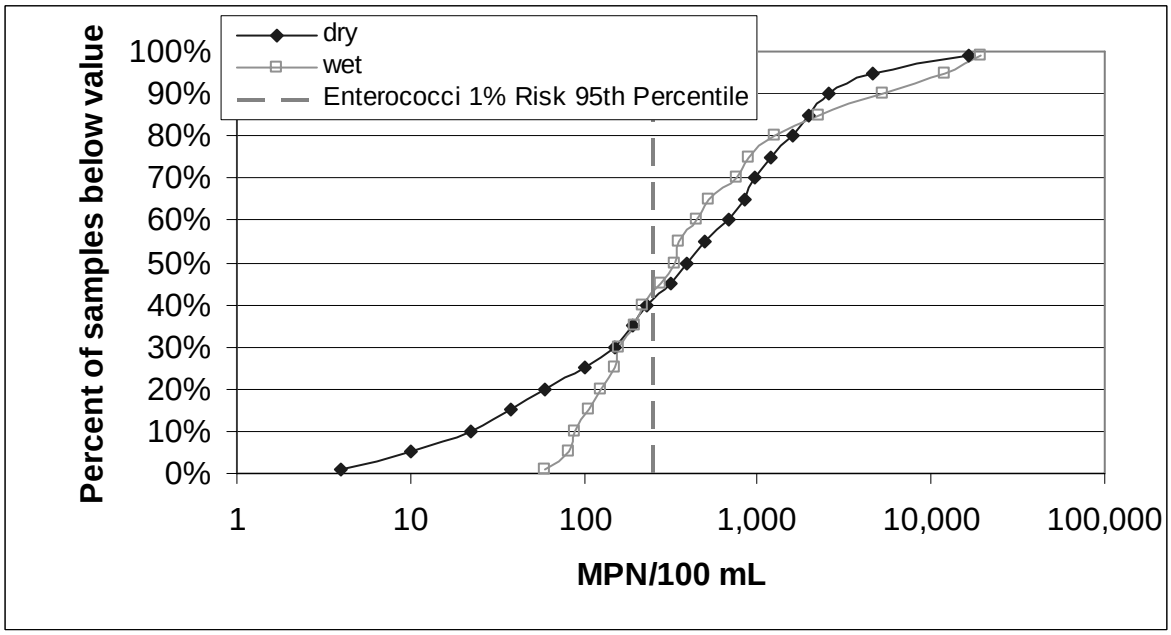
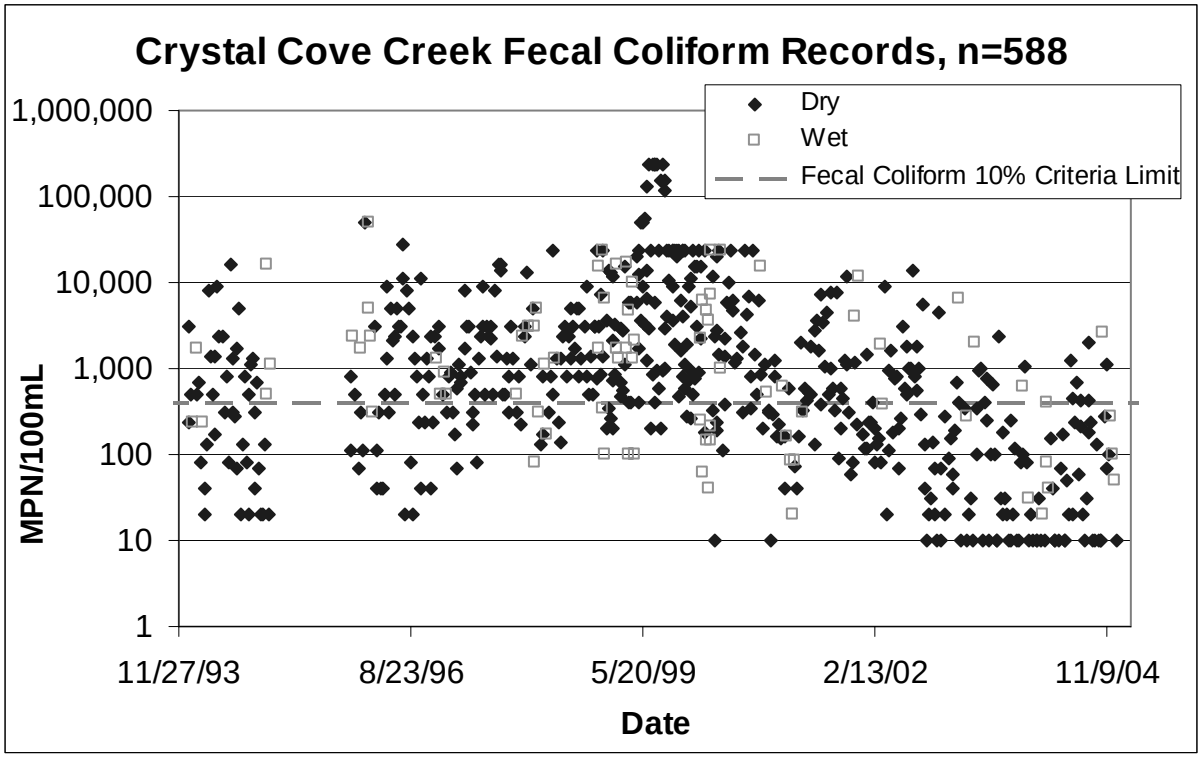


Figure A 43: Crystal Cove Creek fecal coliform data and corresponding cumulative frequency distribution



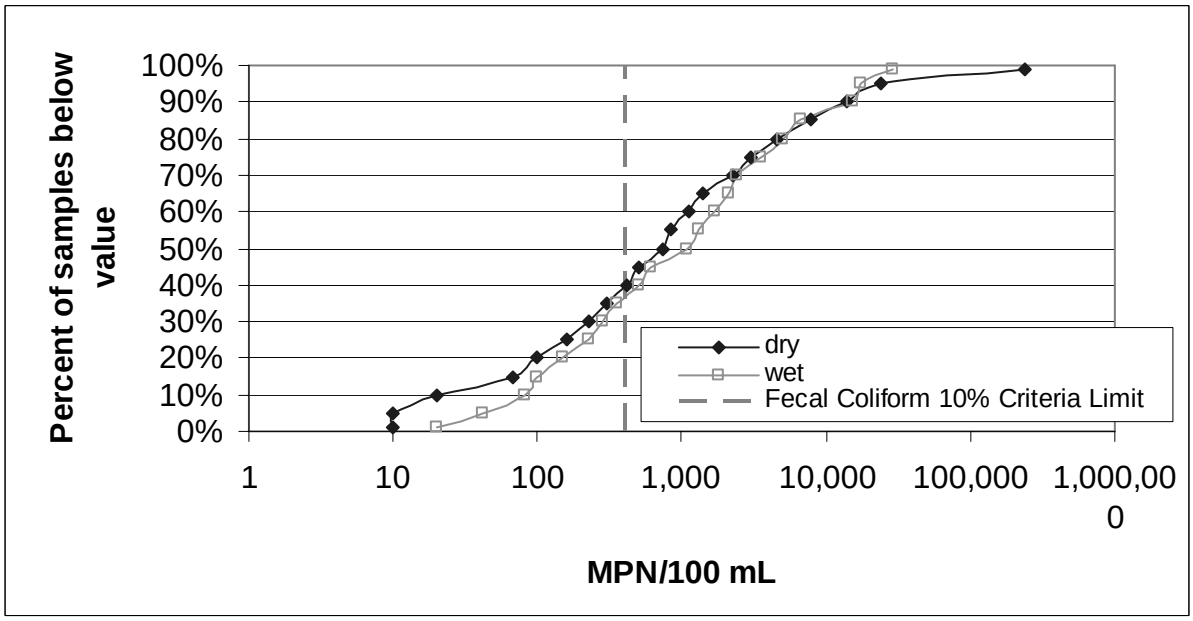
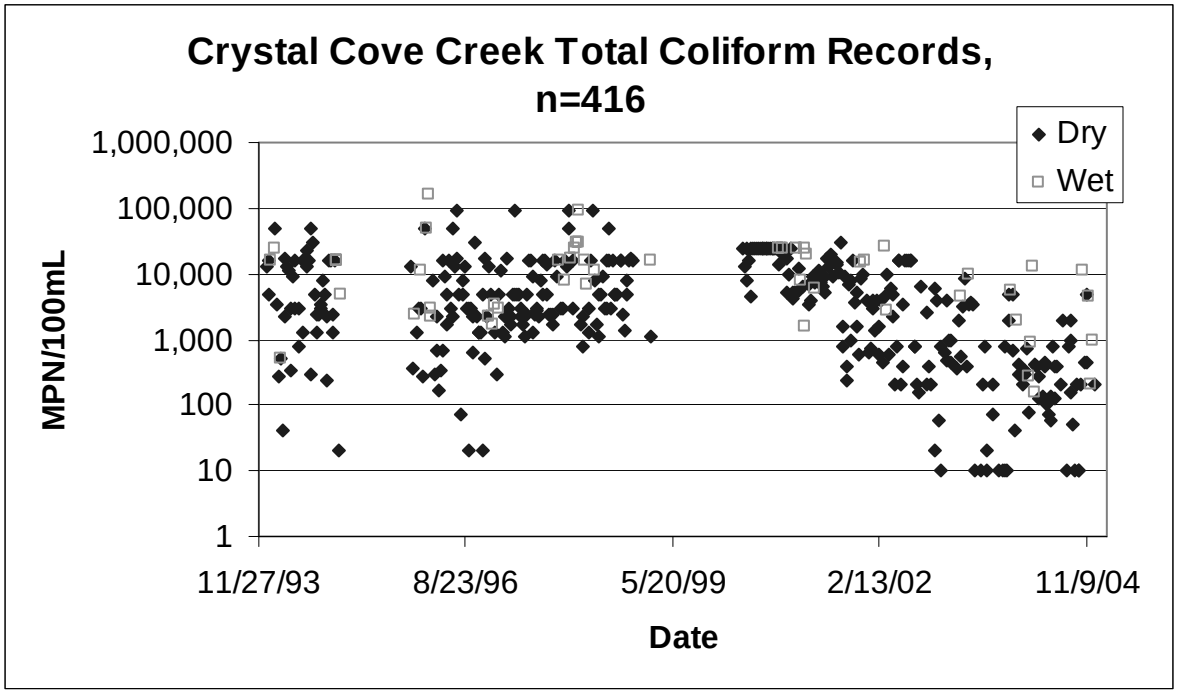


Figure A 44: Crystal Cove Creek total coliform data and corresponding cumulative frequency distribution



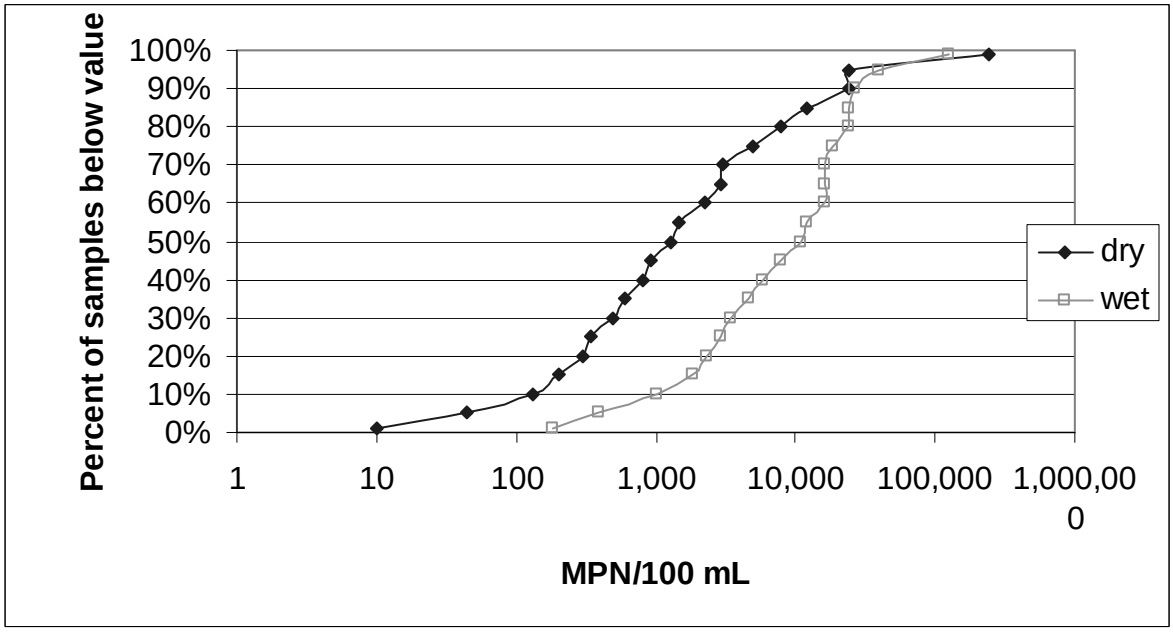


Figure A 45: Percentage of samples from Crystal Cove Creek which exceed thresholds, by month

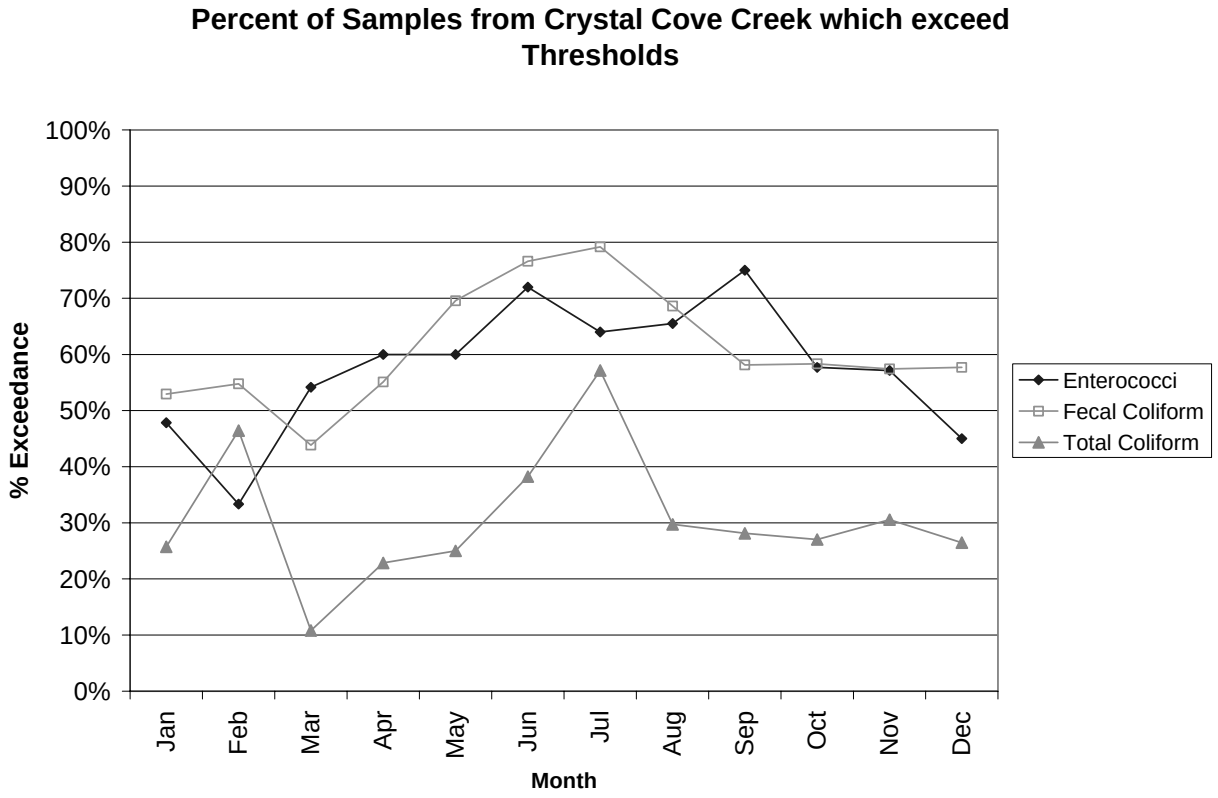
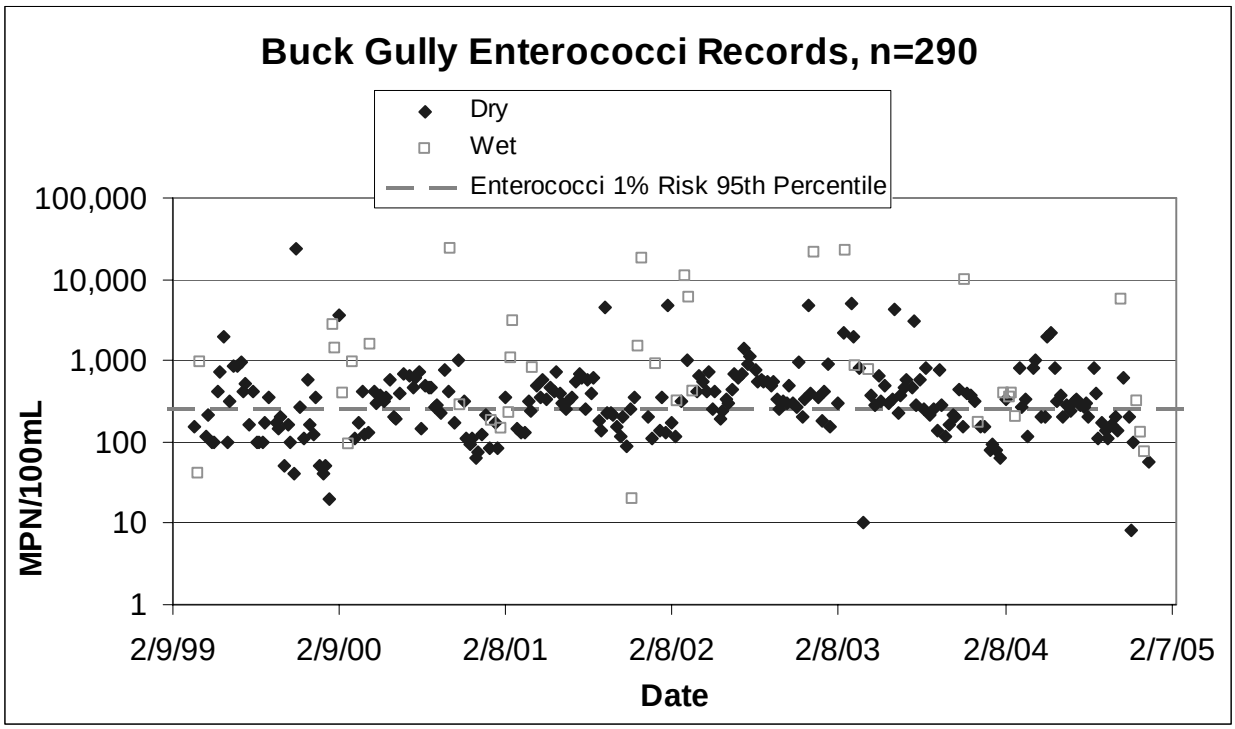


Figure A 46: Buck Gully enterococci data and corresponding cumulative frequency distribution



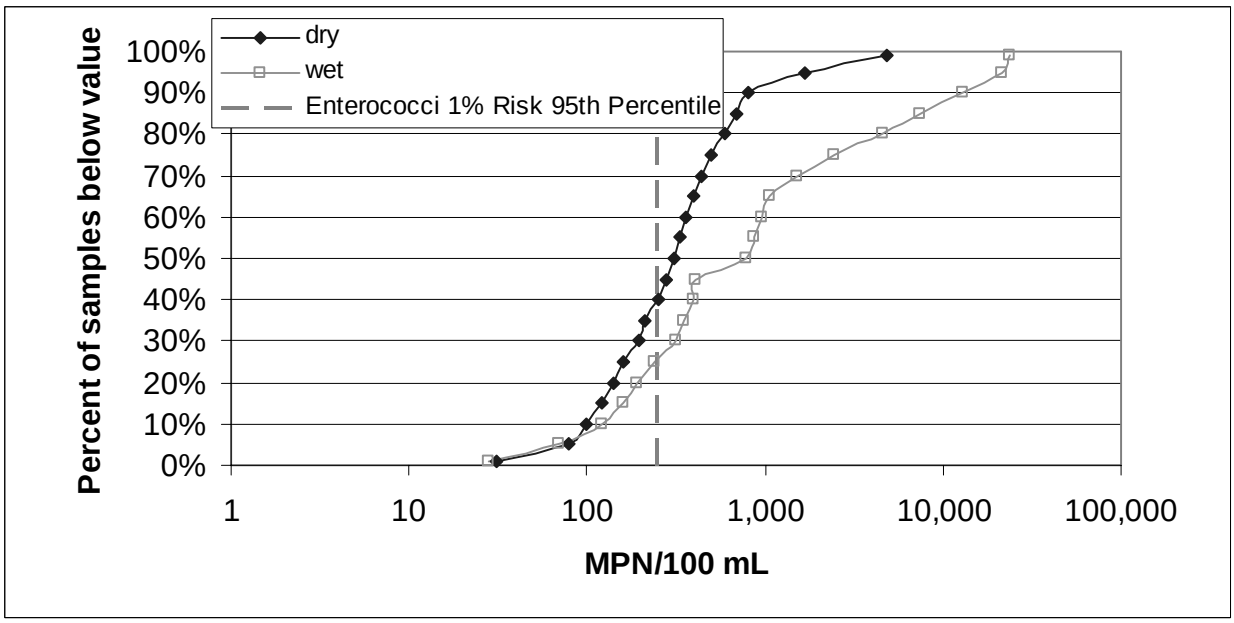
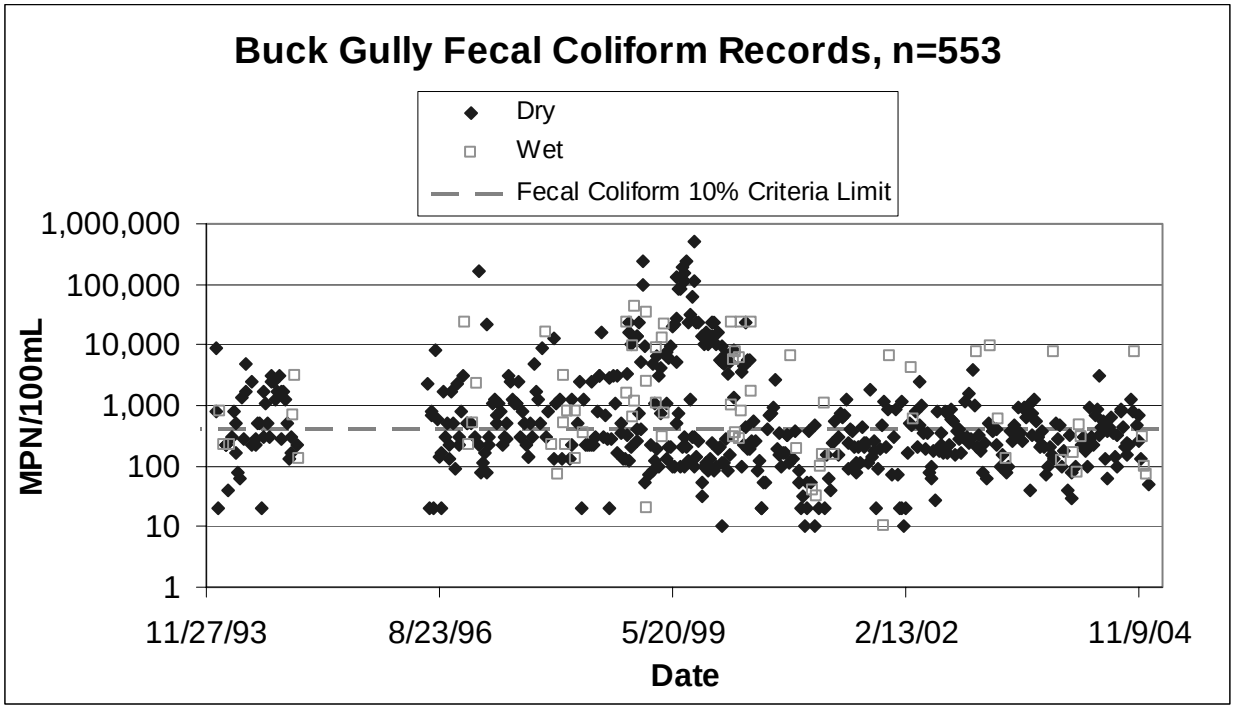


Figure A 47: Buck Gully fecal coliform data and corresponding cumulative frequency distribution



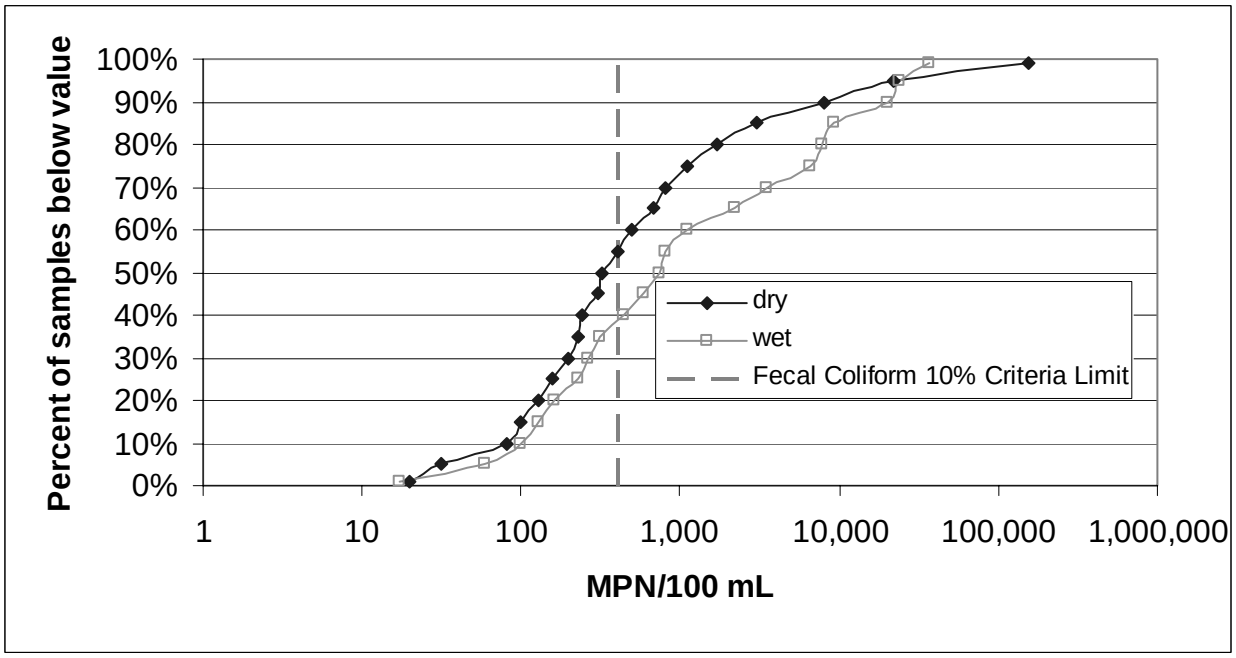
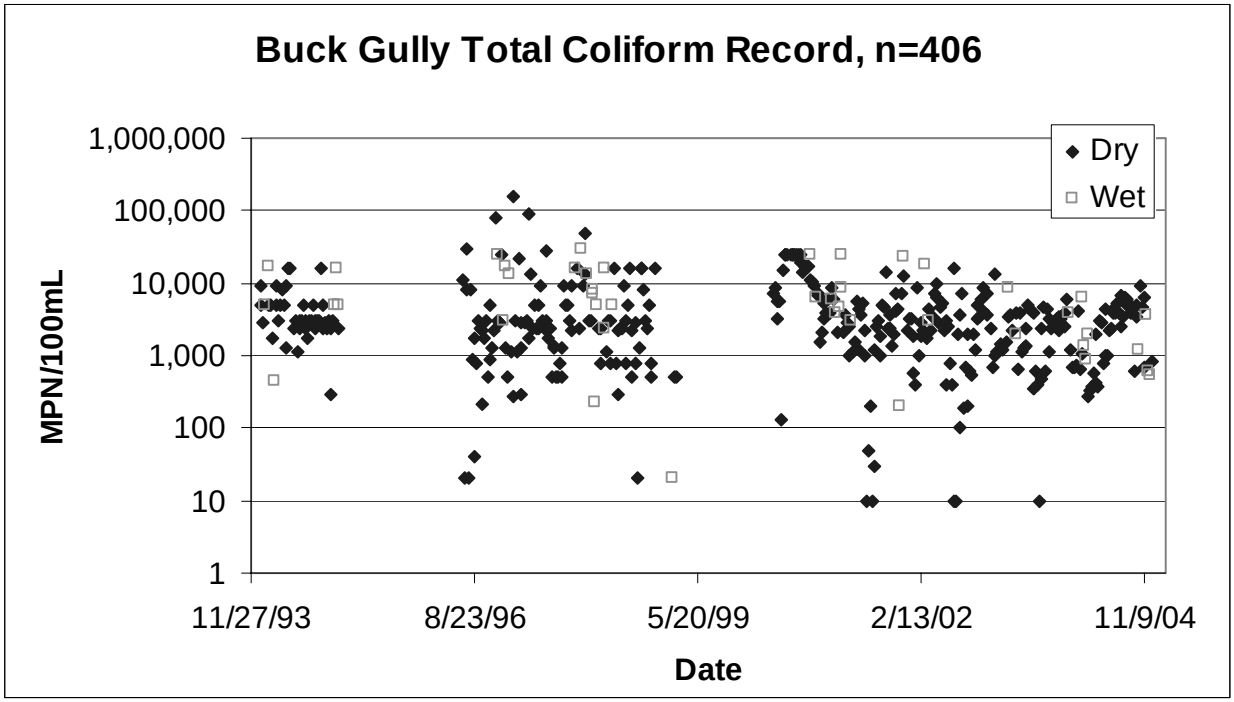


Figure A 48: Buck Gully total coliform data and corresponding cumulative frequency distribution



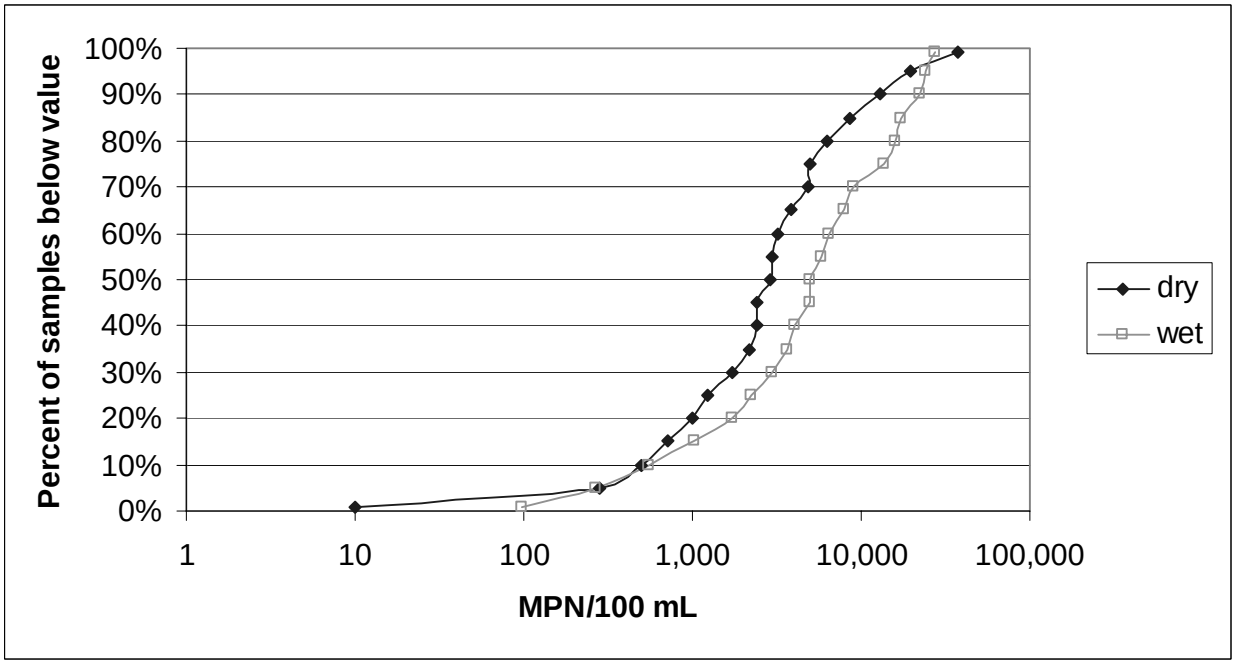


Figure A 49: Percentage of samples from Buck Gully which exceed thresholds, by month

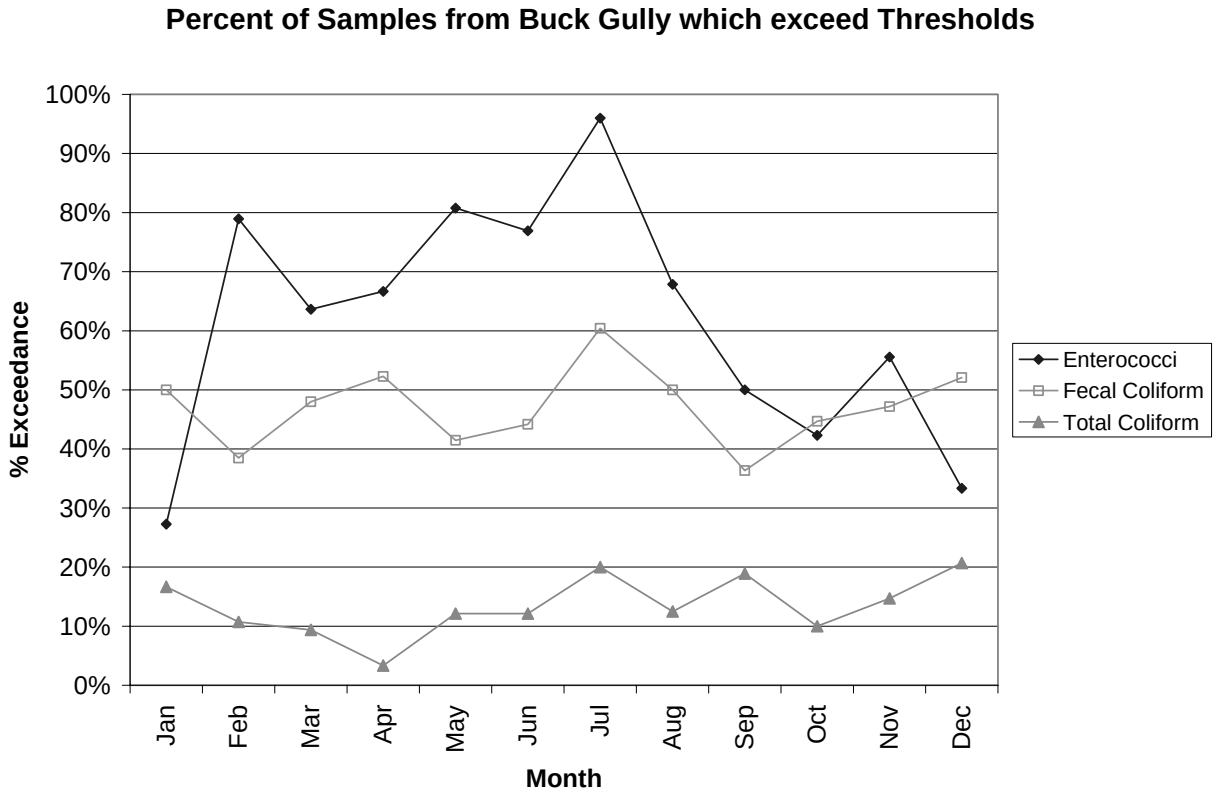
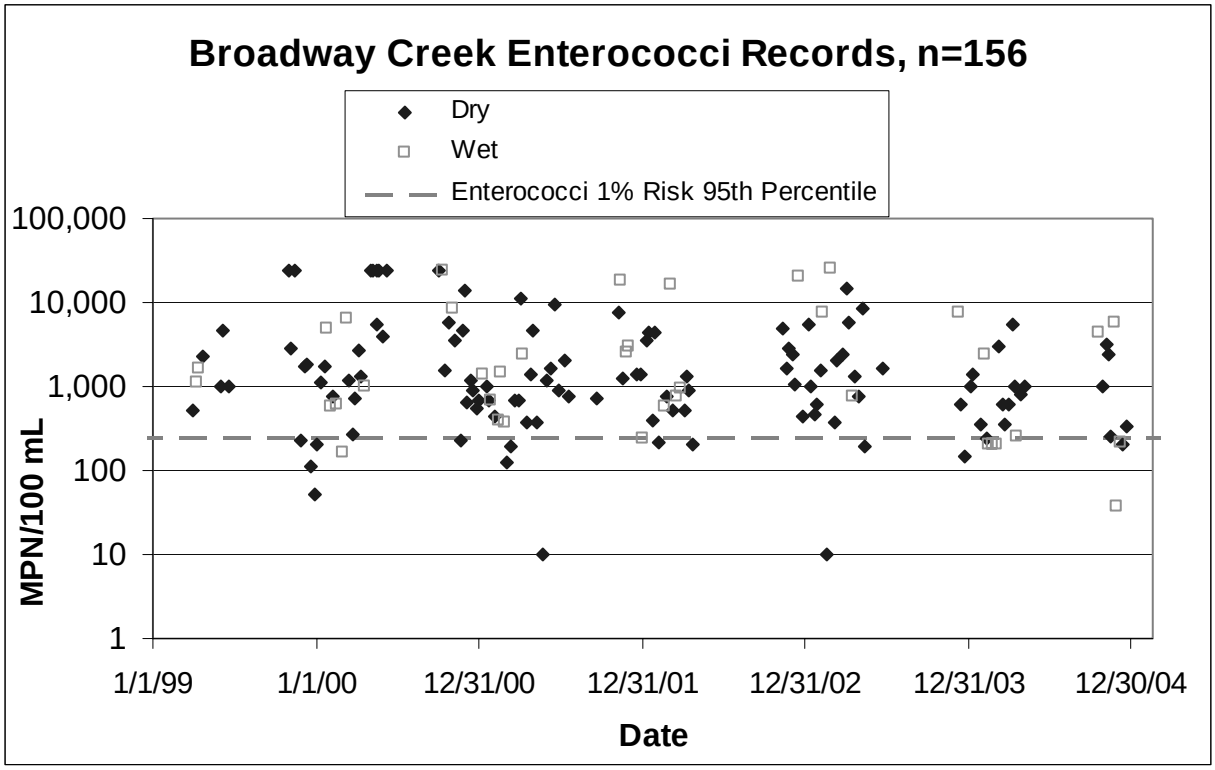


Figure A 50: Broadway Creek enterococci data and corresponding cumulative frequency distribution



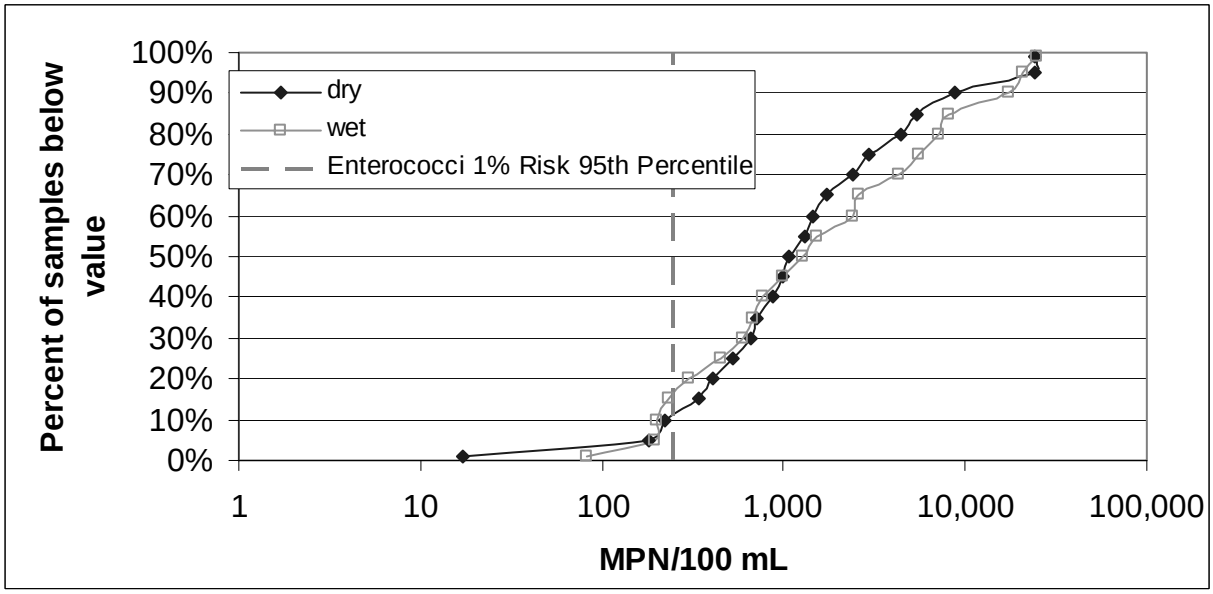
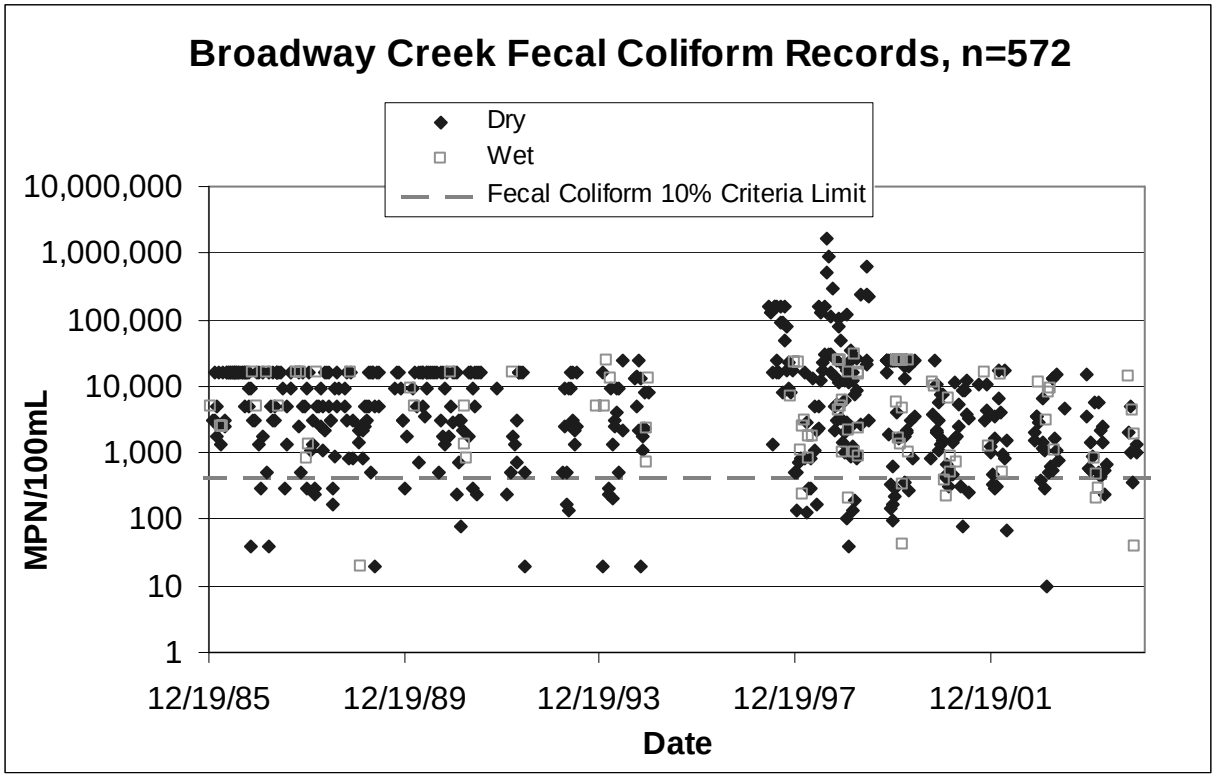


Figure A 51: Broadway Creek fecal coliform data and corresponding cumulative frequency distribution



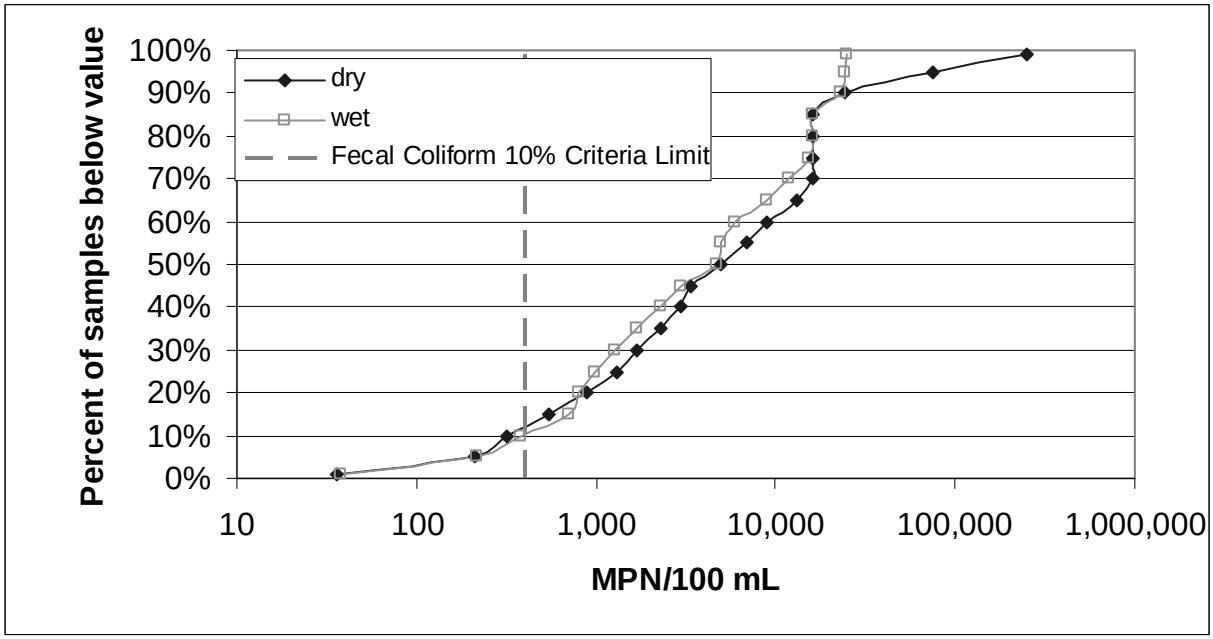
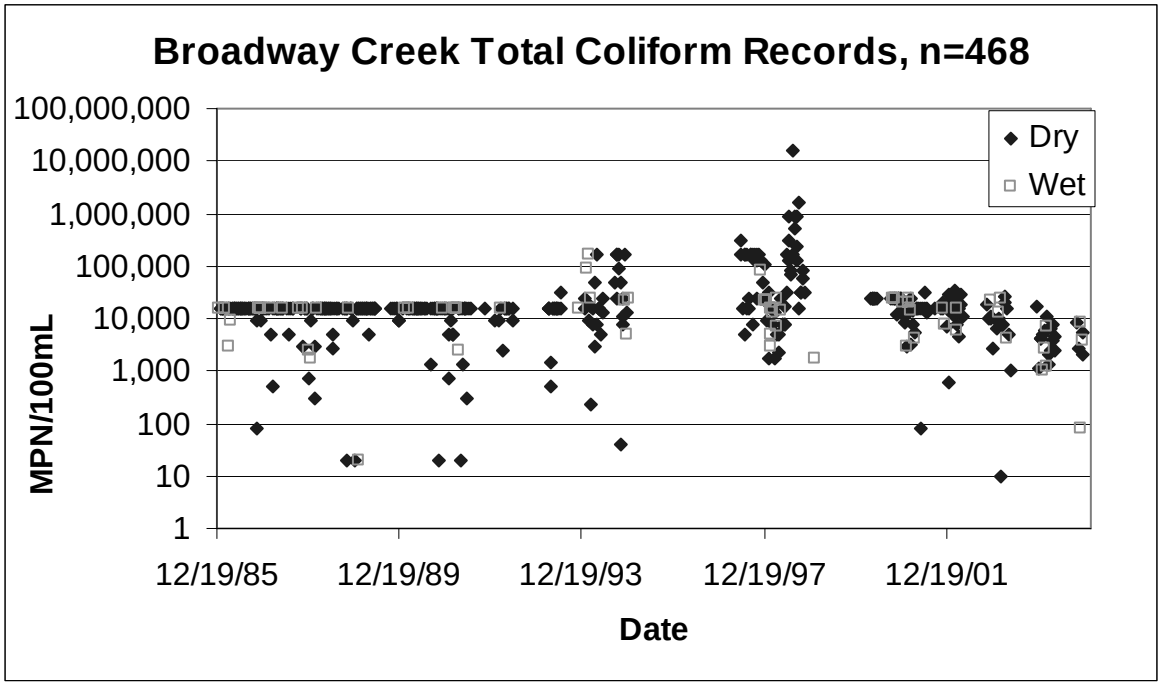


Figure A 52: Broadway Creek total coliform data and corresponding cumulative frequency distribution



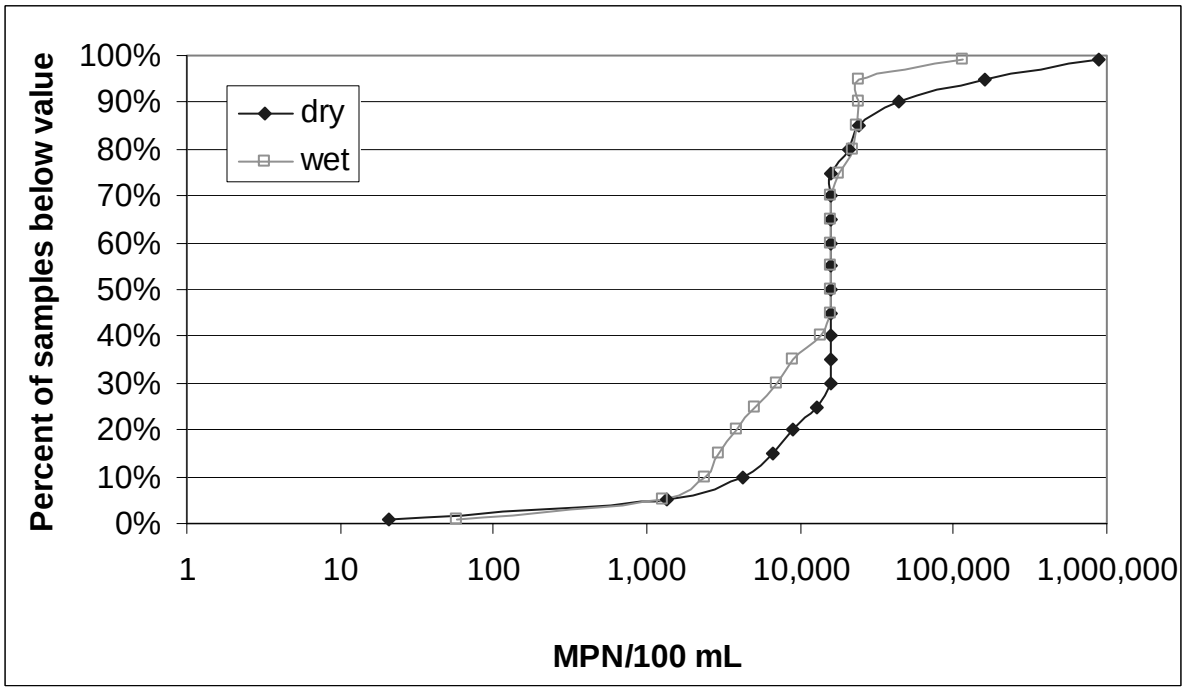
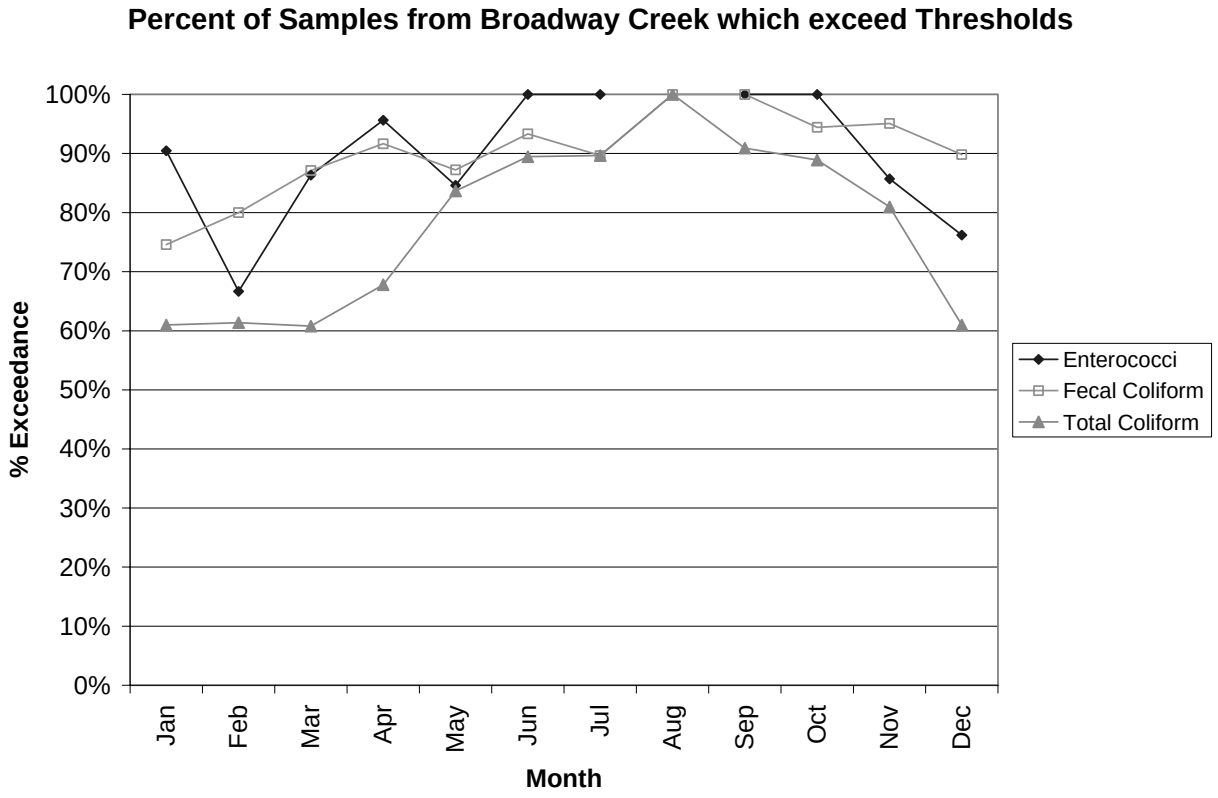


Figure A 53: Percentage of samples from Broadway Creek which exceed thresholds, by month



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)

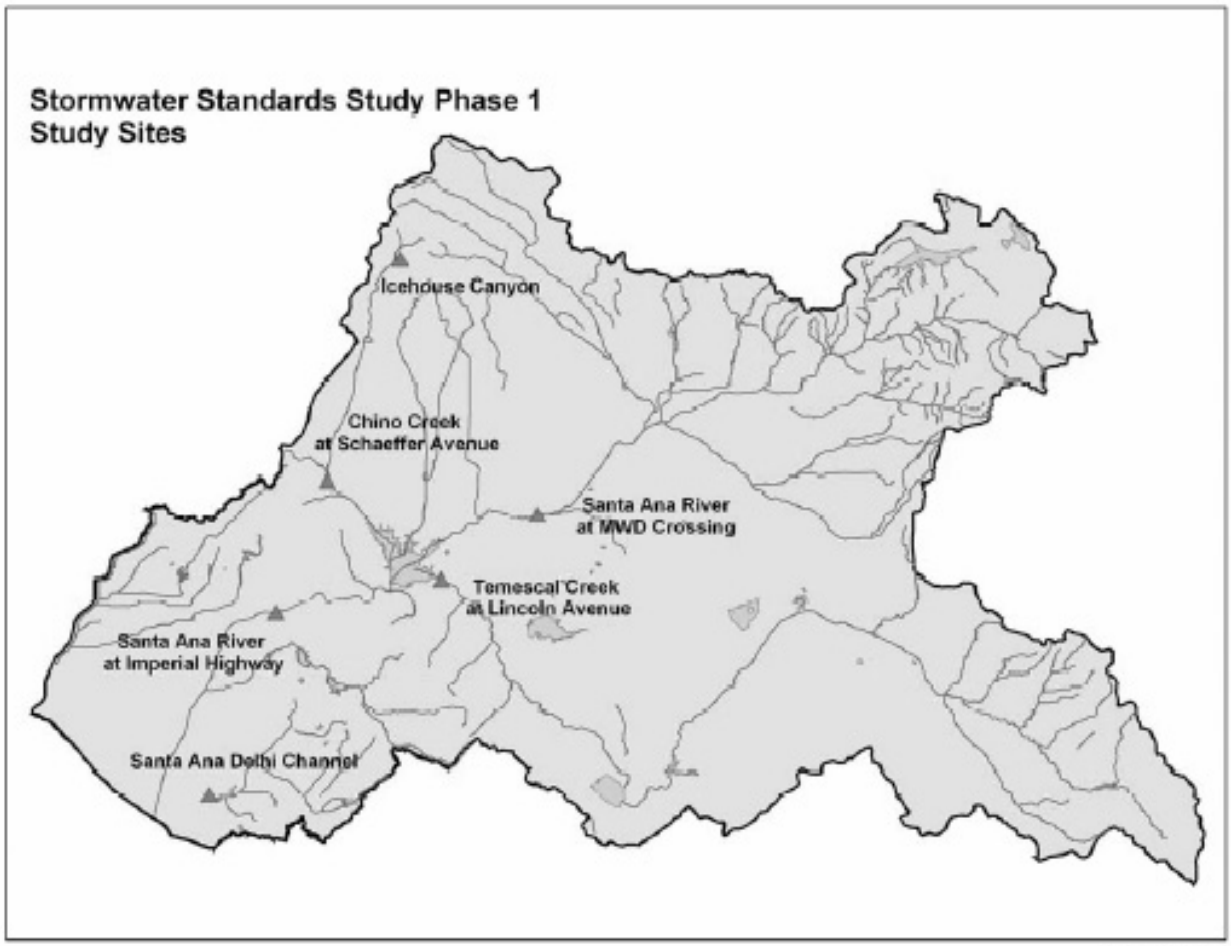


Figure 19
Study Sites Selected for Detailed Analysis

Figure B 2: Flow rate and bacteria concentration, Chino Creek (CDM 2005 Figure 35)

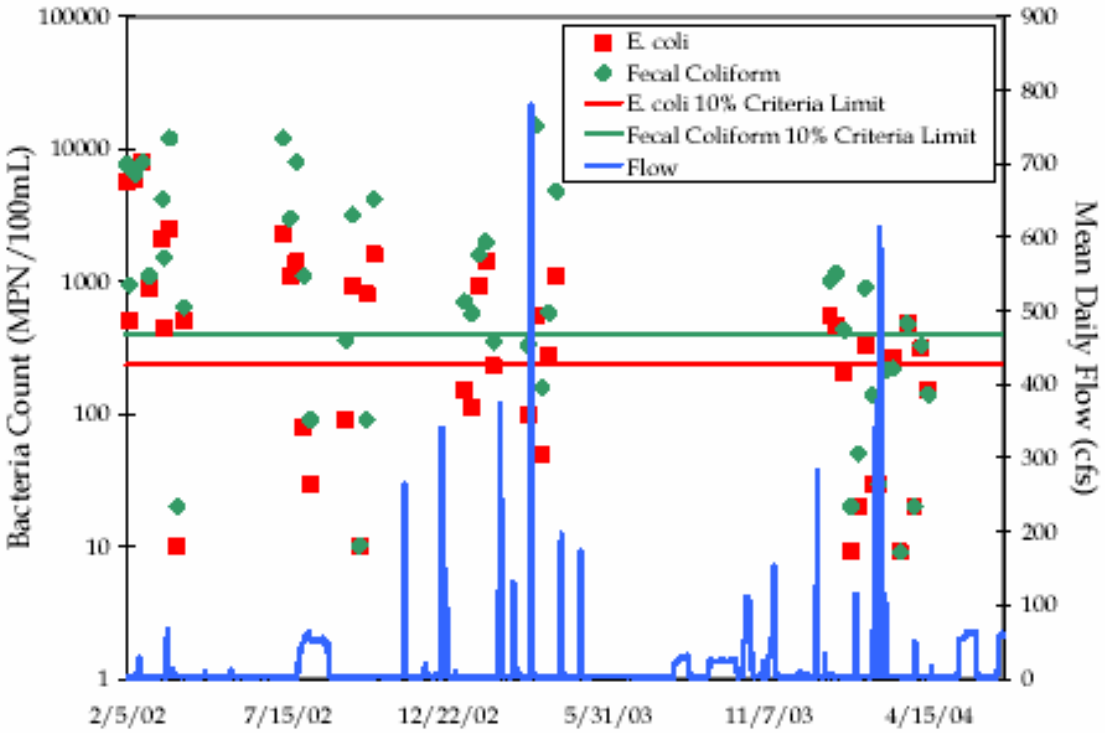


Figure 35
Time Series of Bacteria Counts and Flow at the Chino Creek at Schaeffer Avenue Study Site

Figure B 3: Flow rate and bacteria concentration, Santa Ana Delhi Channel (CDM 2005 Figure 53)

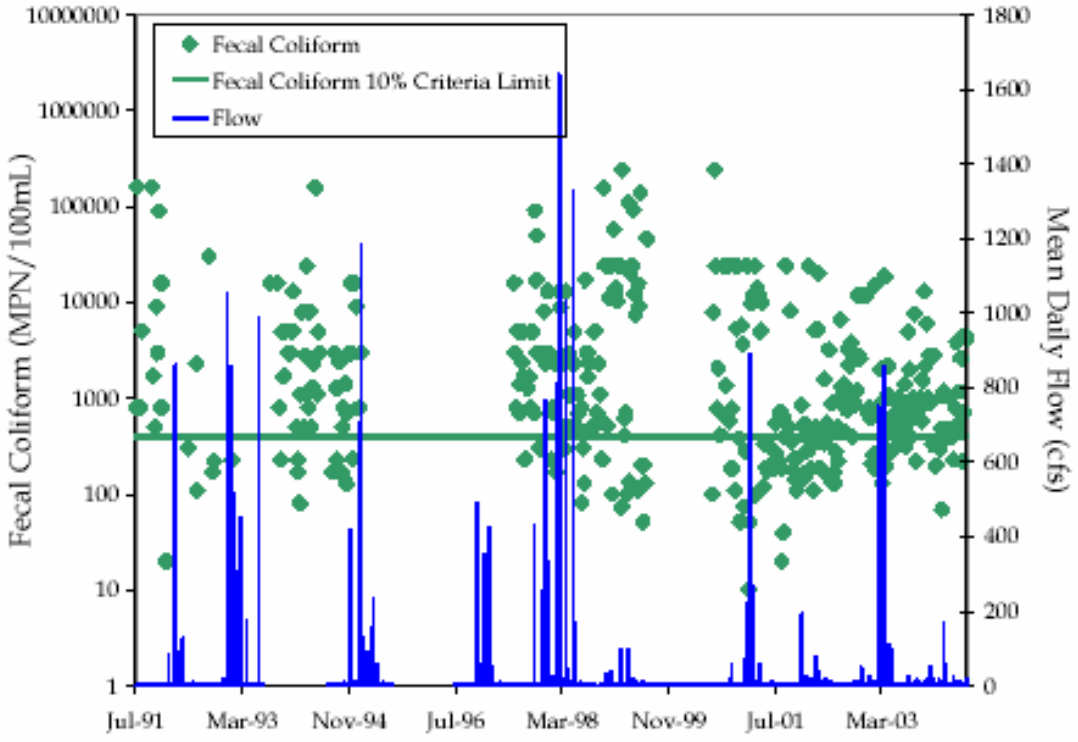


Figure 53
Time Series of Bacteria Concentrations and
Flow in the Santa Ana Delhi Channel - Backbay

Figure B 4: Flow rate and bacteria concentration, Temescal Creek (CDM 2005 Figure 72)

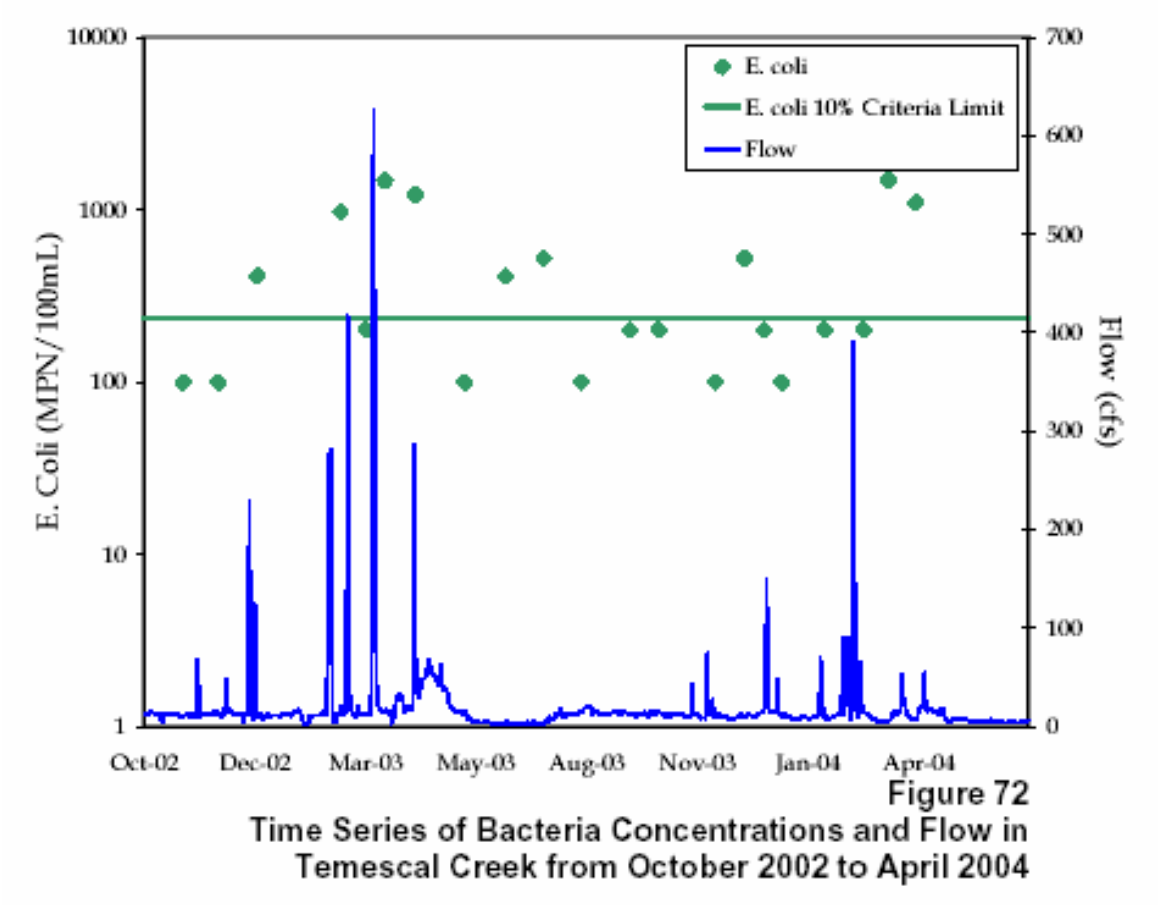


Figure B 5: Flow rate and bacteria concentration, Santa Ana River at MWD Crossing (CDM 2005 Figures 98 and 99)

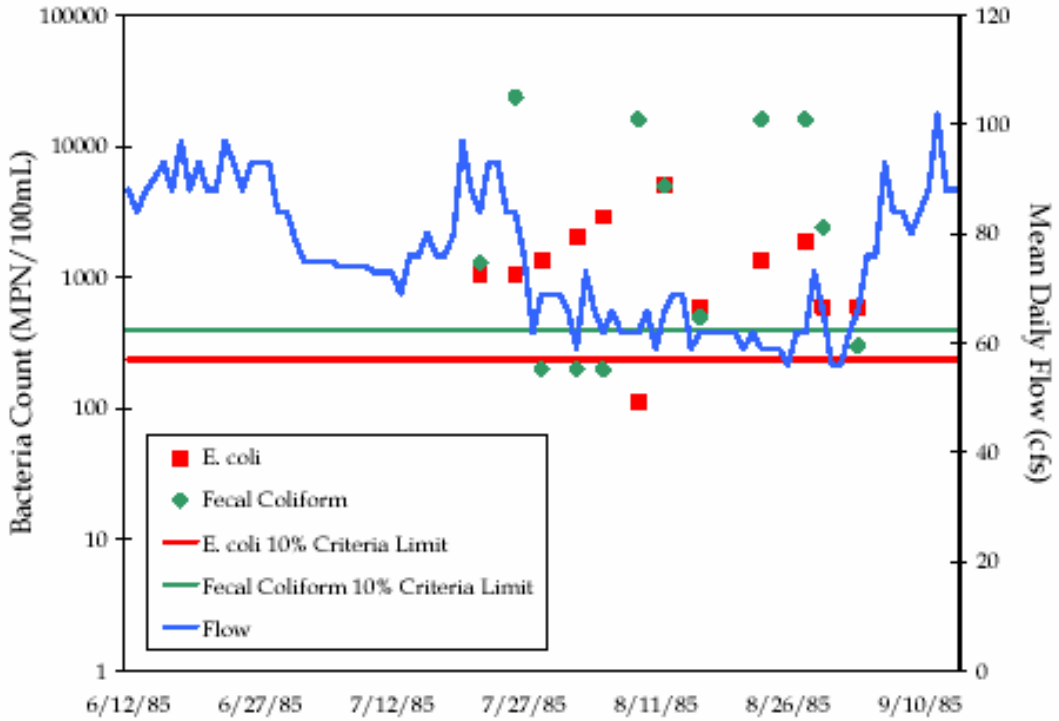


Figure 98
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the MWD Crossing Study Site

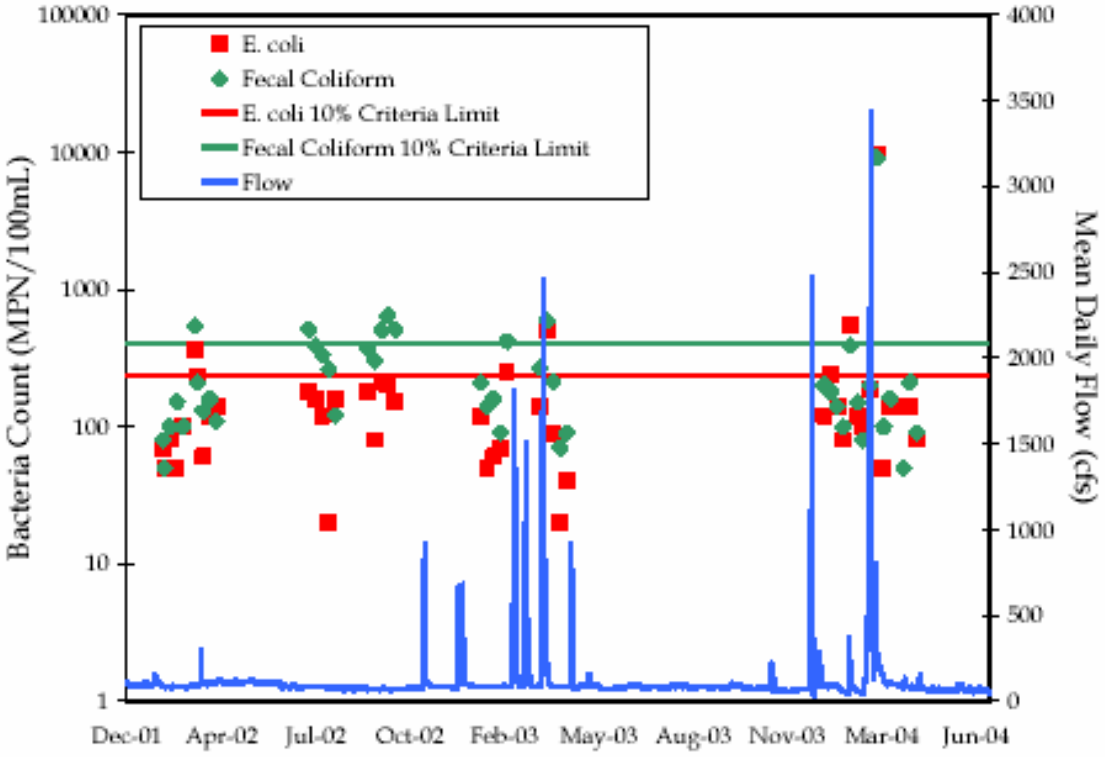


Figure 99
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the MWD Crossing Study Site

Figure B 6: Flow rate and bacteria concentration, Santa Ana River at Imperial Highway (CDM 2005 Figure 83)

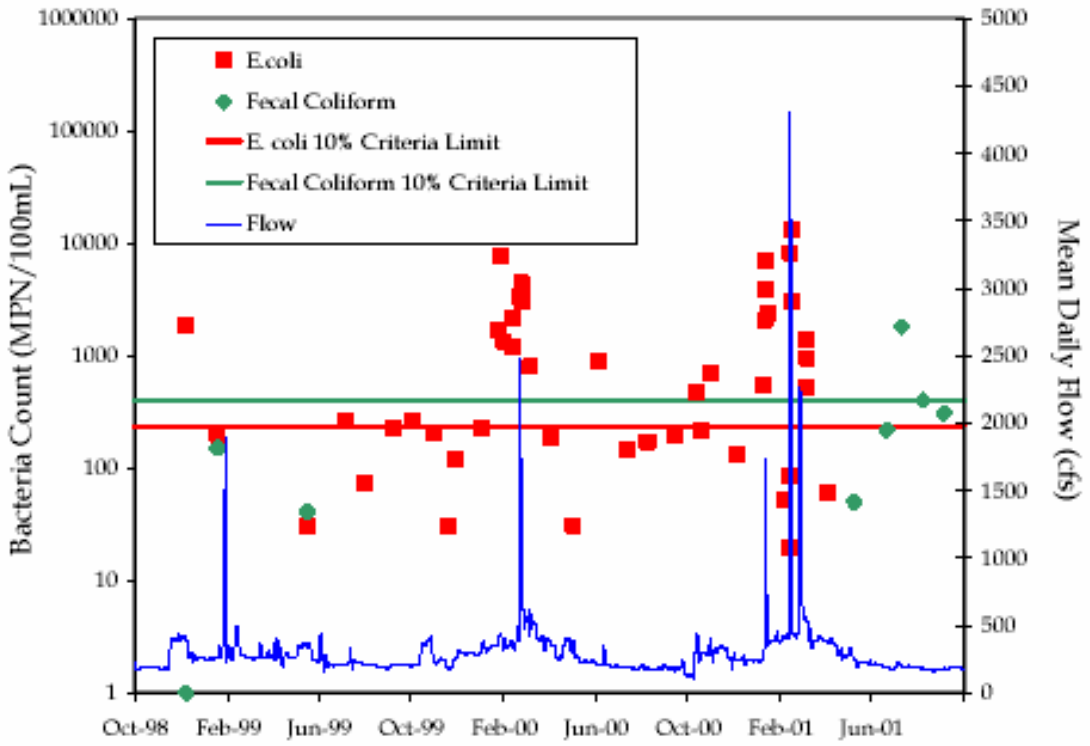


Figure 83
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the Imperial Highway Study Site

Figure B 7: Flow rate and bacteria concentration, Santa Ana River at Imperial Highway (CDM 2005 Figure s 84 and 85)

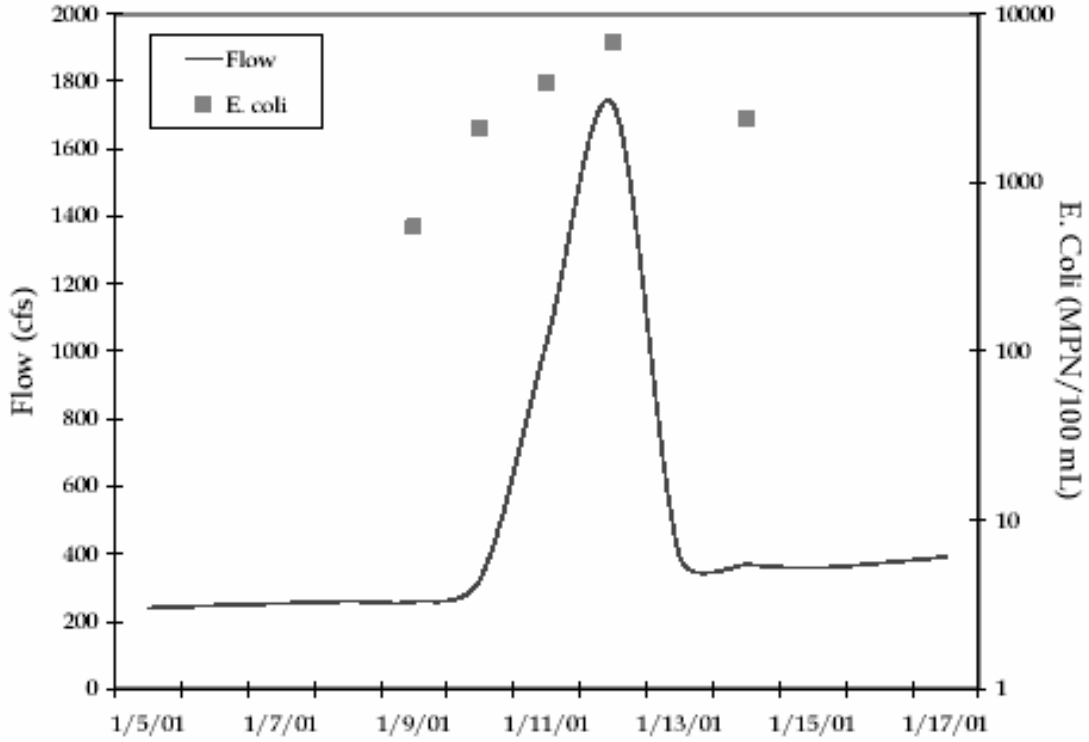


Figure 84
January 2001 Wet Weather E. coli Sampling Event

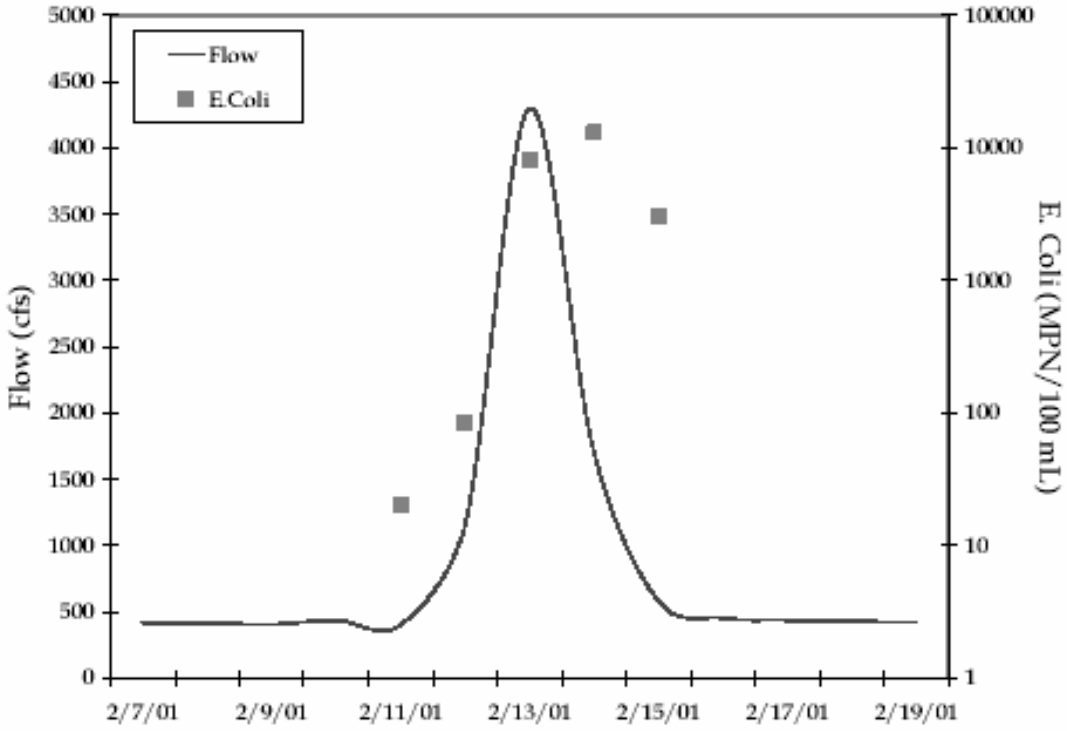


Figure 85
February 2001 Wet Weather E. coli Sampling Event

Figure B 8: Percent of months exceeding objectives (CDM 2005 Figure 102)

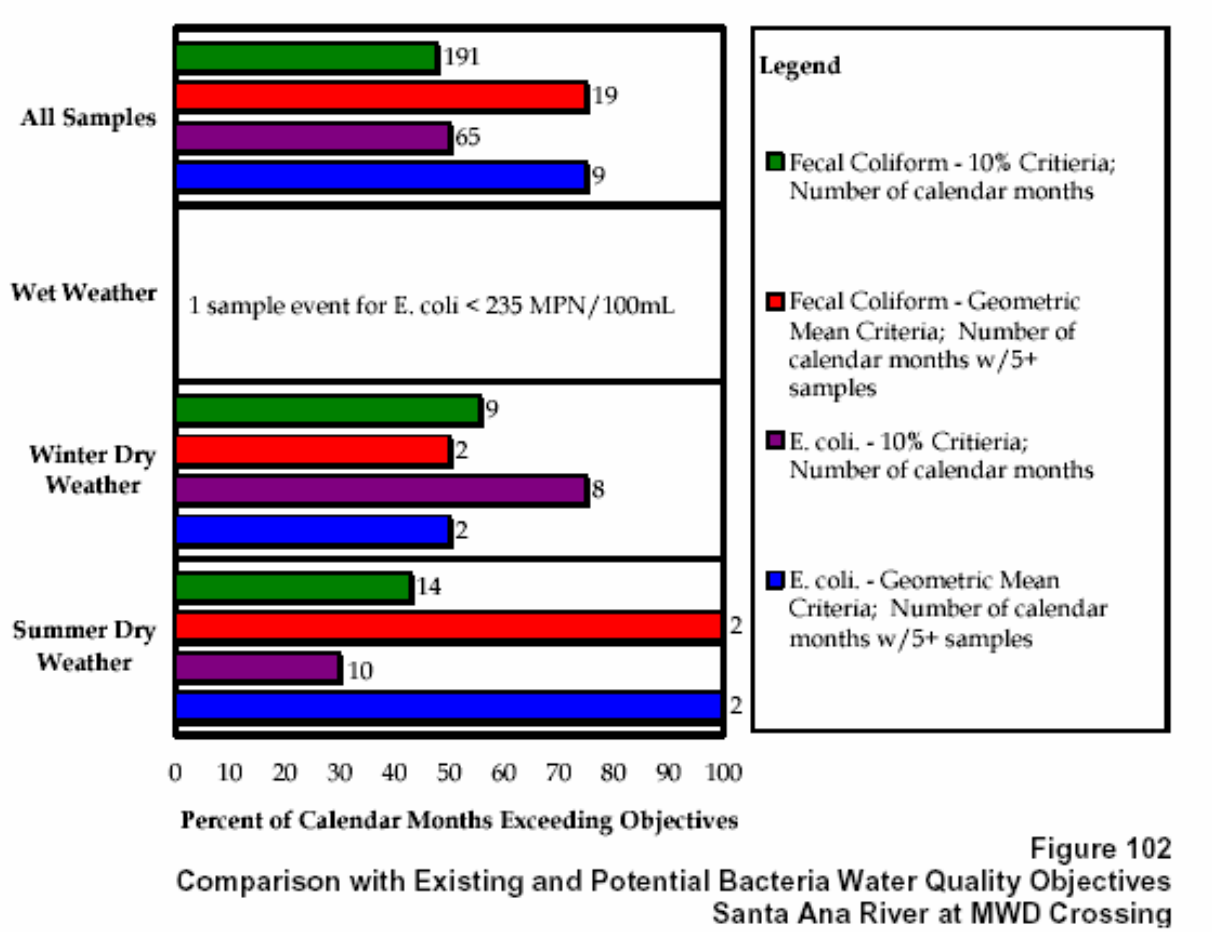


Figure 102
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana River at MWD Crossing

Figure B 9: Percent of months exceeding objectives (CDM 2005 Figure 110)

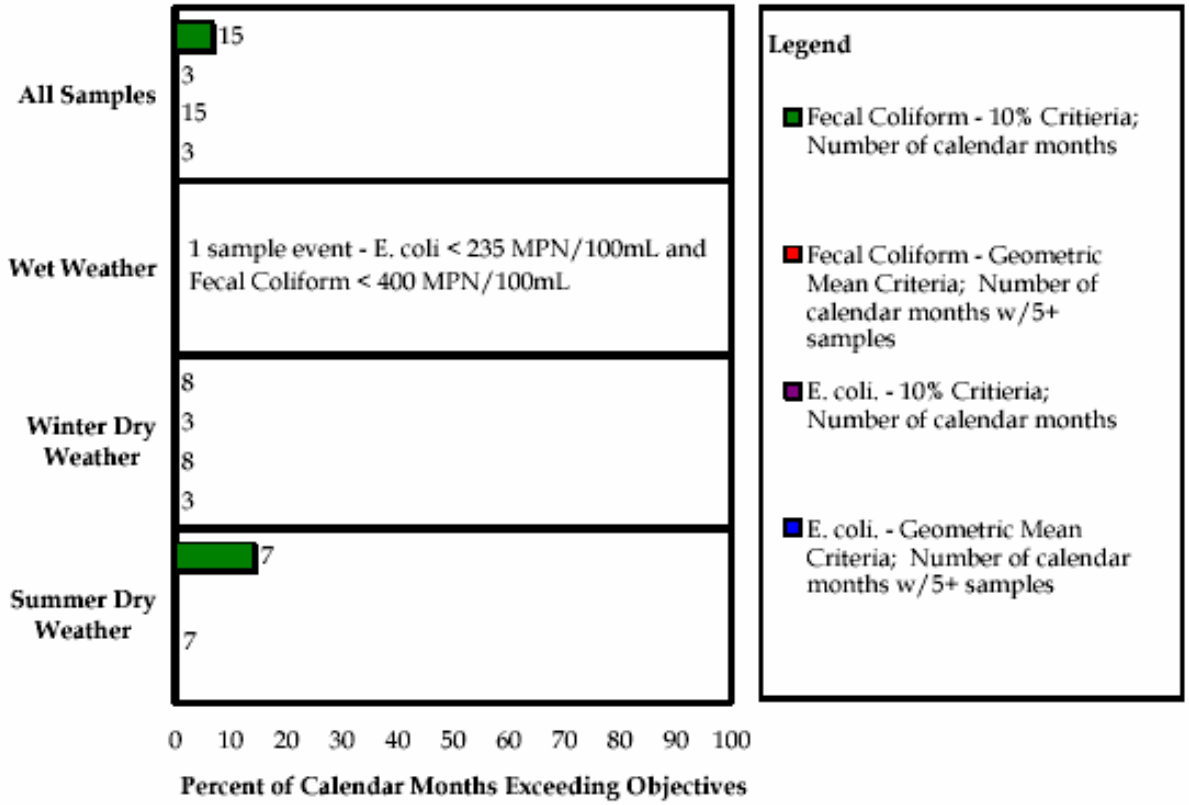


Figure 110
Comparison with Existing and Potential Bacteria Water Quality Objectives
Icehouse Canyon Creek

Figure B 10: Percent of months exceeding objectives (CDM 2005 Figure 88)

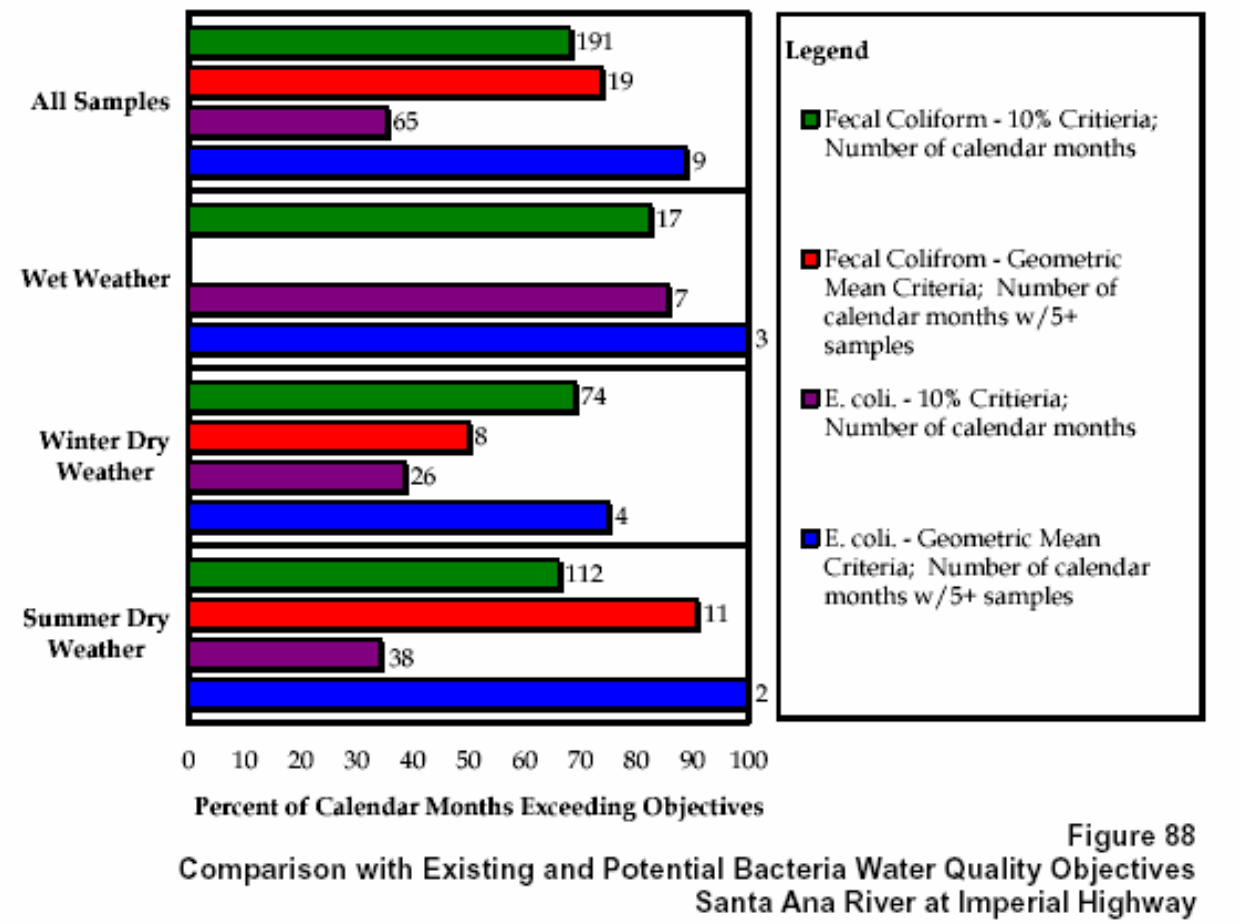


Figure 88
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana River at Imperial Highway

Figure B 11: Percent of months exceeding objectives (CDM 2005 Figure 74)

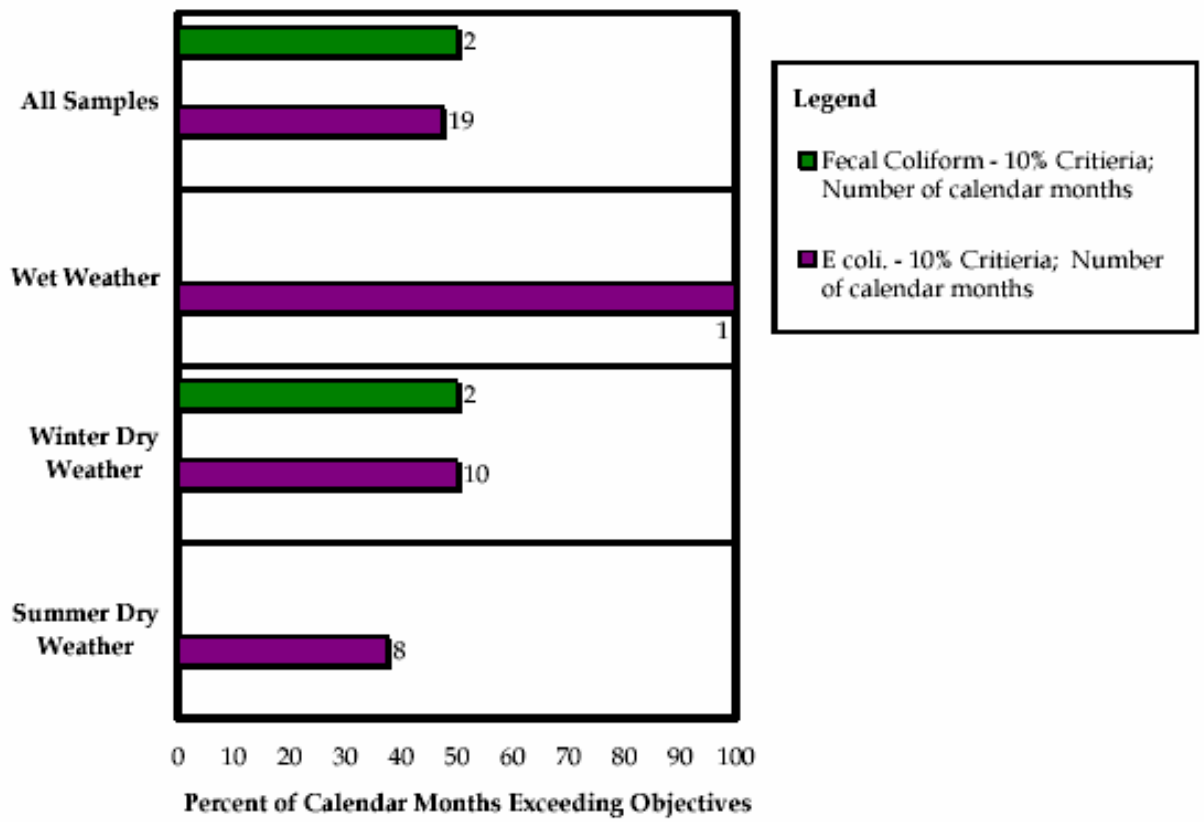


Figure 74
Comparison with Existing and Potential Bacteria Water Quality Objectives
Temescal Creek Near Lincoln Avenue

Figure B 12: Percent of months exceeding objectives (CDM 2005 Figure 38)

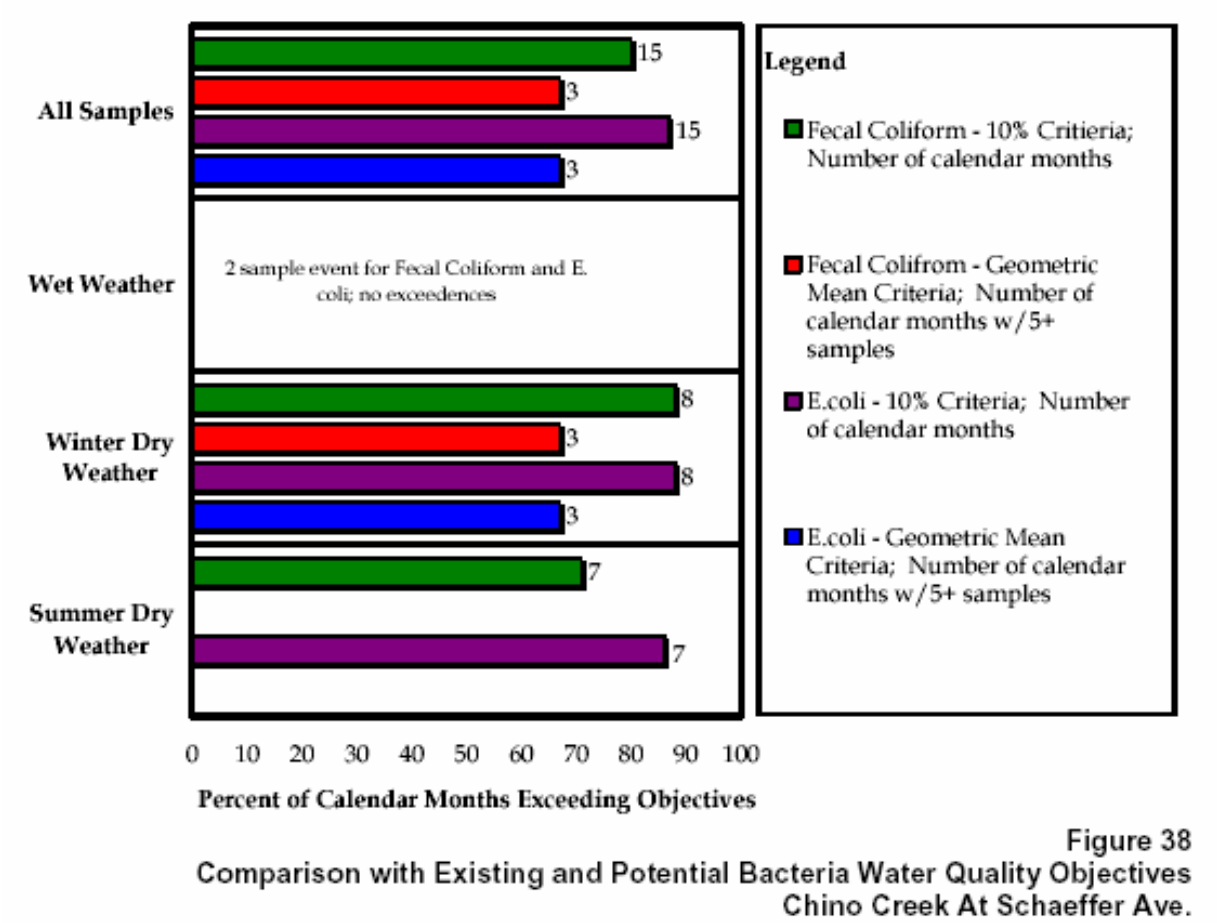


Figure 38
Comparison with Existing and Potential Bacteria Water Quality Objectives
Chino Creek At Schaeffer Ave.

Figure B 13: Percent of months exceeding objectives (CDM 2005 Figure 57)

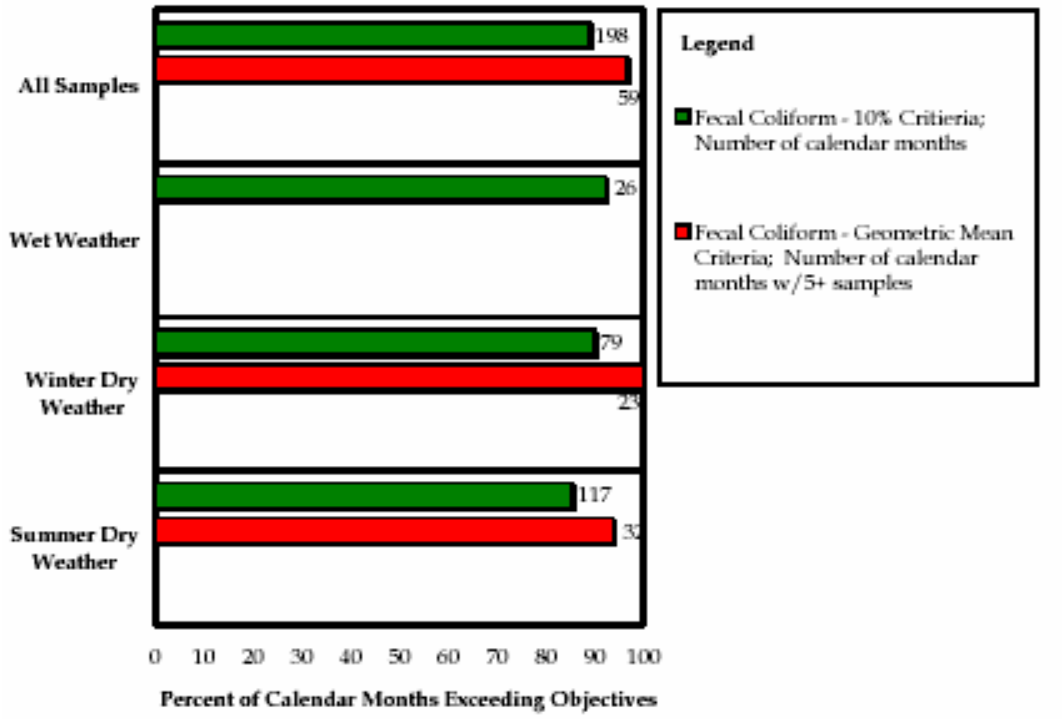


Figure 57
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana Delhi Channel near Irvine Ave.

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).

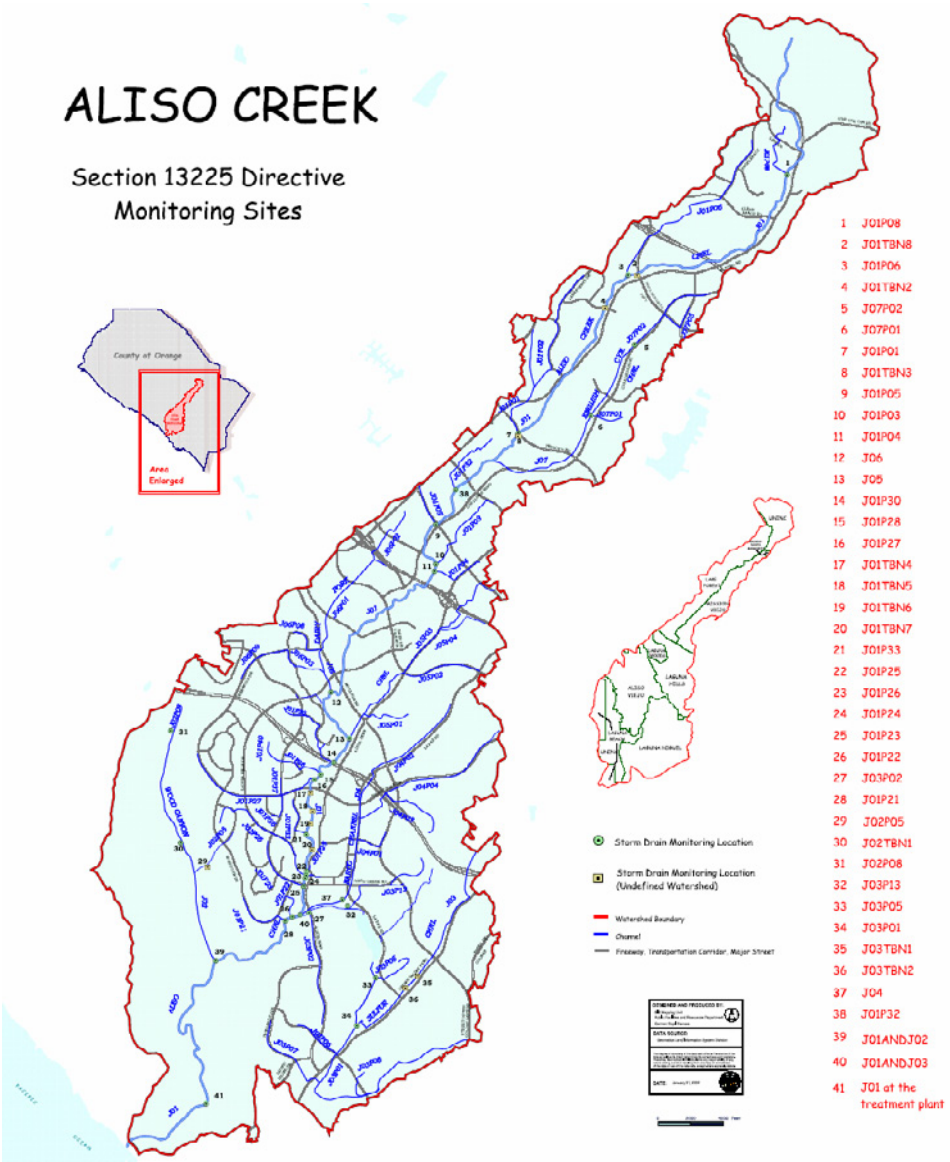
All monitoring of the BMPs and their receiving waters took place during dry weather. Consequently, low flows were mostly sampled, but during the wet season a proportion of these were probably elevated flows during storm recessions.

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

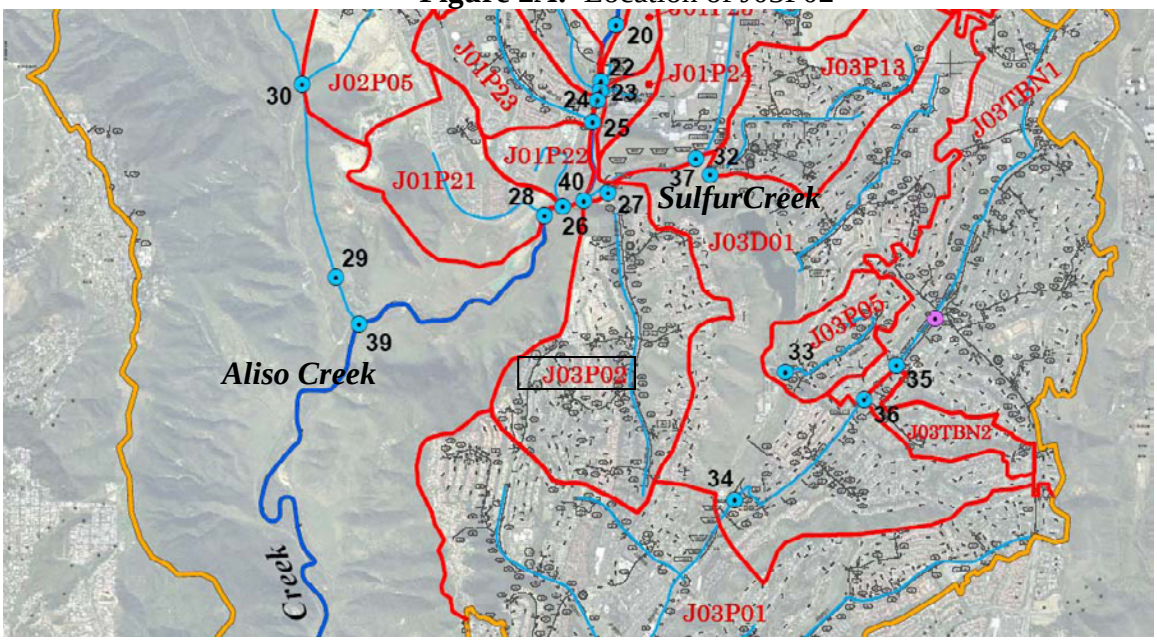
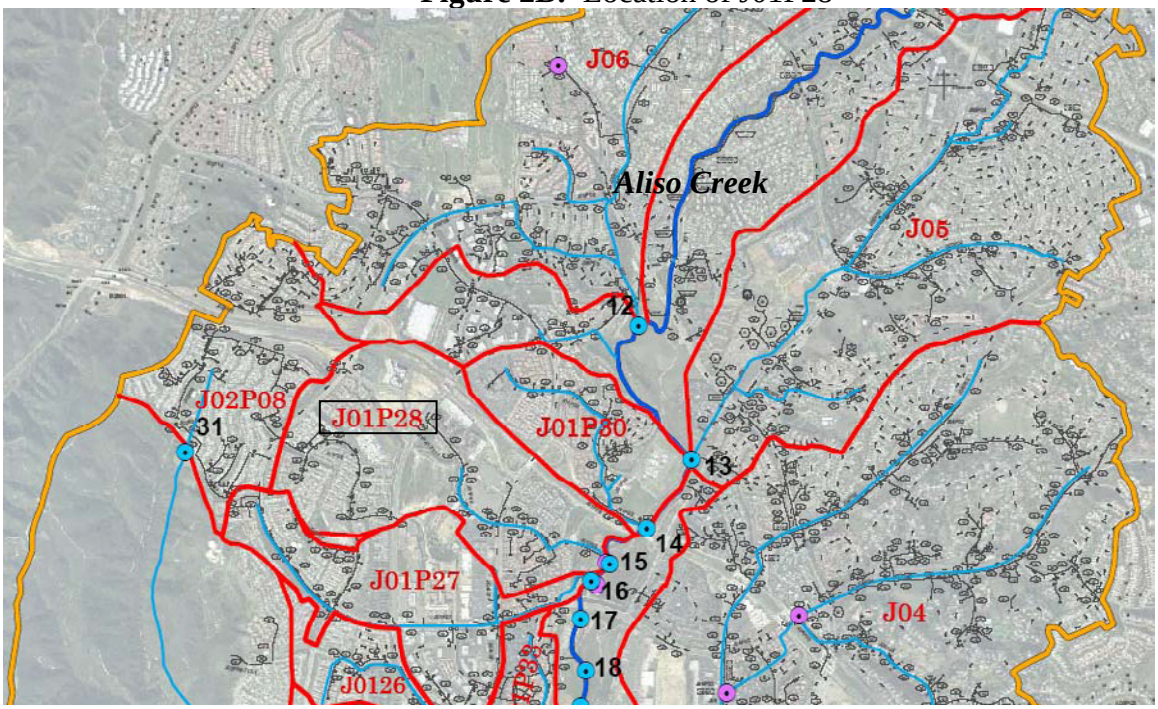


Figure 2B: Location of J01P28



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

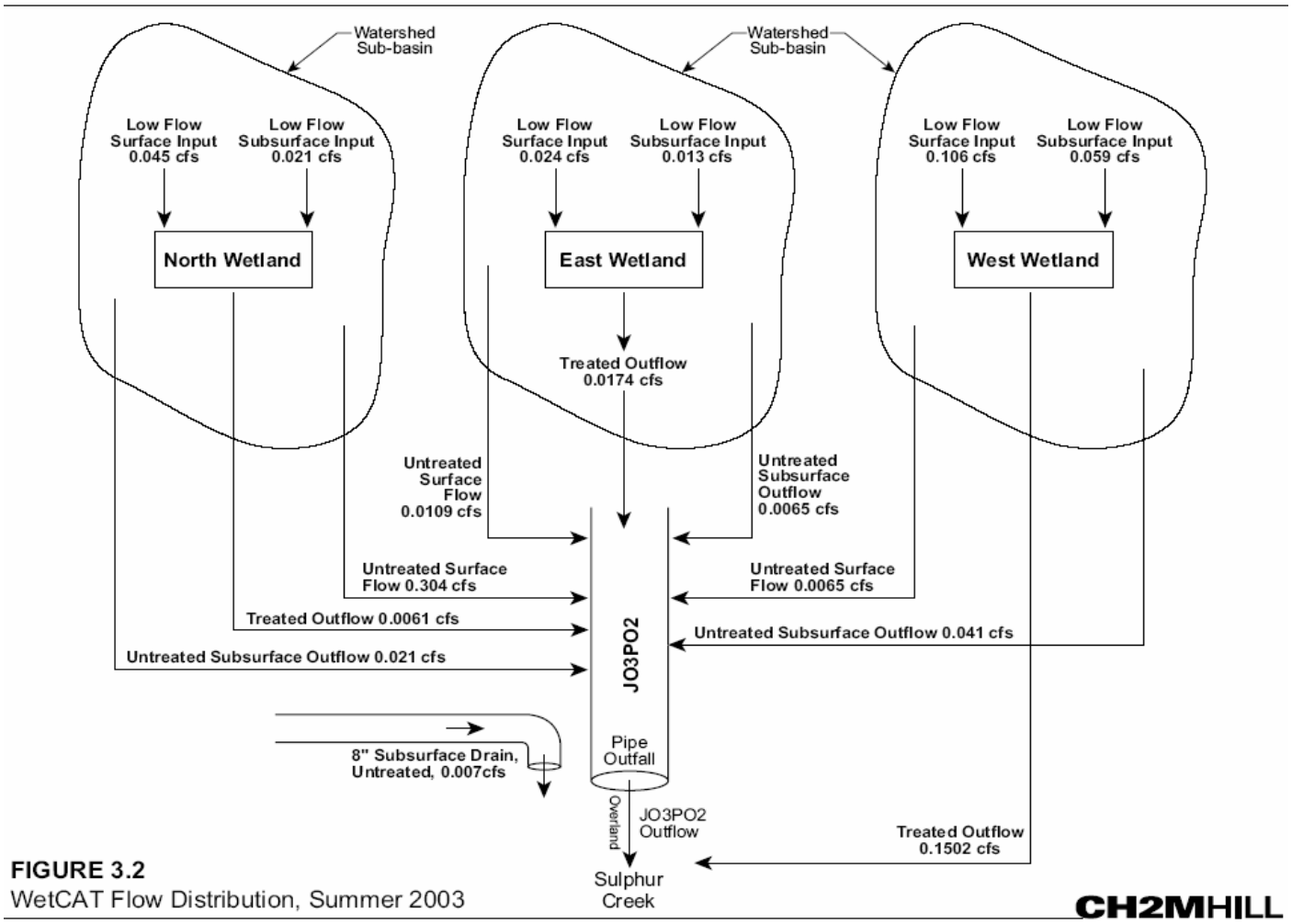
Sampling Procedures

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.

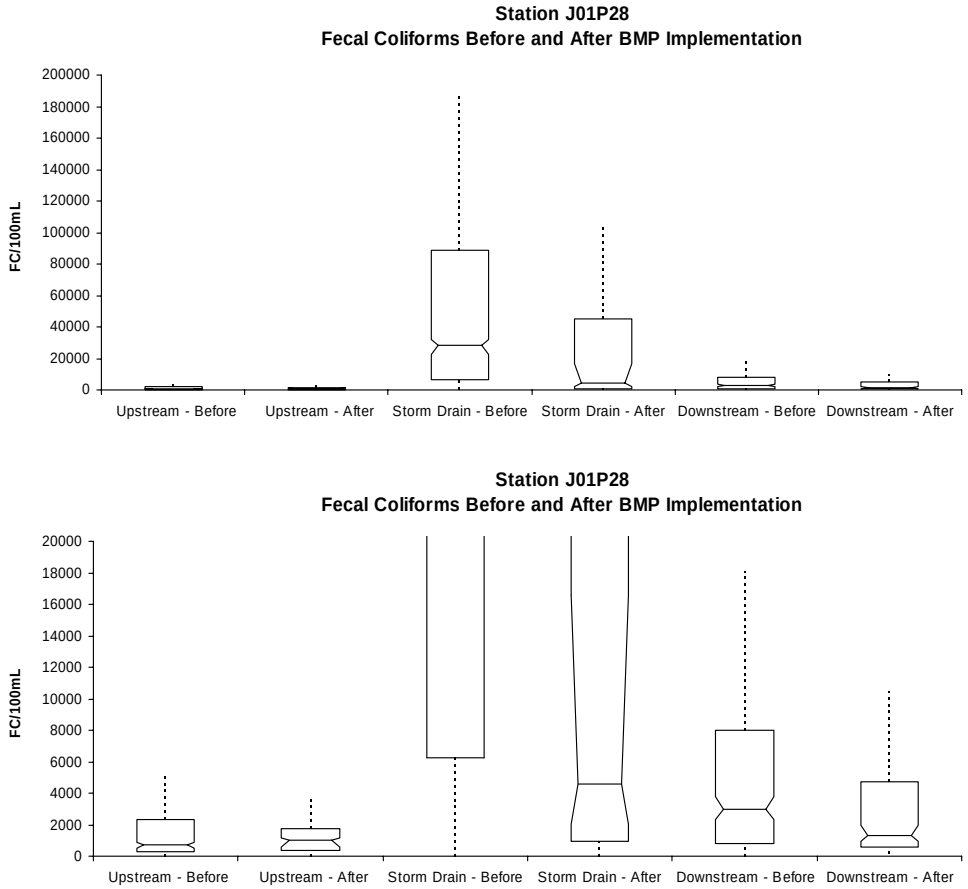


Figure 4: ENT levels for J01P28 monitoring site.

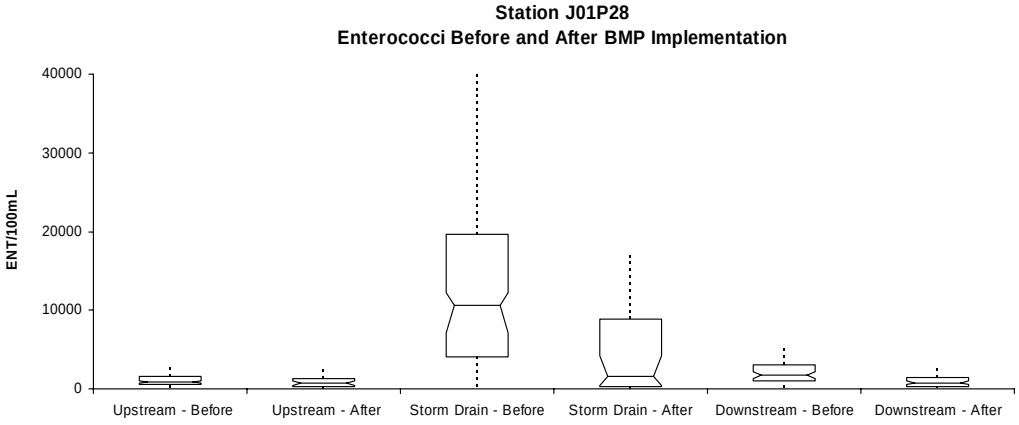
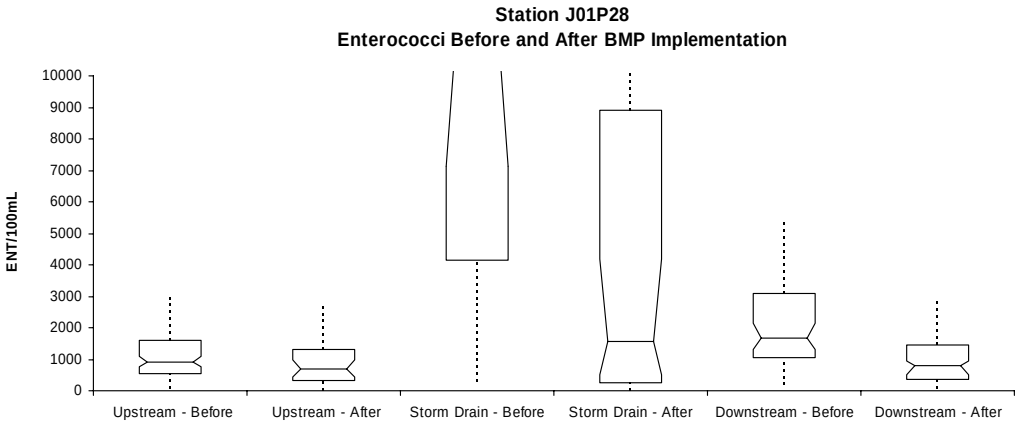


Figure 4 (continued)



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

[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:
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Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

Balance Project Assignment 205018

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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)

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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

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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)

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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

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FIGURES

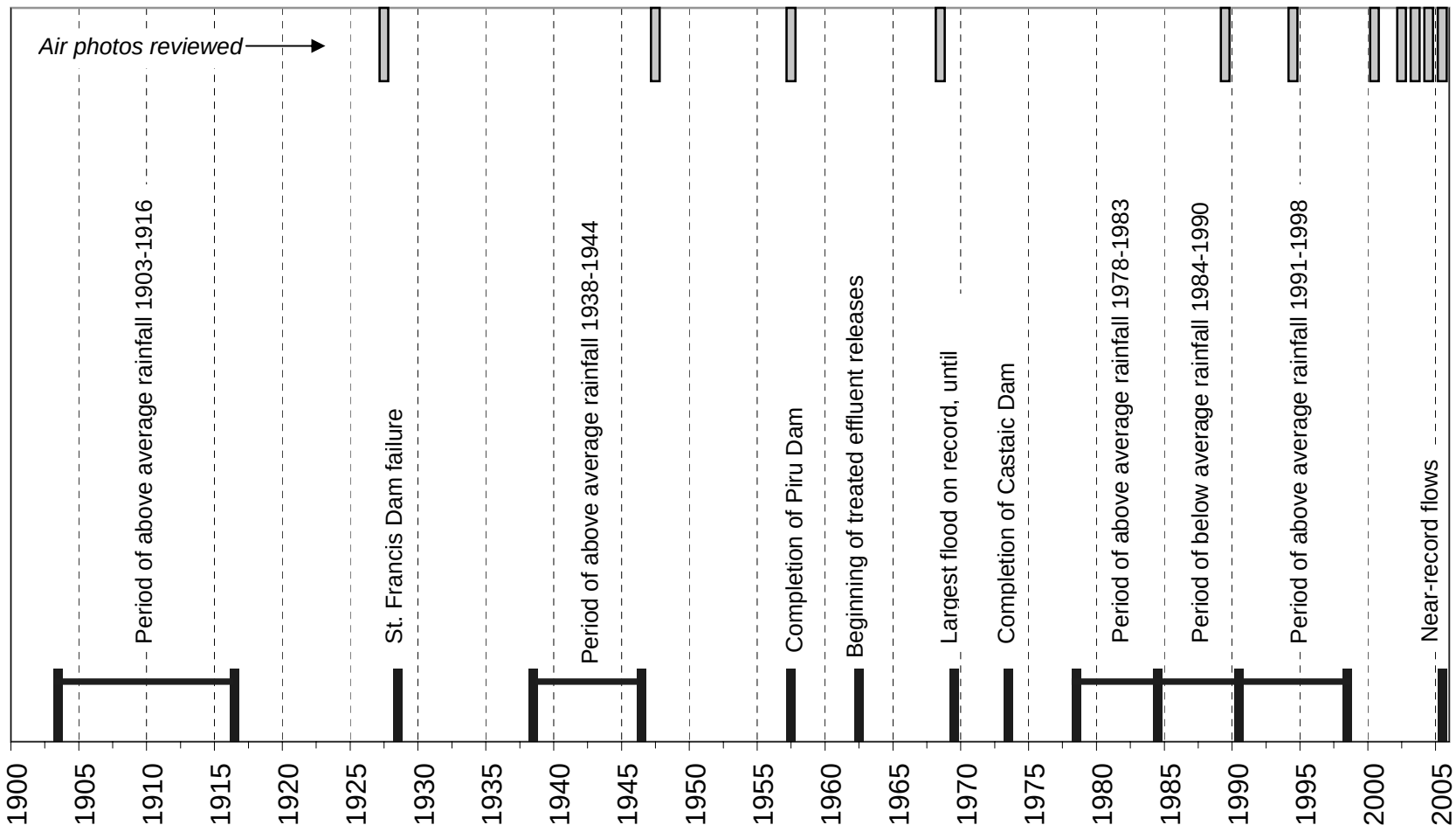

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Figure 1. Timeline of selected major events in the upper Santa Clara River, California. Also shown (at top) are the years for which aerial photographs were analyzed.

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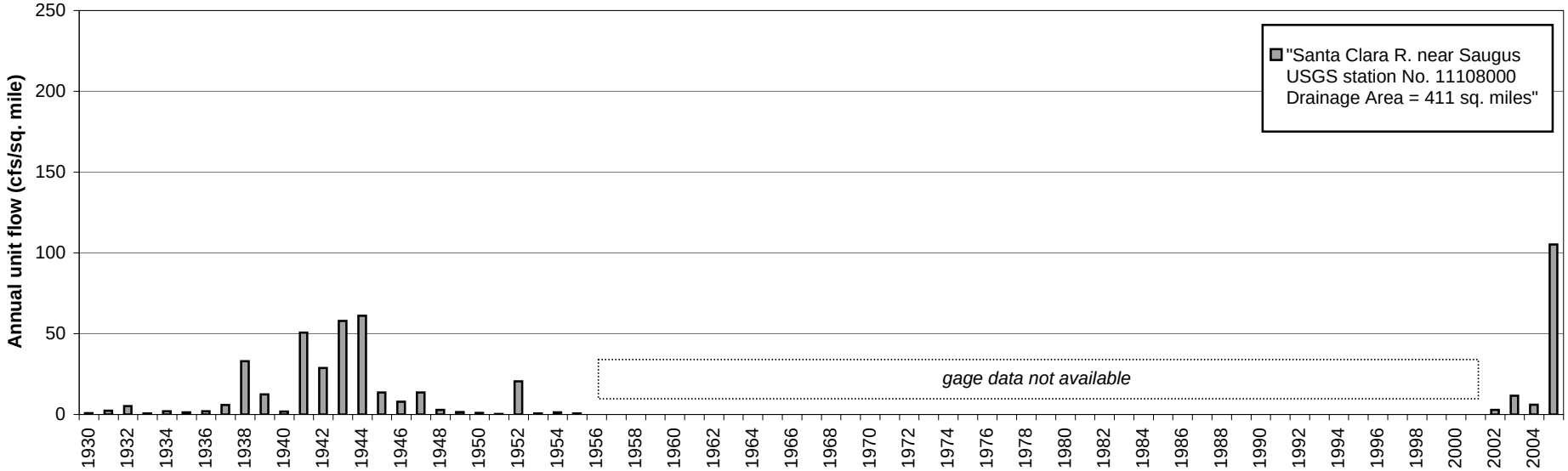

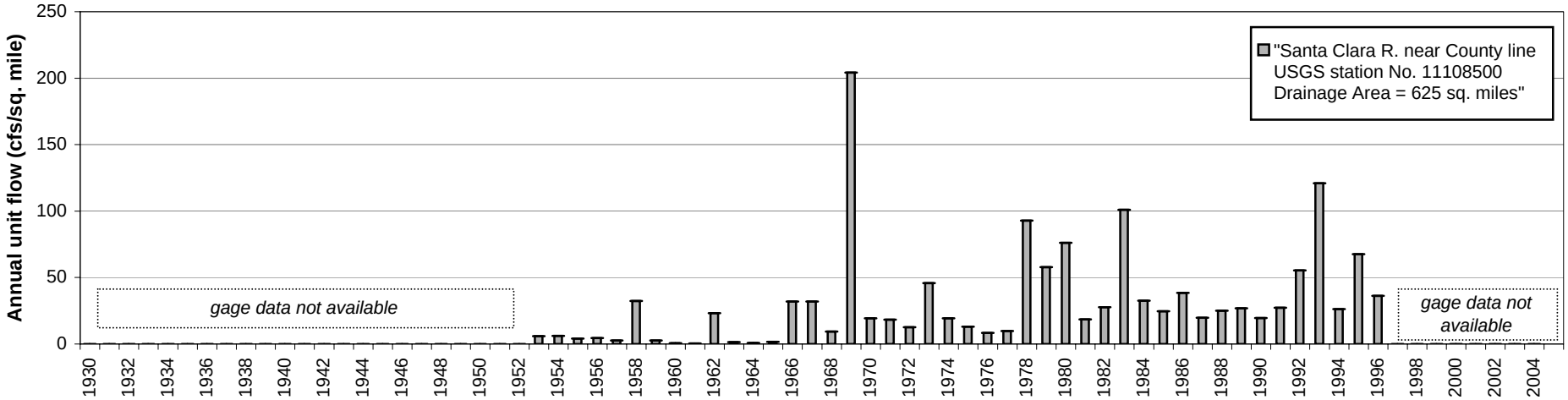

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Figure 2. Annual unit runoff (annual flow per square mile) for the Santa Clara River near Newhall at two separate gaging stations. Note that flow in drier years has increased since the 1960s, most likely due to release of treated effluent to the River.

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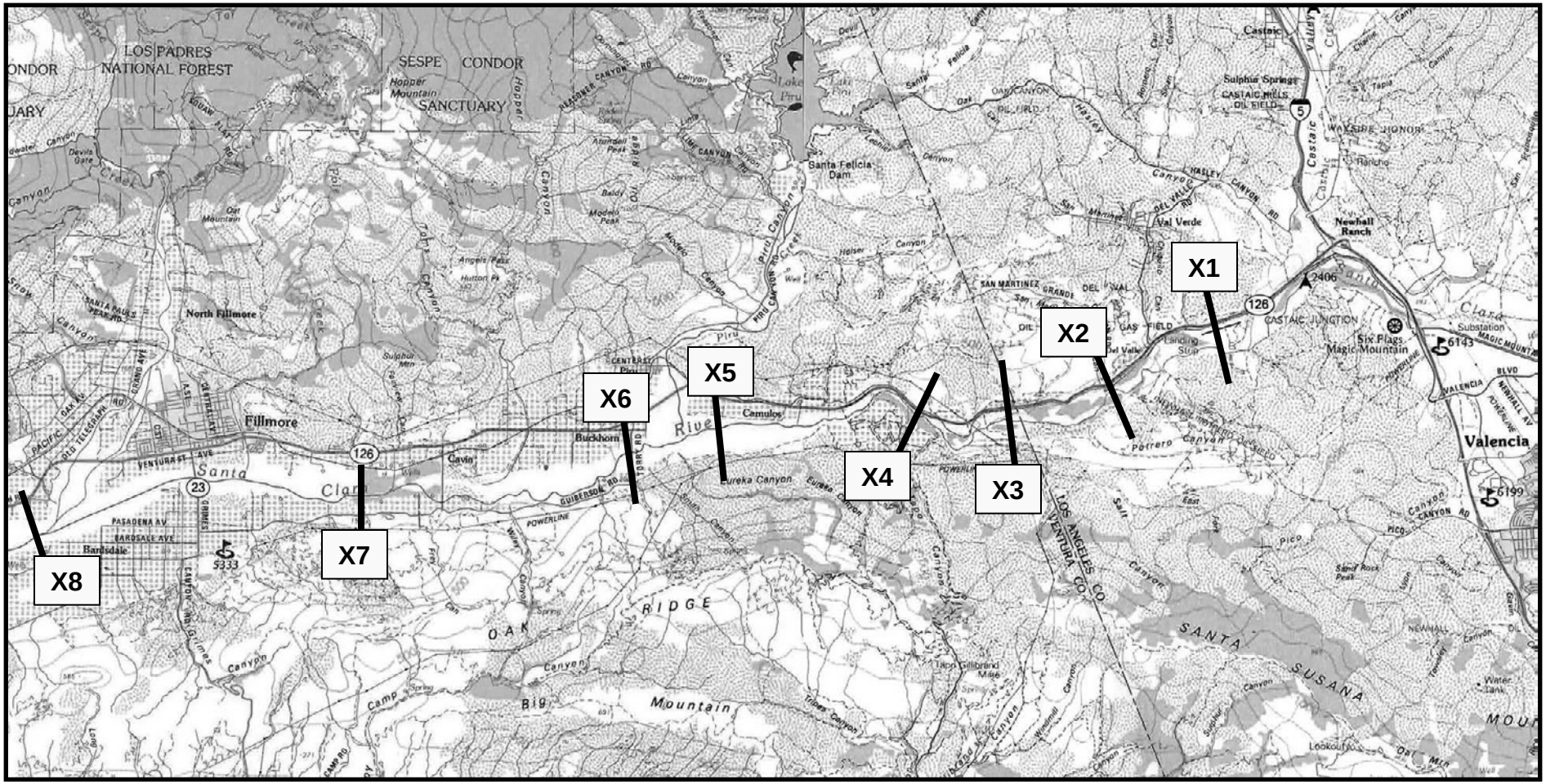

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Figure 3. Location of channel cross sections on the Santa Clara River, measured on aerial photographs.

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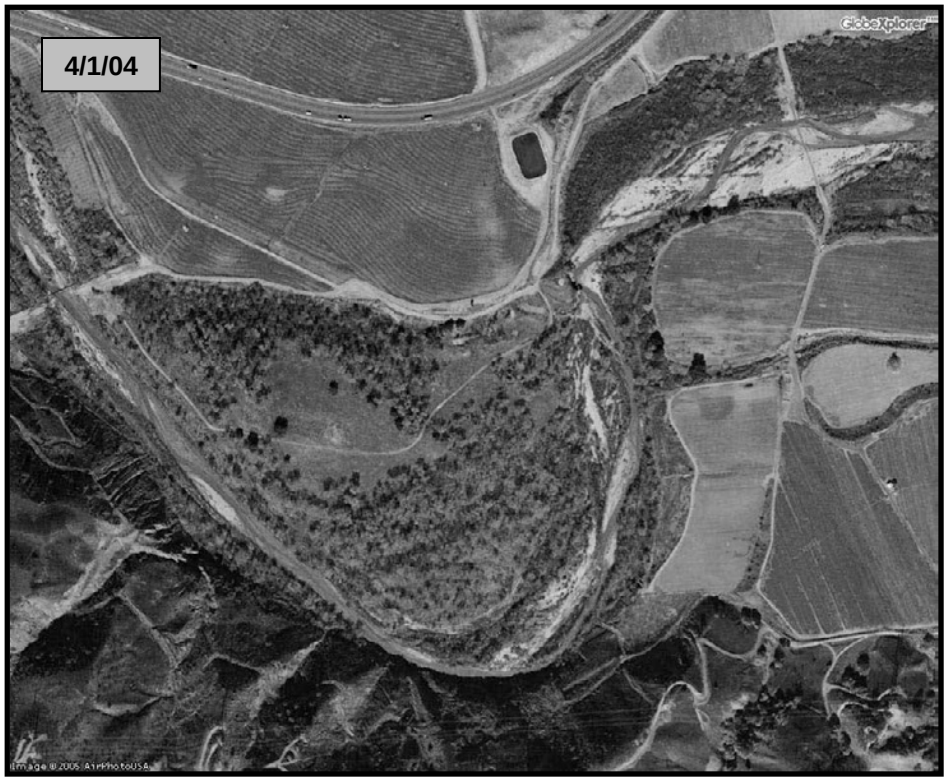

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Figure 4. Comparison of 2004 and 2005 conditions on the Santa Clara River, just downstream of the L.A./Ventura County line. Note that significant channel widening occurred in response to the 2005 events, even in heavily vegetated areas. See appendix A for photo sources.

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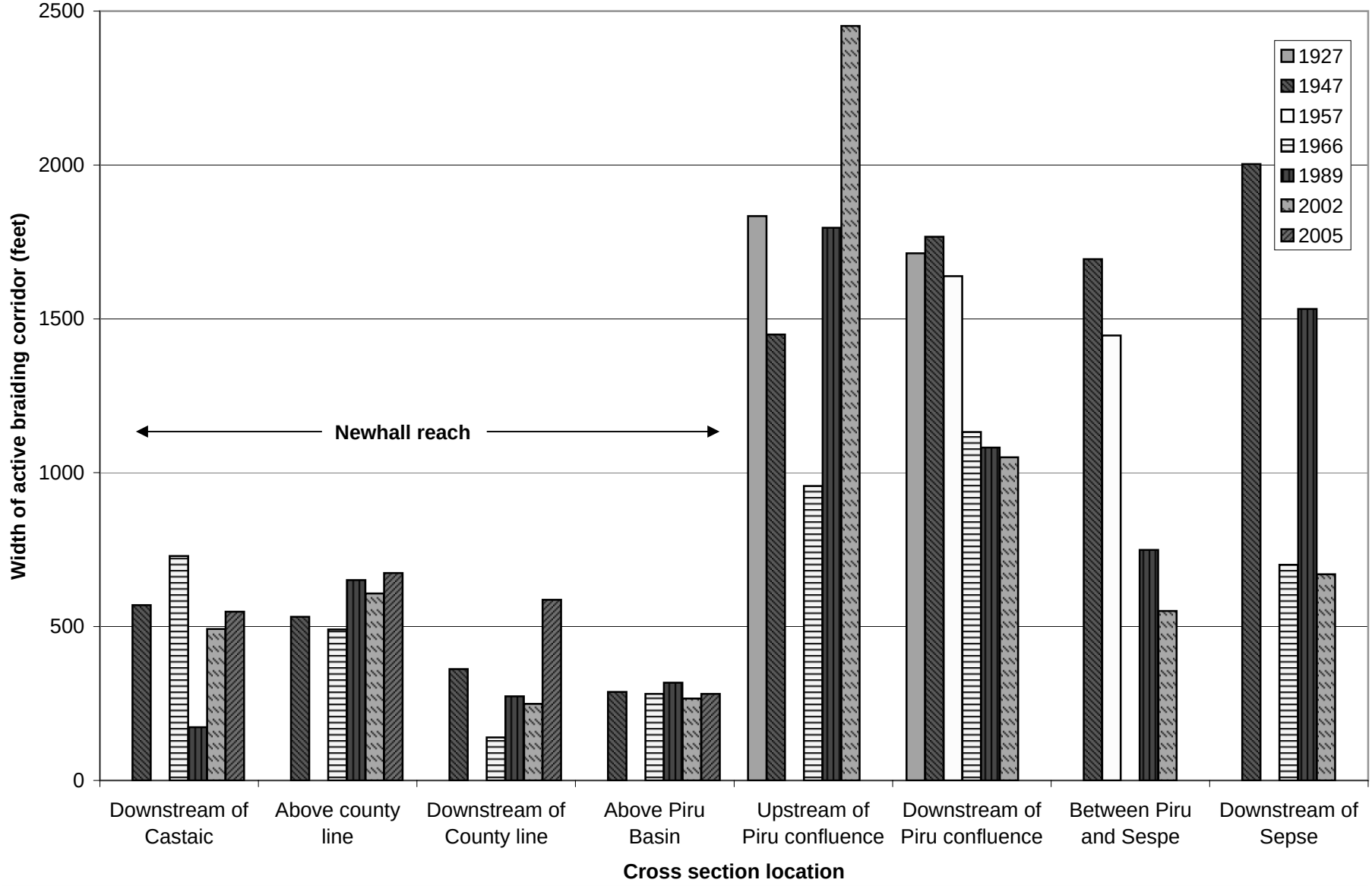

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Figure 5. Measurements of active braiding corridor width from aerial photographs, for cross sections on the Santa Clara River.

Photo cross section data.xls, Summary graph

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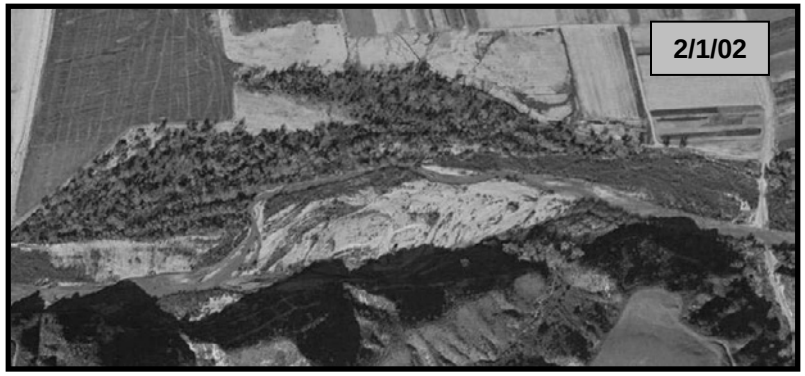

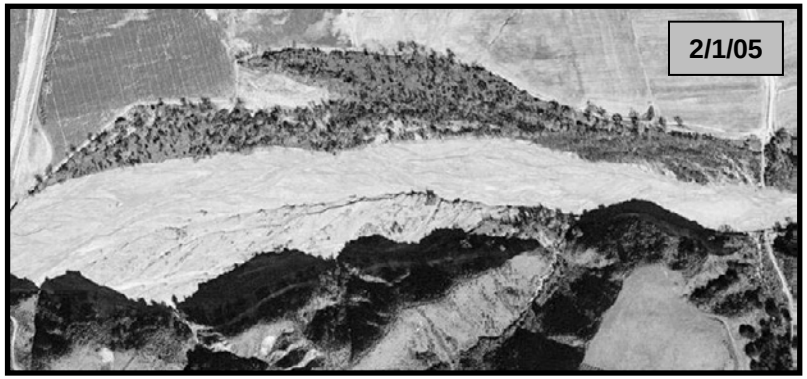

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Figure 6. Progression of aerial photographs downstream of Castaic Canyon, showing channel change between 1993 and 2005. Note that there was little change between 2000 and 2004, but the active corridor widened significantly in response to the 2005 events, and that channel traces within the active corridor were effectively erased. See appendix A for photo sources.

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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

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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

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APPENDIX G

NEWHALL RANCH HYDROMODIFICATION ANALYSIS

NEWHALL RANCH
HYDROMODIFICATION CONTROL

Prepared for

Newhall Land
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Prepared by

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January 2008

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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.

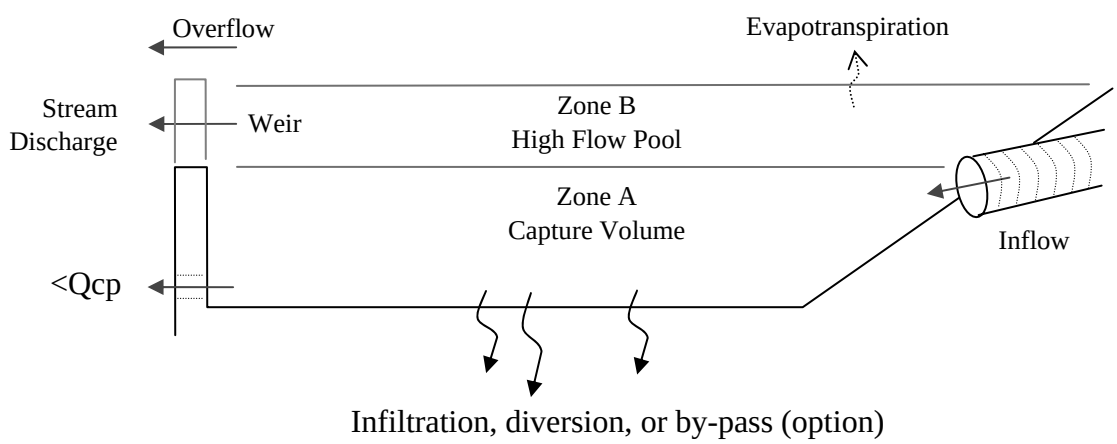


Figure 1. Conceptualized Configuration of Flow Duration Basin

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. Flow Duration Control Basin Configuration

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.

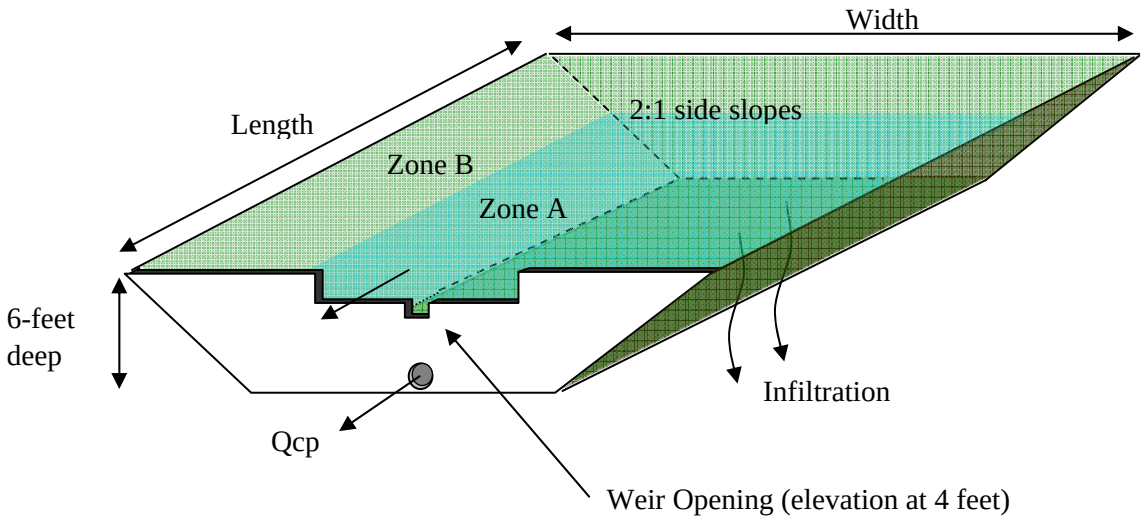


Figure 2. Conceptual Illustration of a Flow Duration Basin

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. Normalized Sizing Charts

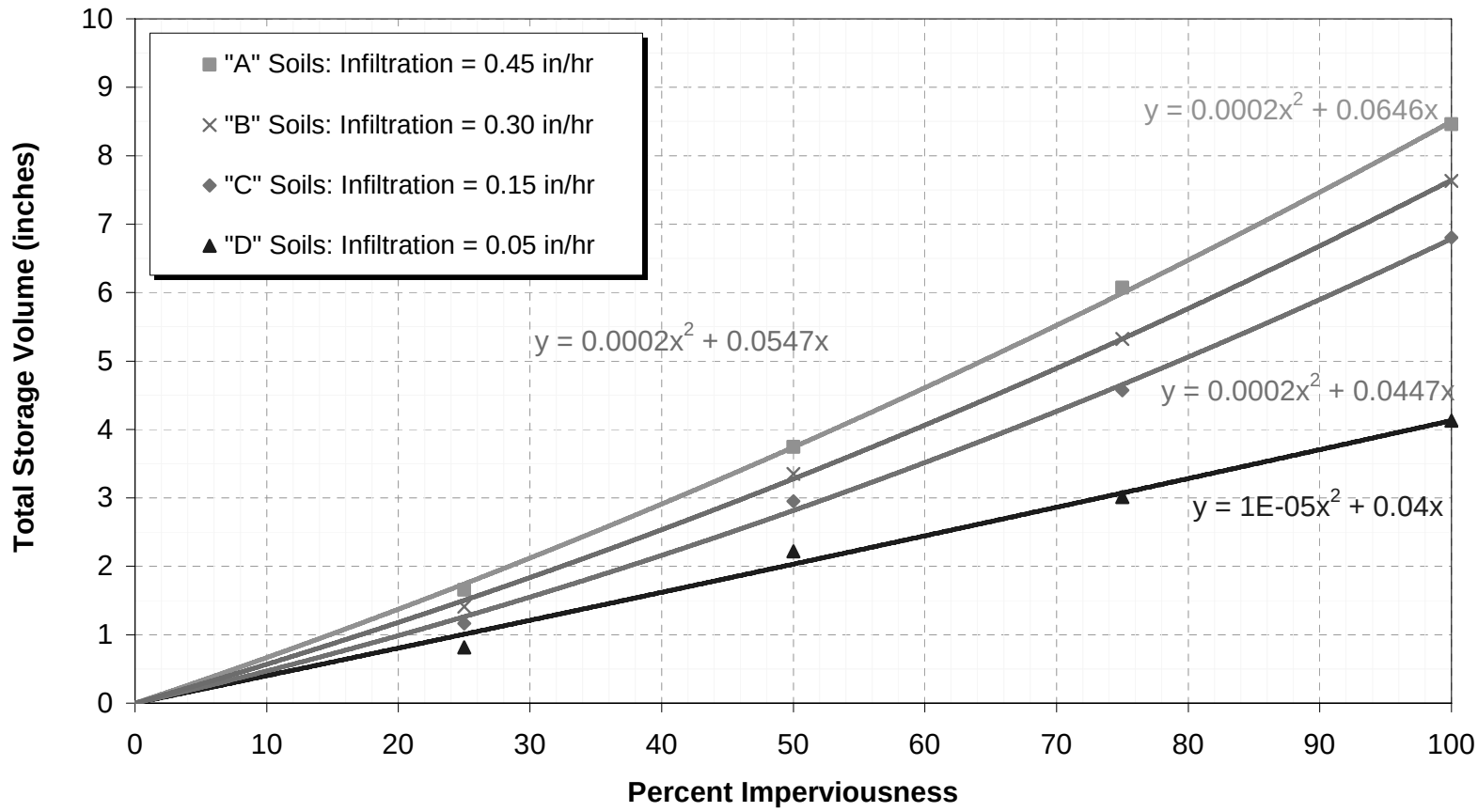
Figures 3 through 5 present the normalized sizing charts developed for the Newhall Ranch watersheds. Figure 3 and 4 provide the total volume (Zone A and B in Figure 2 above) and the capture volume (Zone A in Figure 2 above) requirements, respectively, and Figure 5 provides the surface area requirements 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

Newhall Precipitation; Qcp = 2 cfs/100 acres

Figure 3

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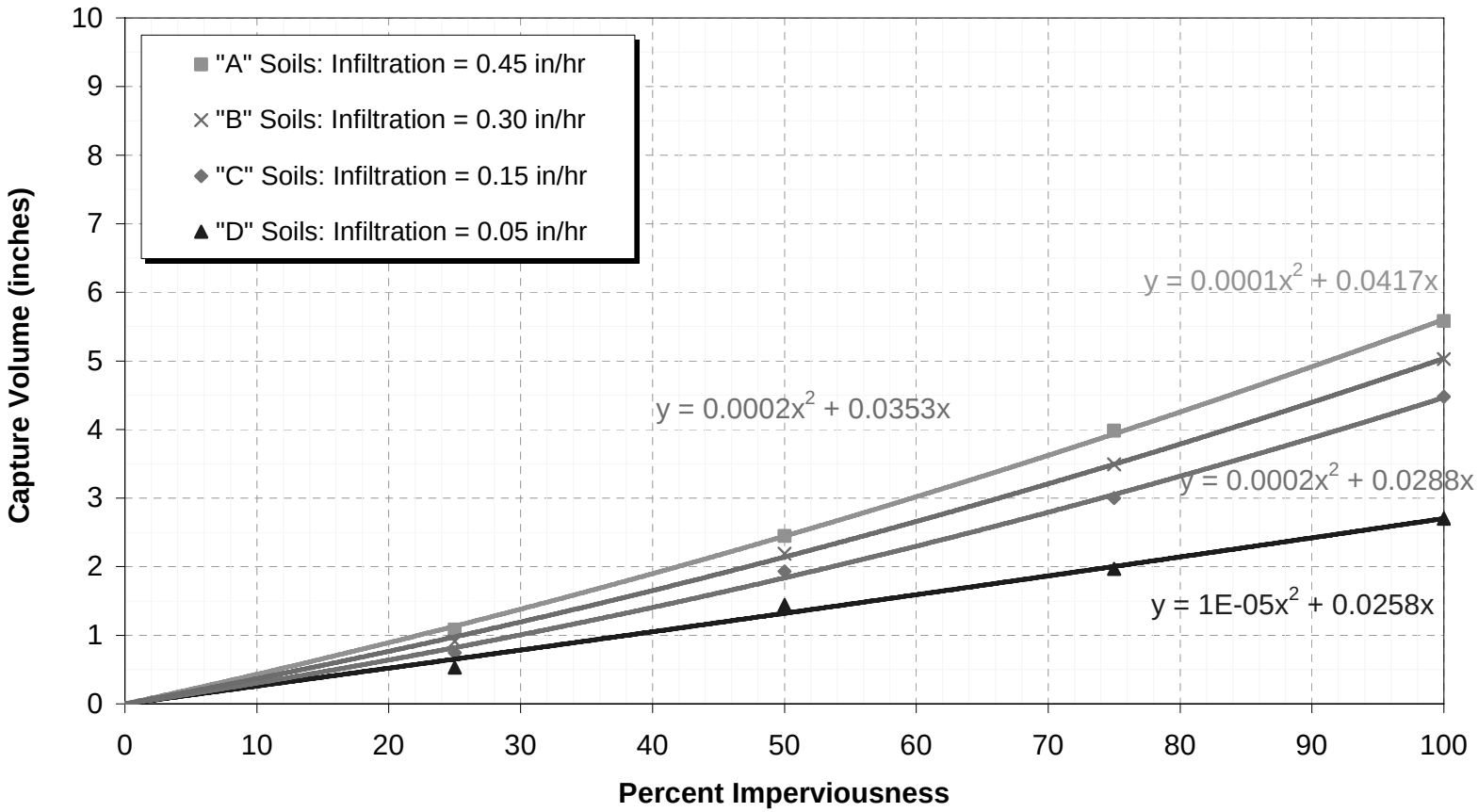
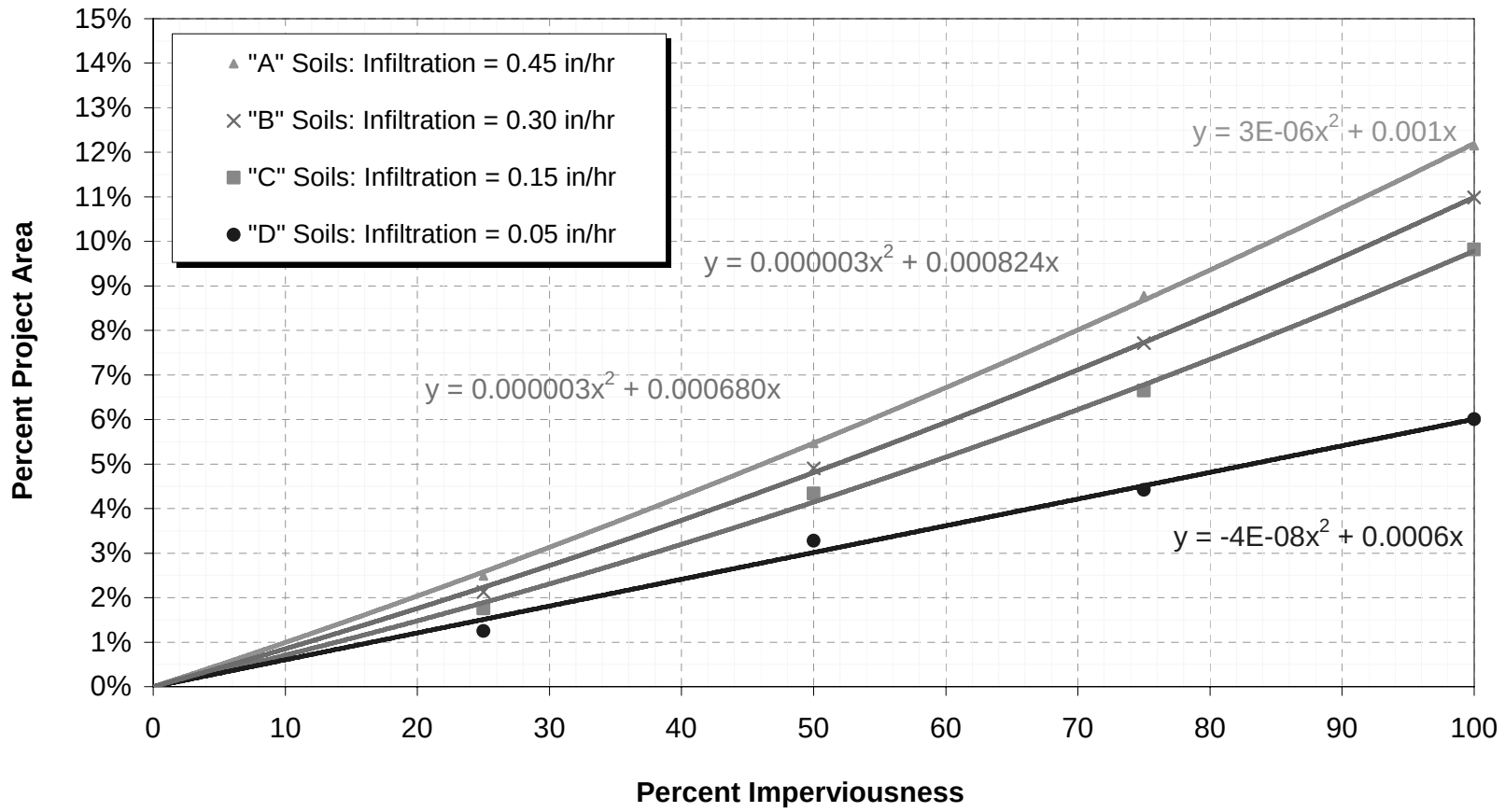


Required Flow Duration Control Capture Volume

Newhall Precipitation; Qcp = 2 cfs/100 acres

Figure 4

GeoSyntec Consultants



Required Flow Duration Control Basin Area

6-foot deep basin, Weir Crest at 4 feet

Figure 5

GeoSyntec Consultants

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APPENDIX G
ATTACHMENT A
BASIS OF DESIGN: NEWHALL RANCH TRIBUTARIES

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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.

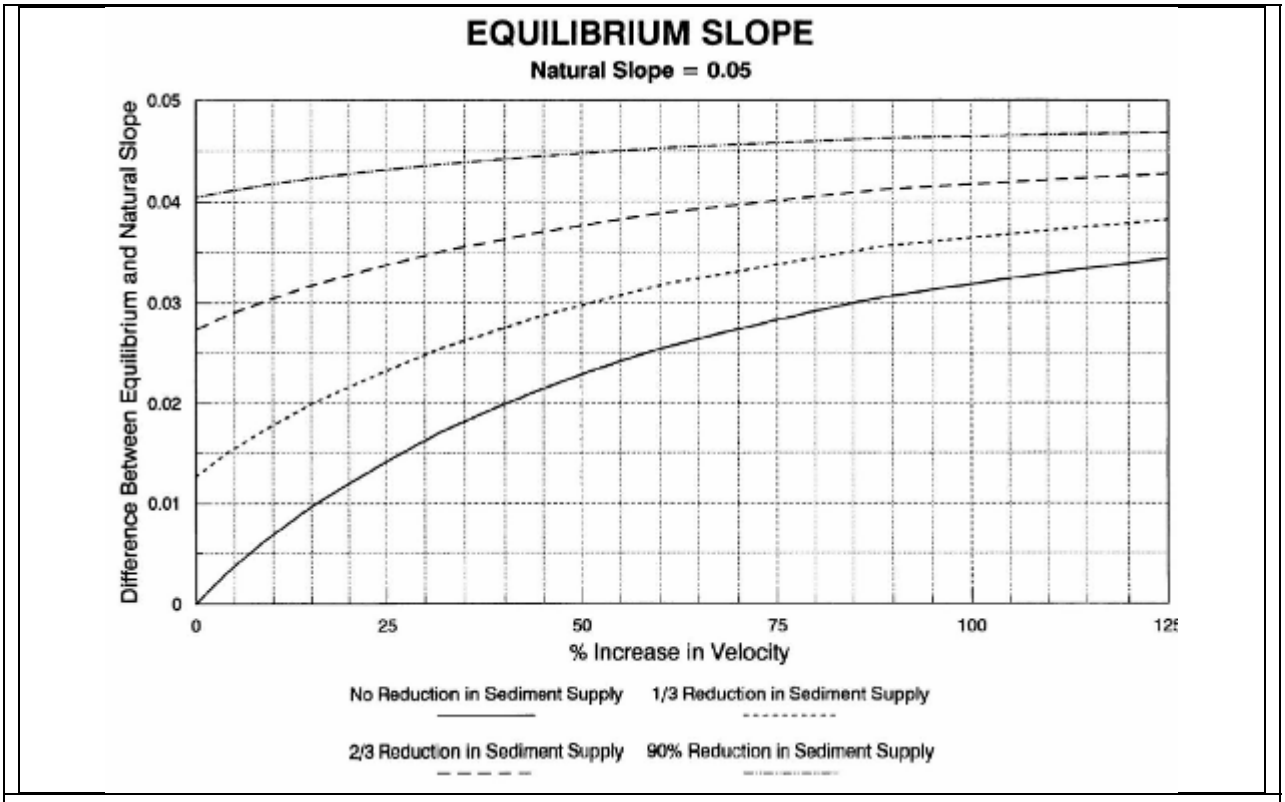


Figure 2. Nomograph for estimating equilibrium slope.
Source: LA County Dept of Public Works, 2006. Appendix C.

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.

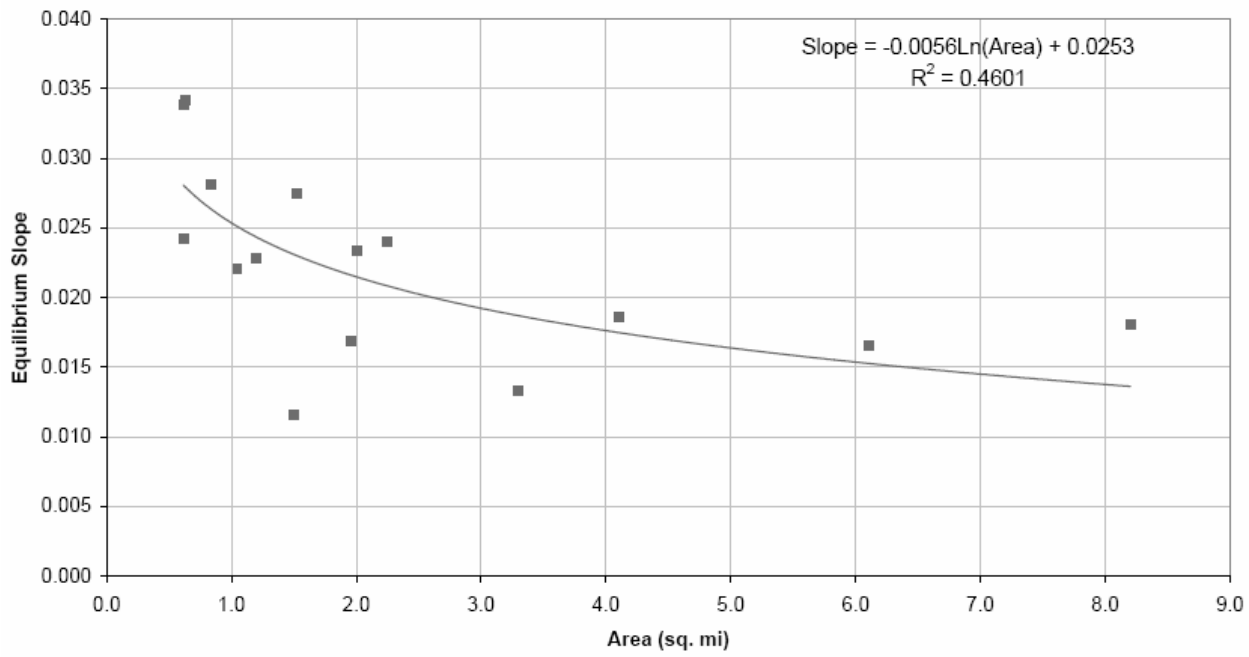


Figure 3. Equilibrium Slope for Rural Reference Reaches

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.

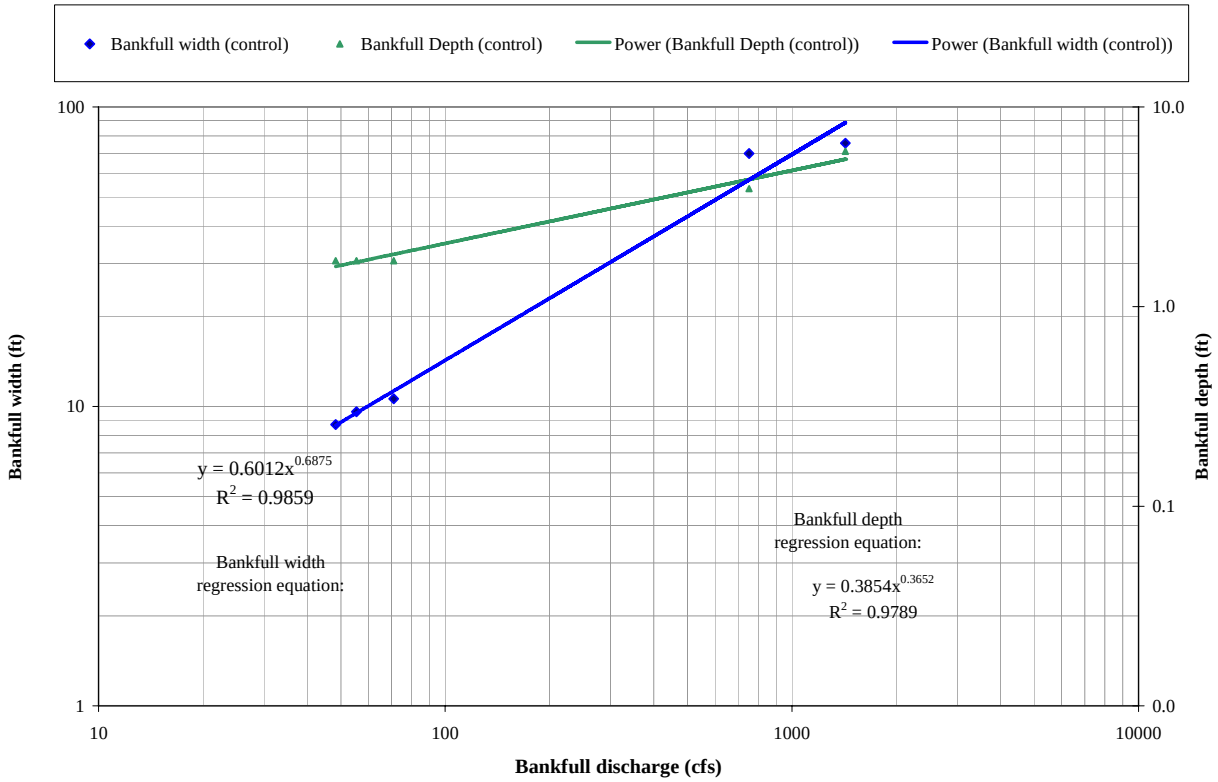
4. CHANNEL WIDTH AND DEPTH

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 Grouted Sloping Boulder (GSB) Drop

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

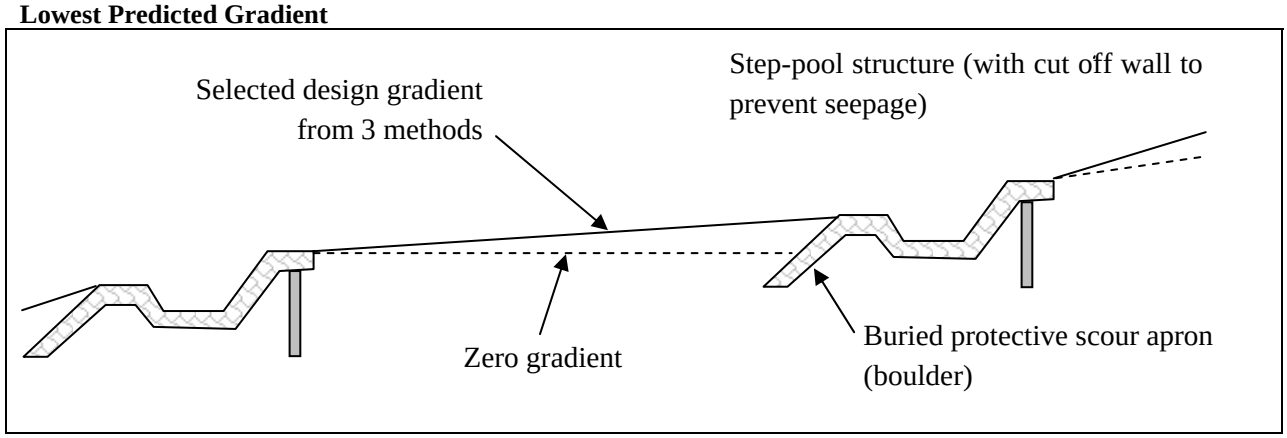
Boulders, comprised of various sizes between 24-inch and 36-inch minimum in all directions, would be placed on the face of the step-pool structure, the crest, the lower part of the side slopes, and pool. The sub-base of the structure will be adequately designed using a mixture of compacted soil and riprap. 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

Grouted Sloping Boulder Drop

SOIL CEMENT DROP STRUCTURE

PWA

Sculpted Concrete Drop Structure

Non-Grouted Boulder Step Pool

PWA

ATTACHMENT B

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Lion Canyon

Geomorphic Reconnaissance

Lion Canyon

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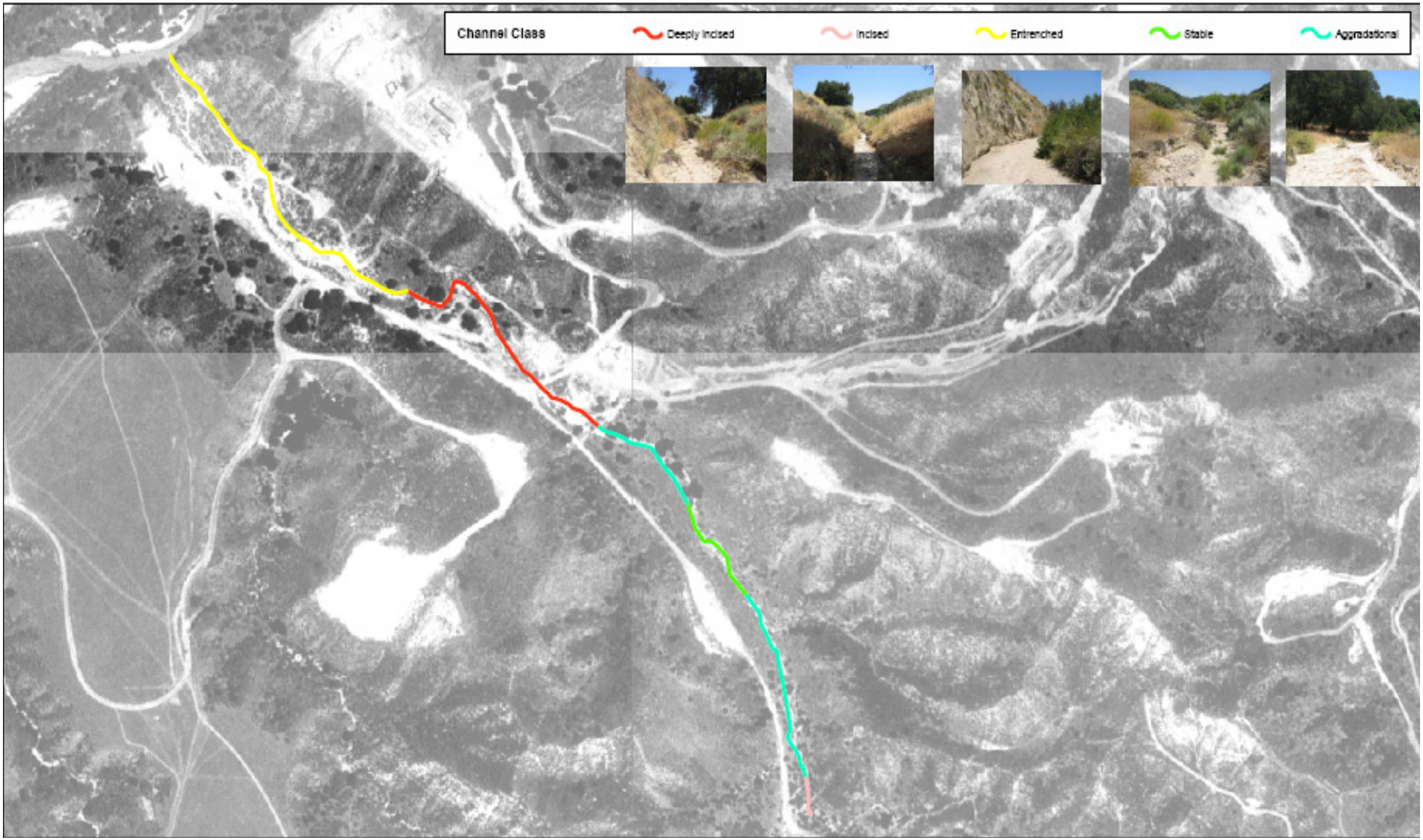
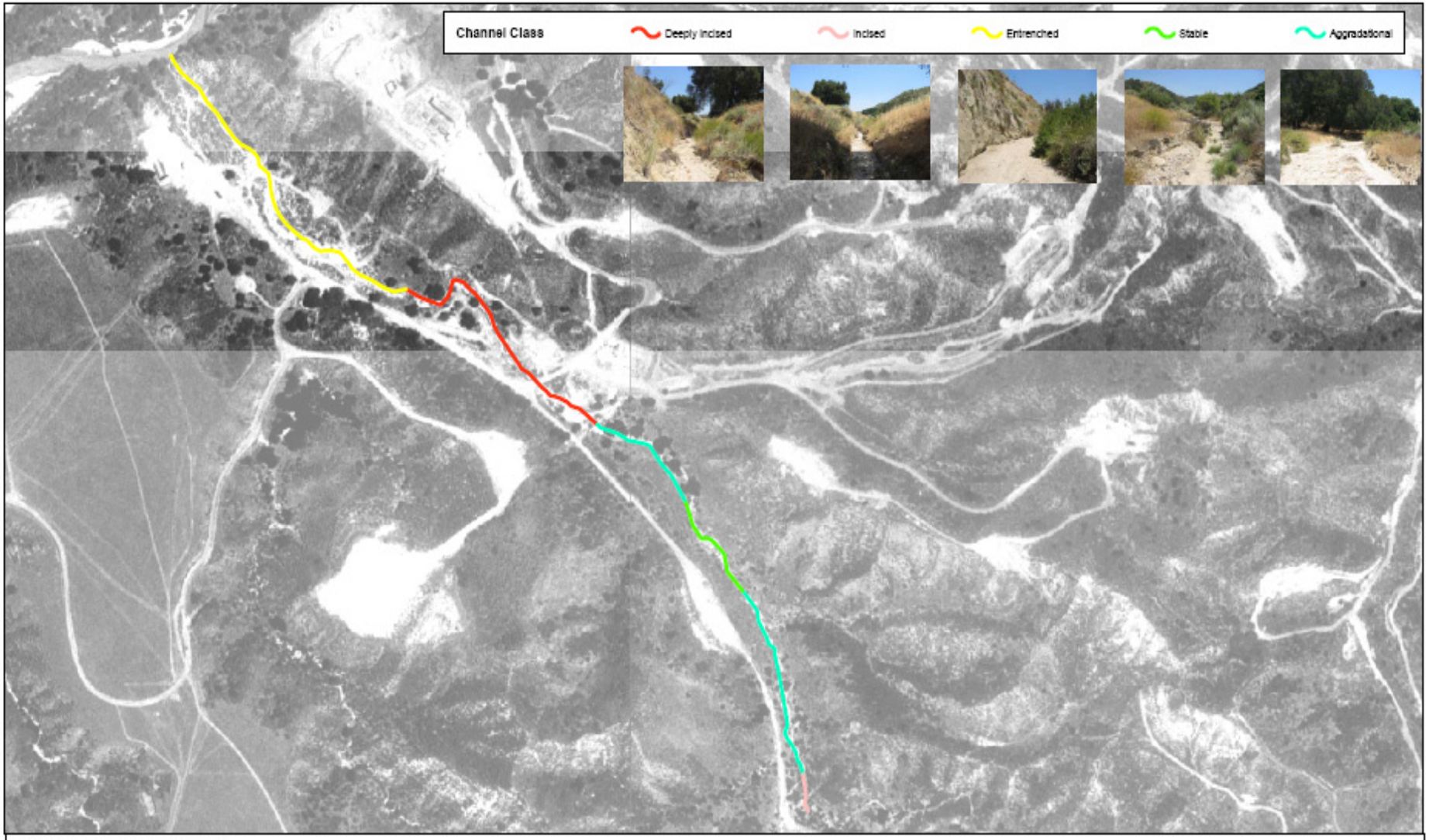




Source: USGS (images), PWA (Geomorph)

N

0 500 1,000 2,000 Feet

figure 1

Newhall Ranch

Geomorphic Stream Assessment Map - Lion Canyon

ref. 1820

PWA

\\fs1\GIS\NewhallRanch\Geomorph4aust_307\Geomorph4aust\1820_Geomorph_Lion_307.mxd

Slightly eroded

Lion #1

Aggraded

Lion #2

Slightly eroding outside bends, aggrading channel

Lion #4

Aggrading

Lion #5

Aggrading

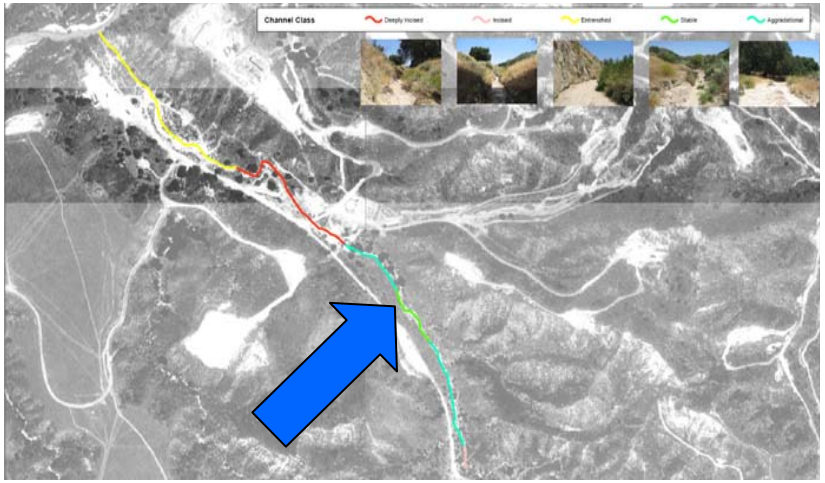
Lion #6

Stable – slightly aggrading

Lion #7

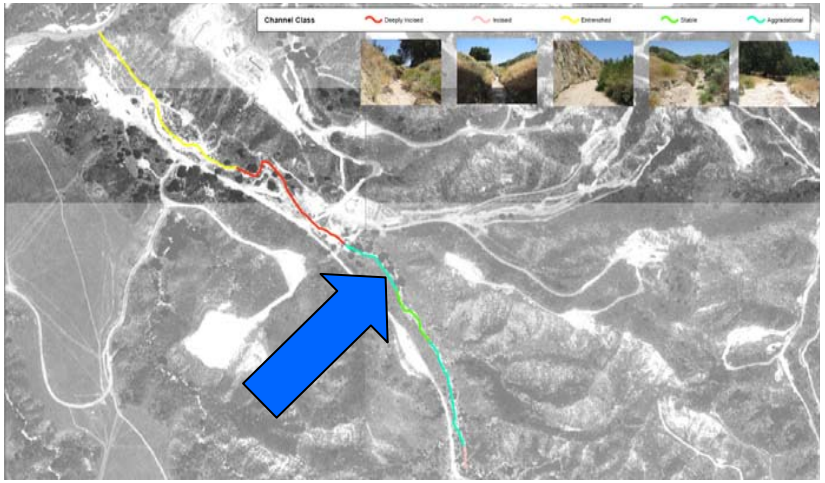
Stable

Lion #8



Stable – slightly aggrading

Lion #9

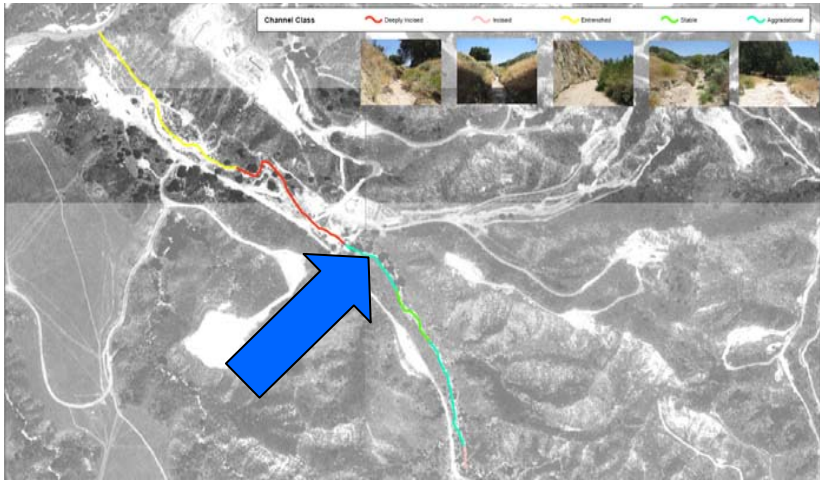


Aggrading

Lion #10

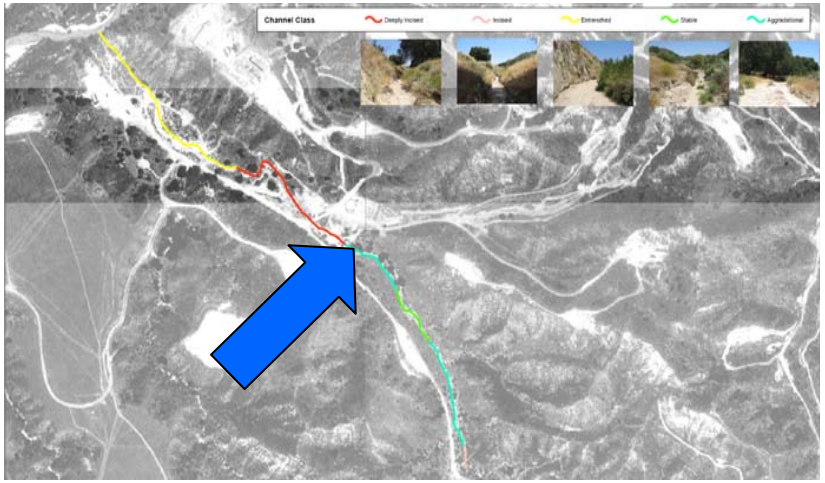
Heavily aggrading

Lion #11



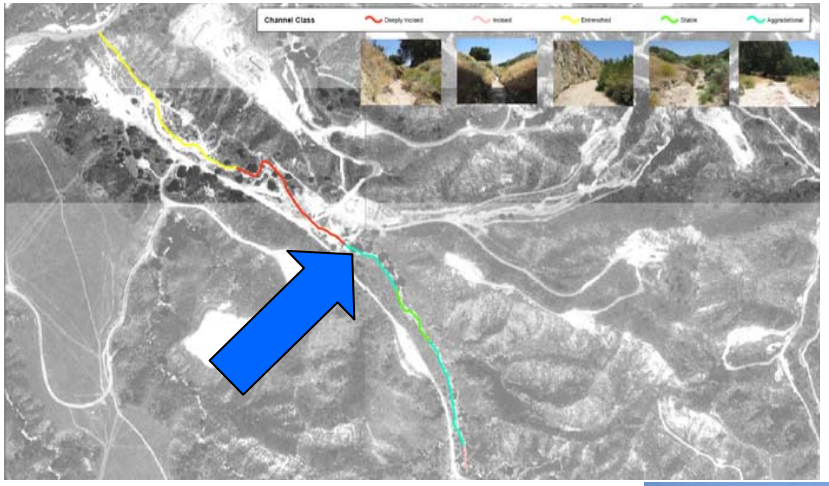
Aggrading

Lion #12



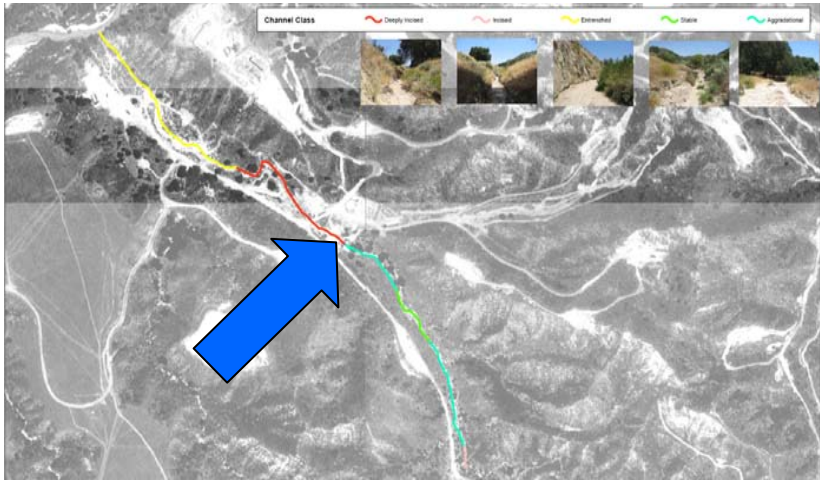
Heavily aggrading

Lion #13



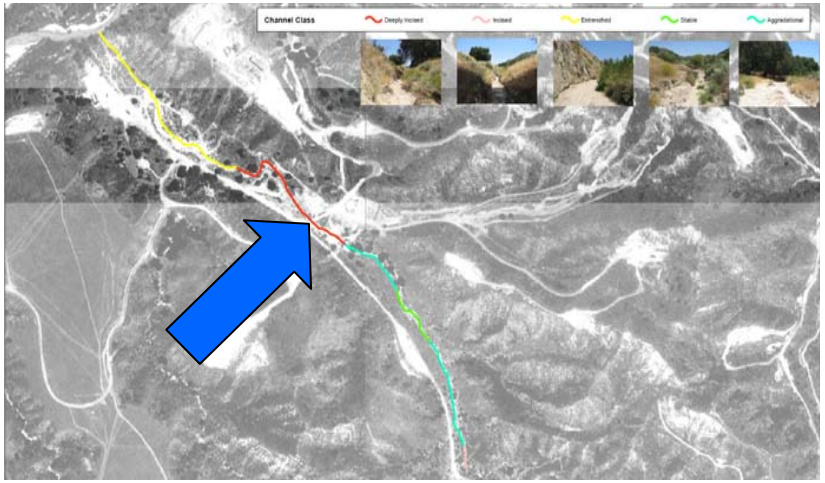
Slightly aggrading

Lion #14



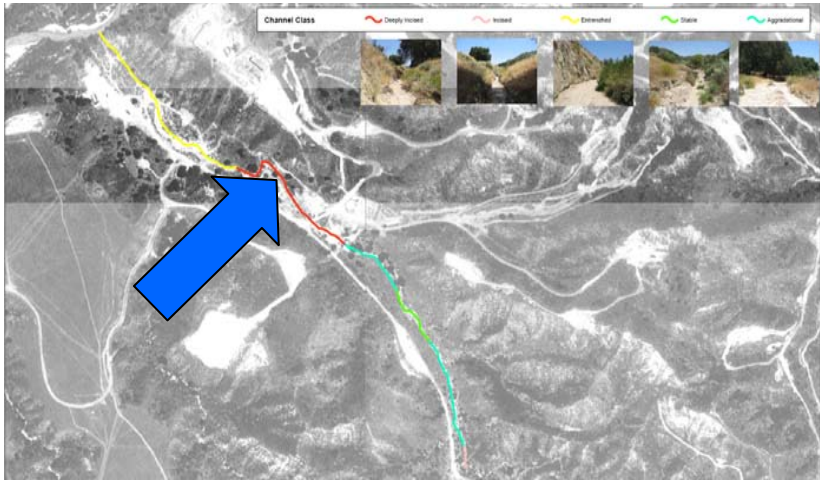
Deeply incised

Lion #15



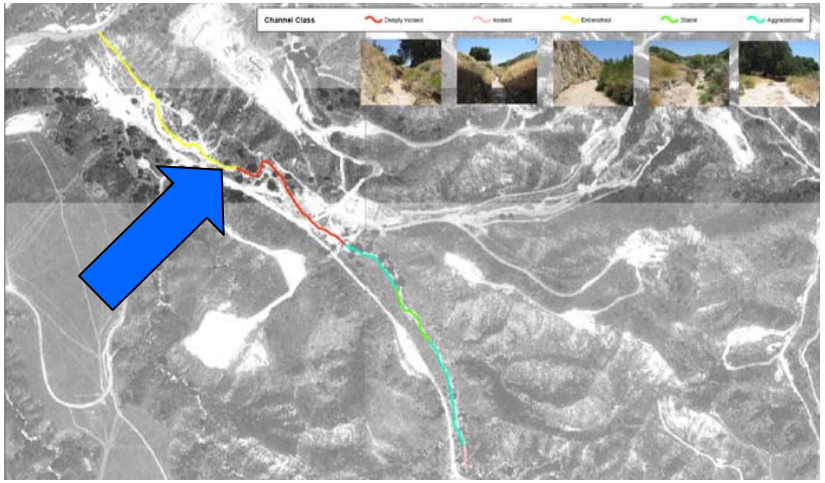
Deeply incised

Lion #16



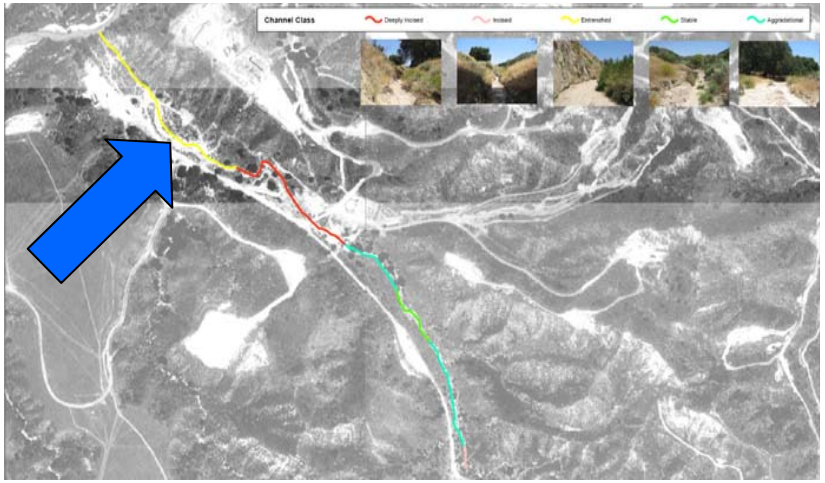
Deeply incised

Lion #17



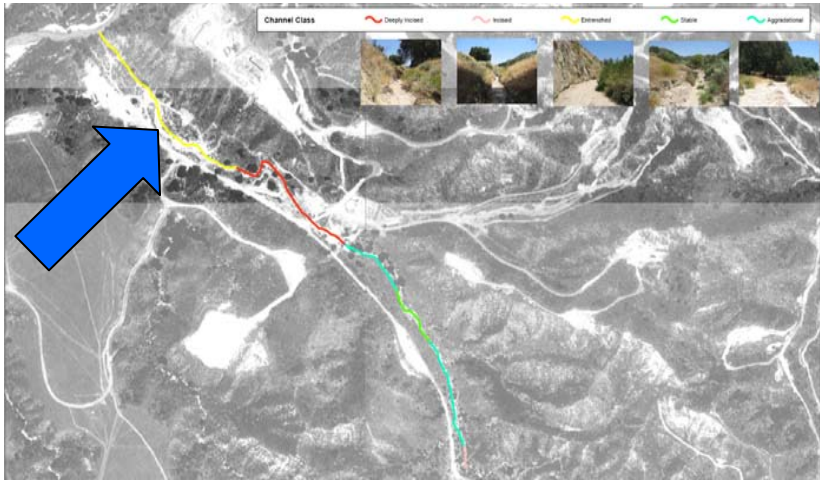
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #18



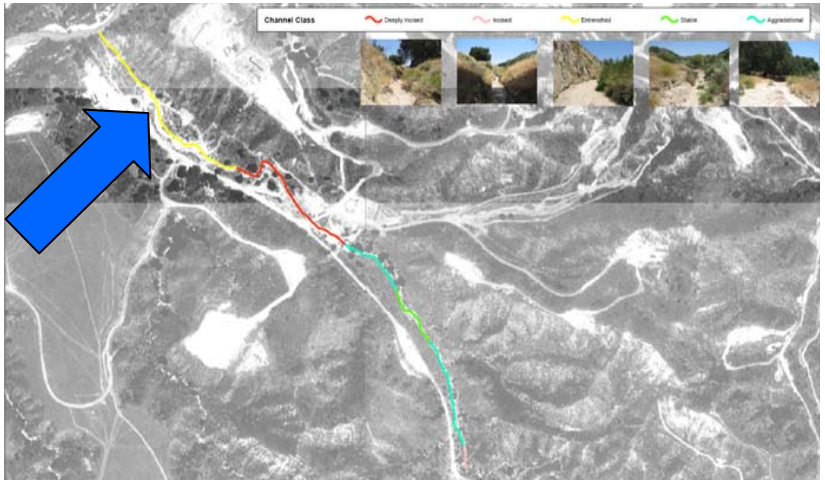
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #19



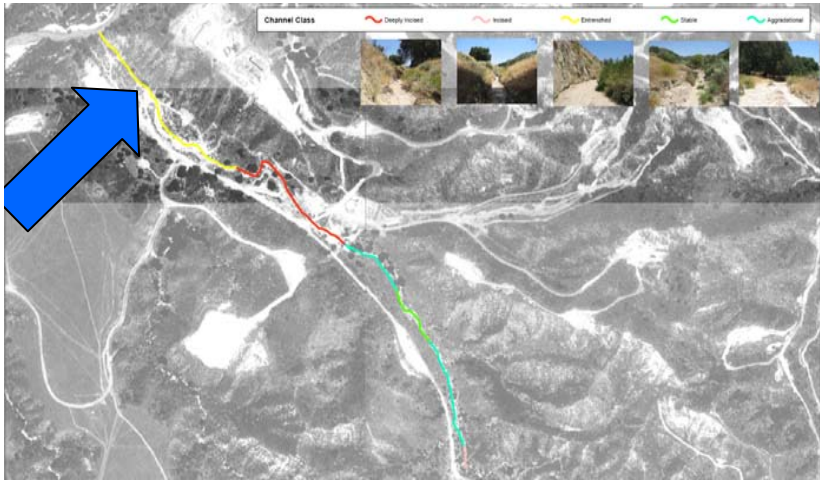
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #20



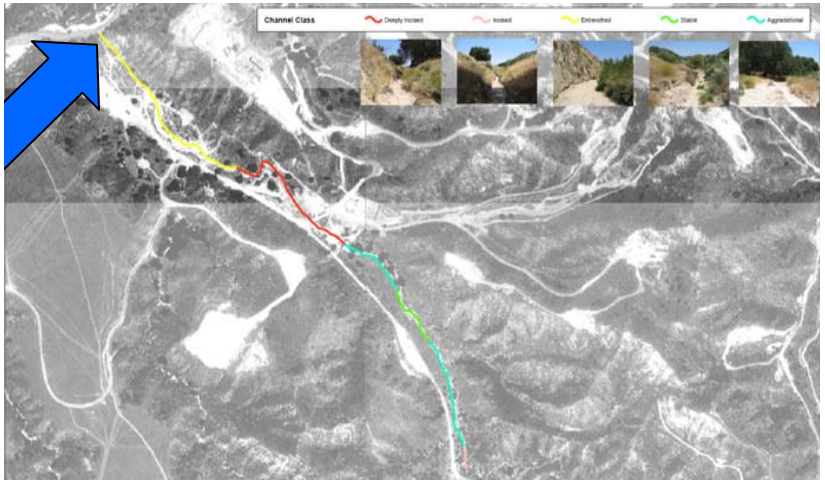
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

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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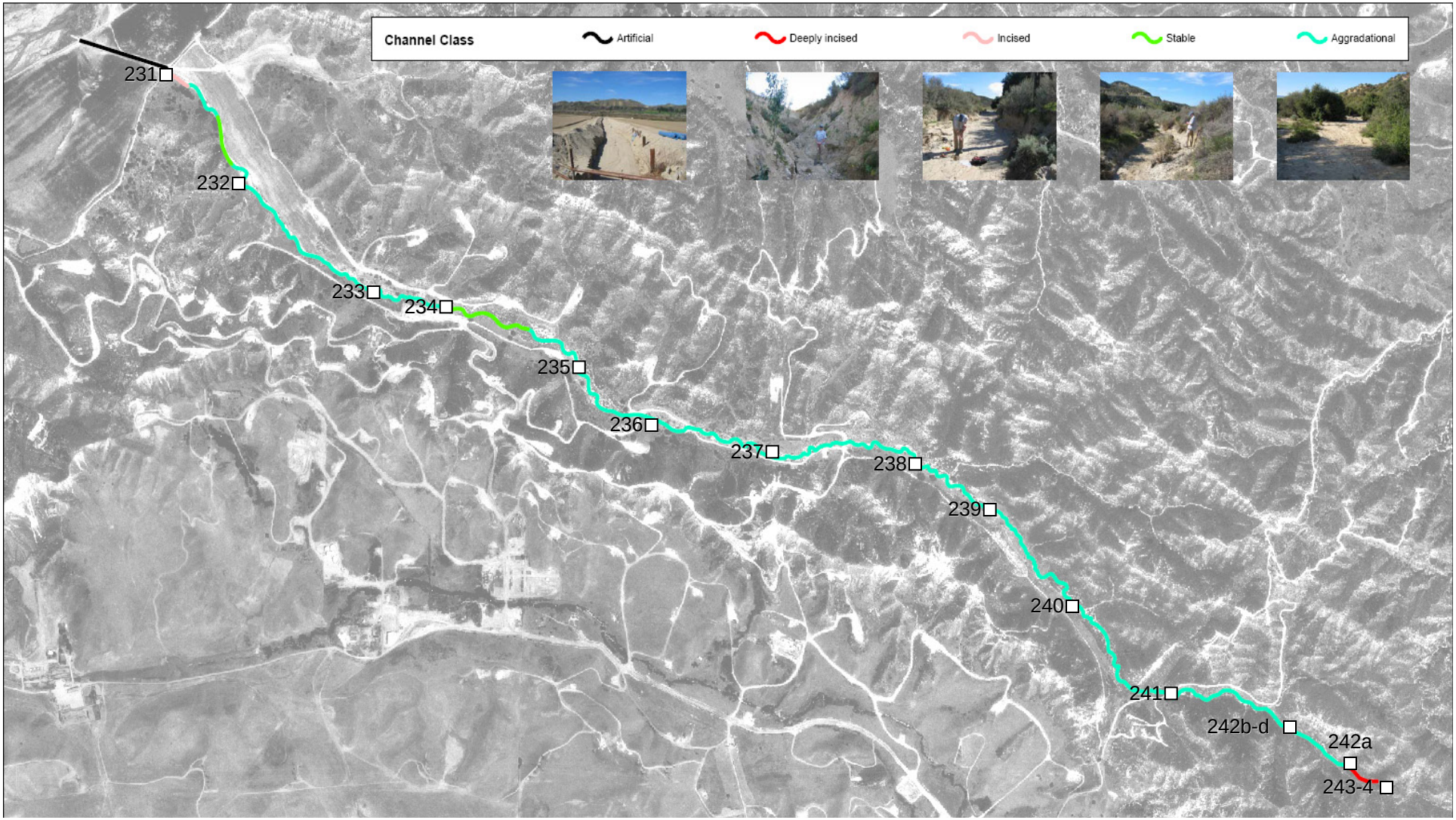
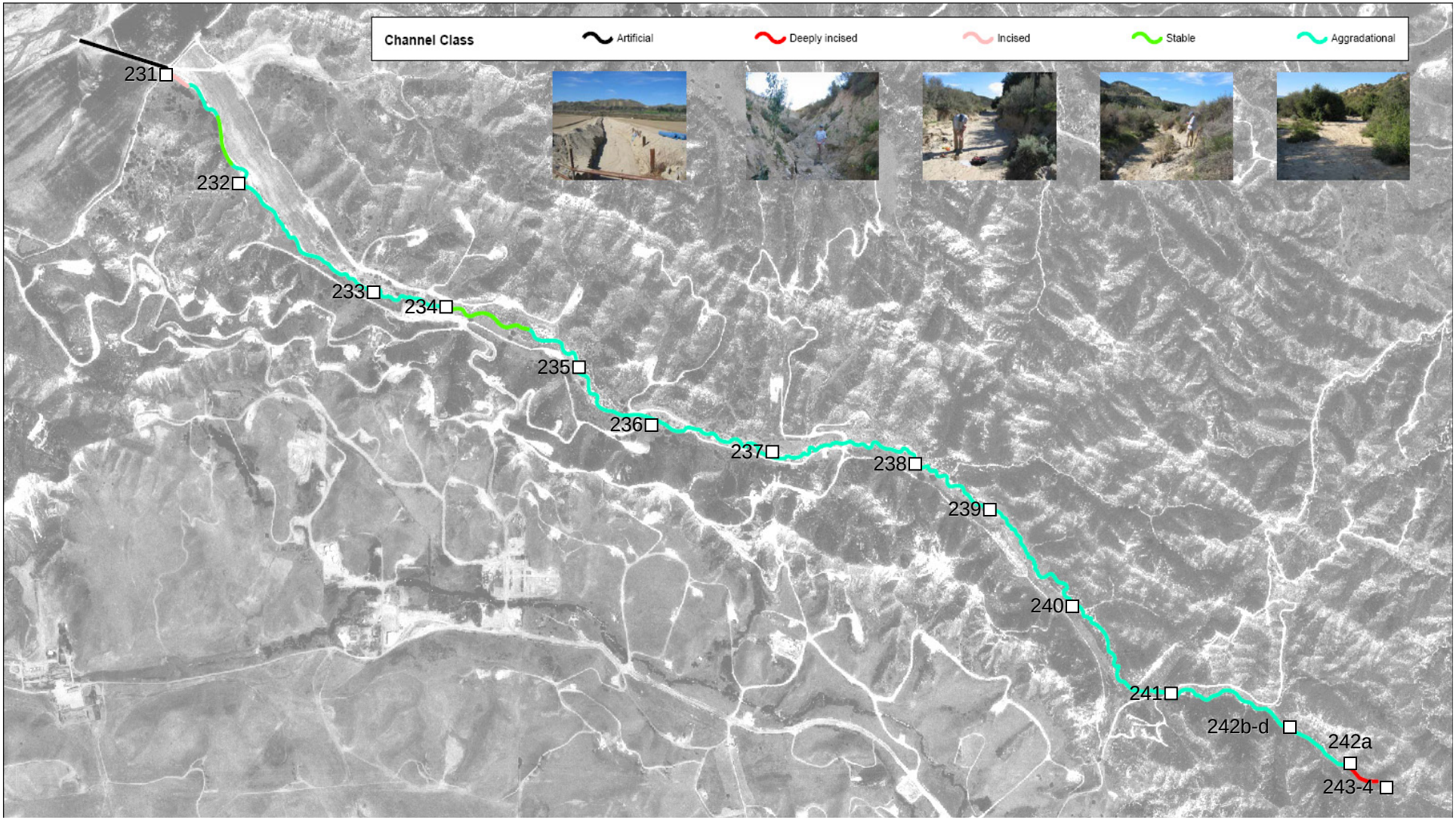
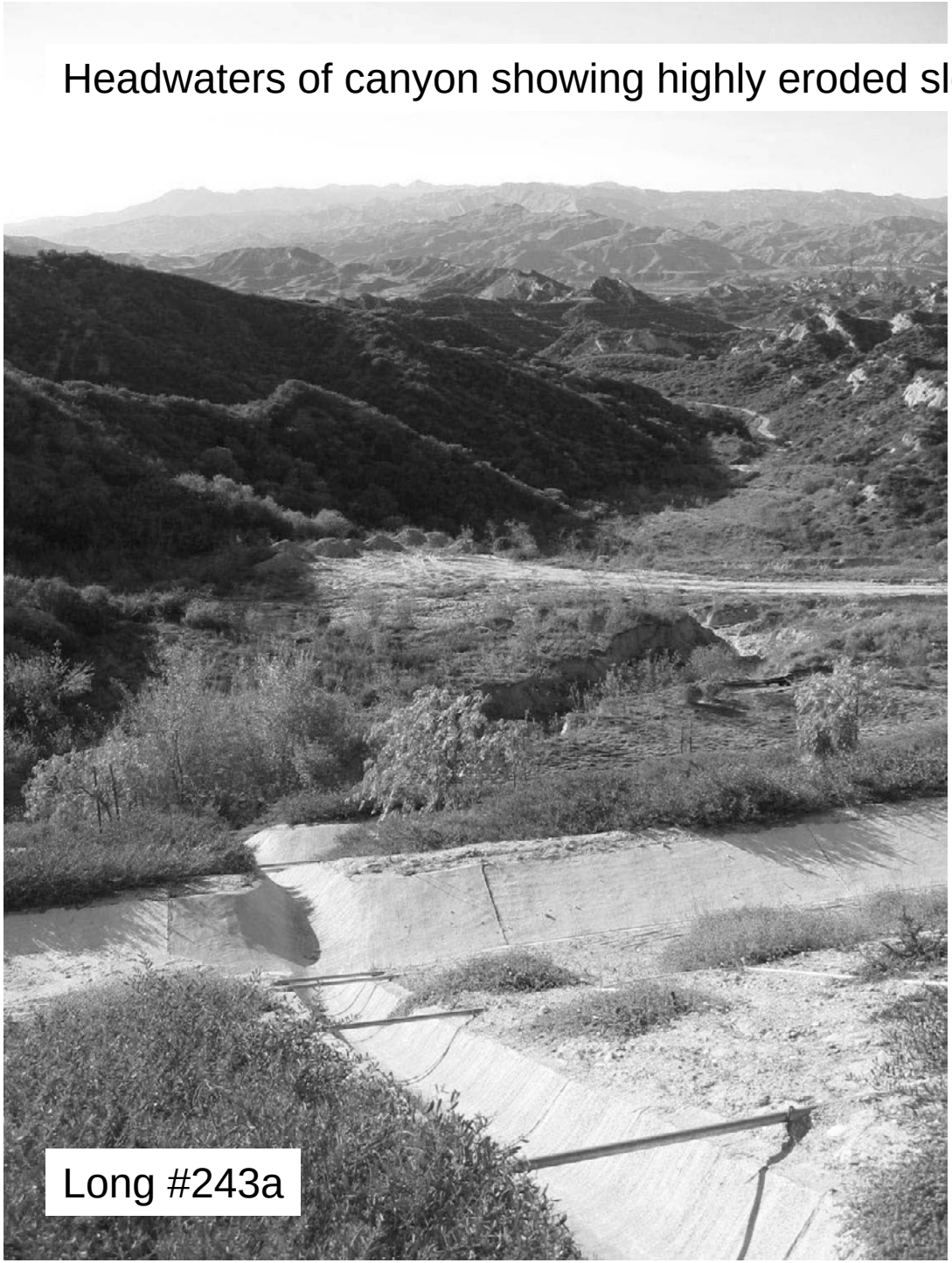


Reach Classification and Photo Points



Headwaters of canyon showing highly eroded slopes



Long #243a

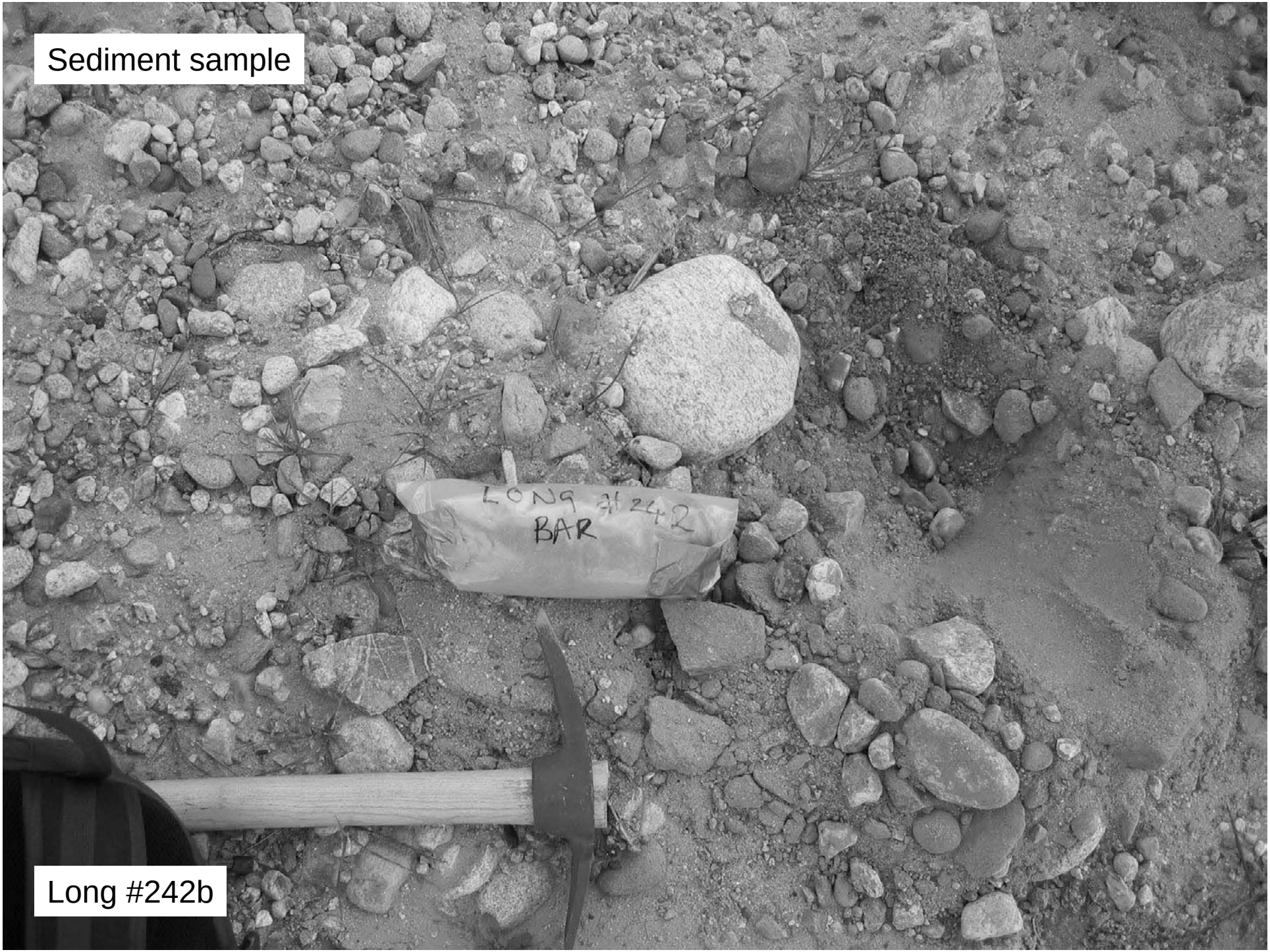
Deeply incised headwaters reach
Long #242a

Sediment sample
LONG #244
BED (Bank Same)
Long #244

Aggraded reach (upstream) with channel sediment being eroded by migrating headcut from downstream reach
Long #us_242d

Aggraded reach
Long #242d

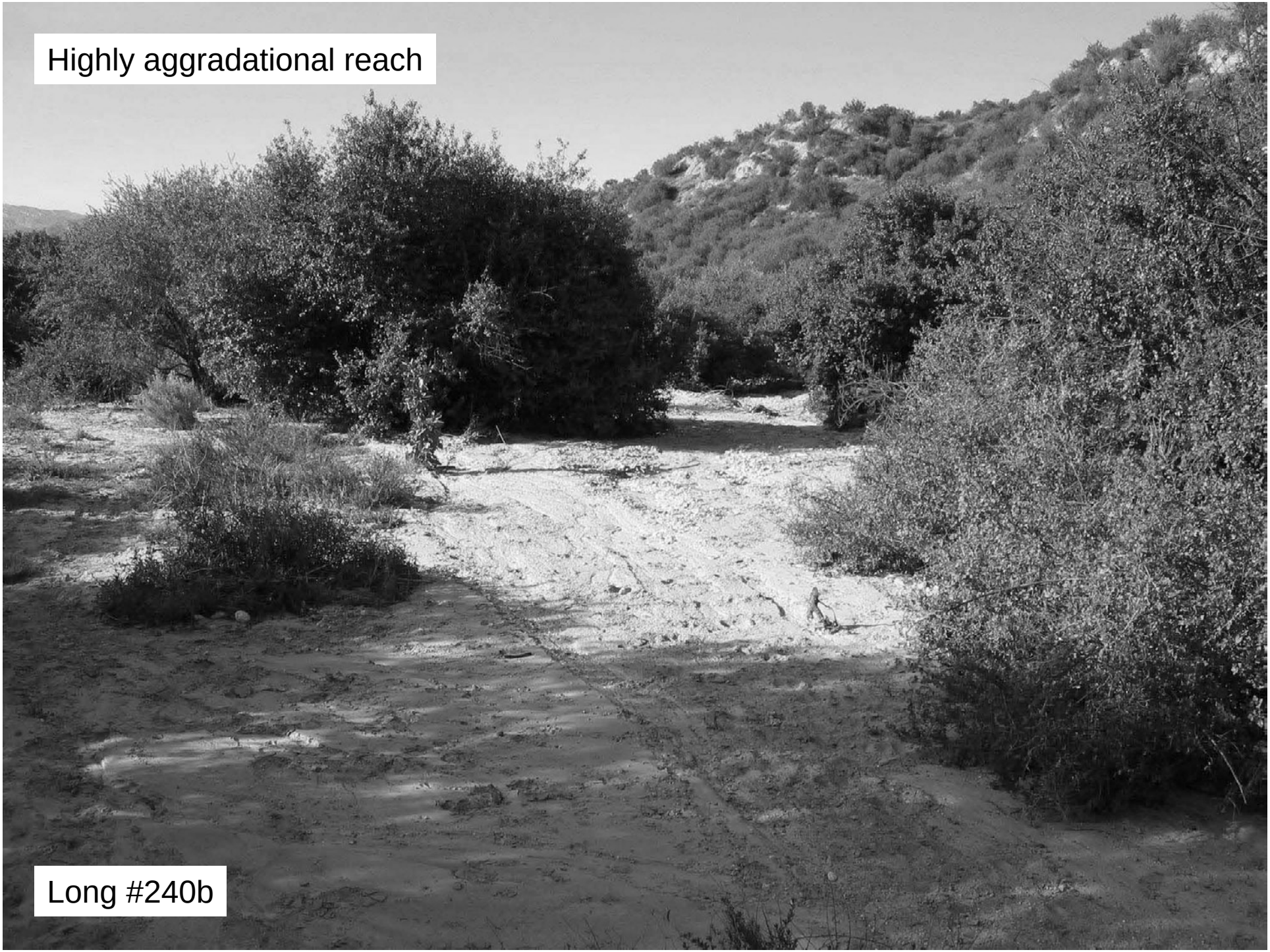
Aggraded reach in historically entrenched section
Long #242c


Sediment sample
LONG #242
BAR
Long #242b

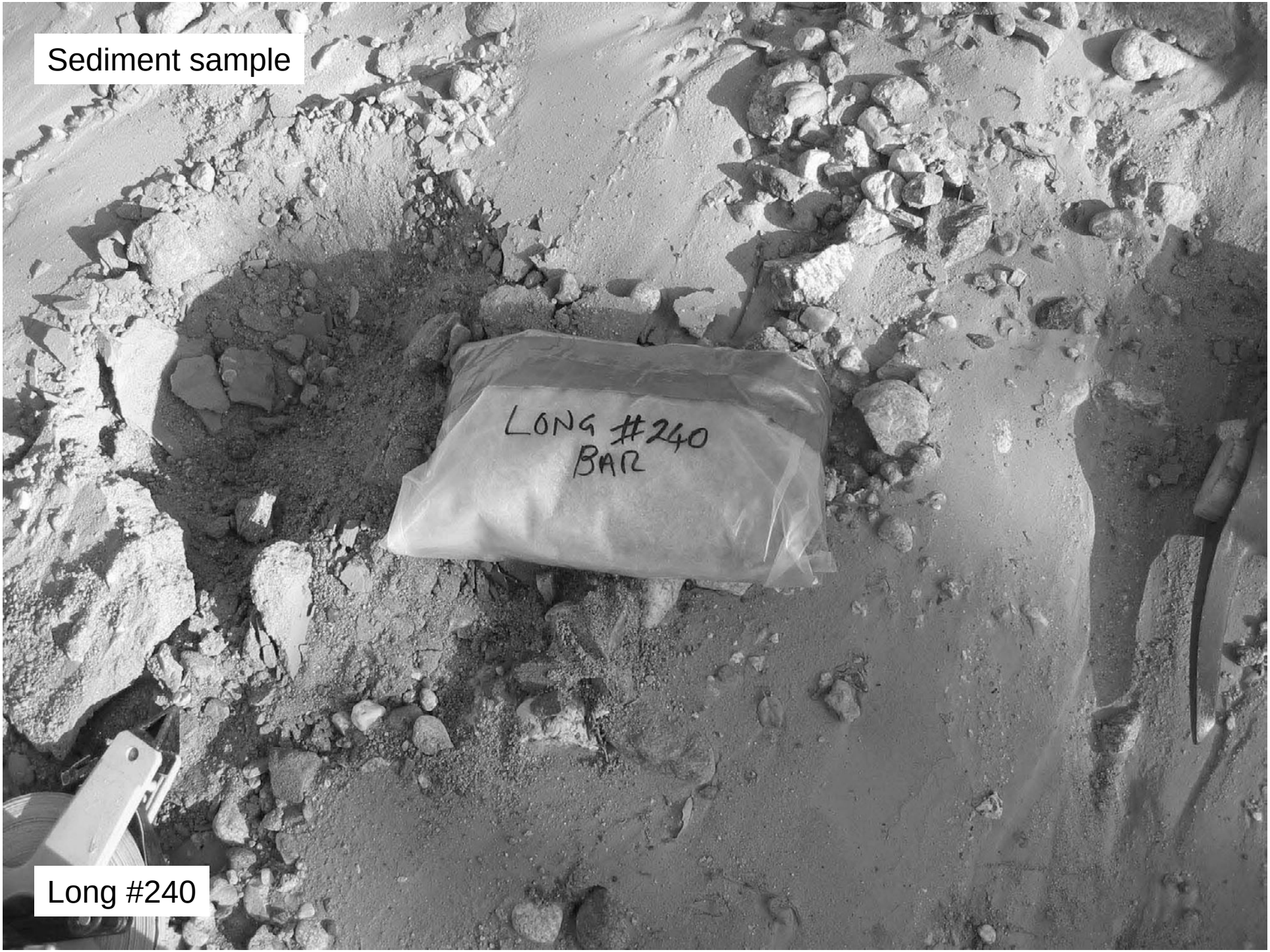
Narrow, slightly entrenched reach showing recent aggradation
Long #241c

Narrow, slightly incised reach showing recent aggradation
Long #241b

Sediment sample
LONG #241
BAR
Long #241


Highly aggradational reach
Long #240b

Highly aggradational reach
Long #240a

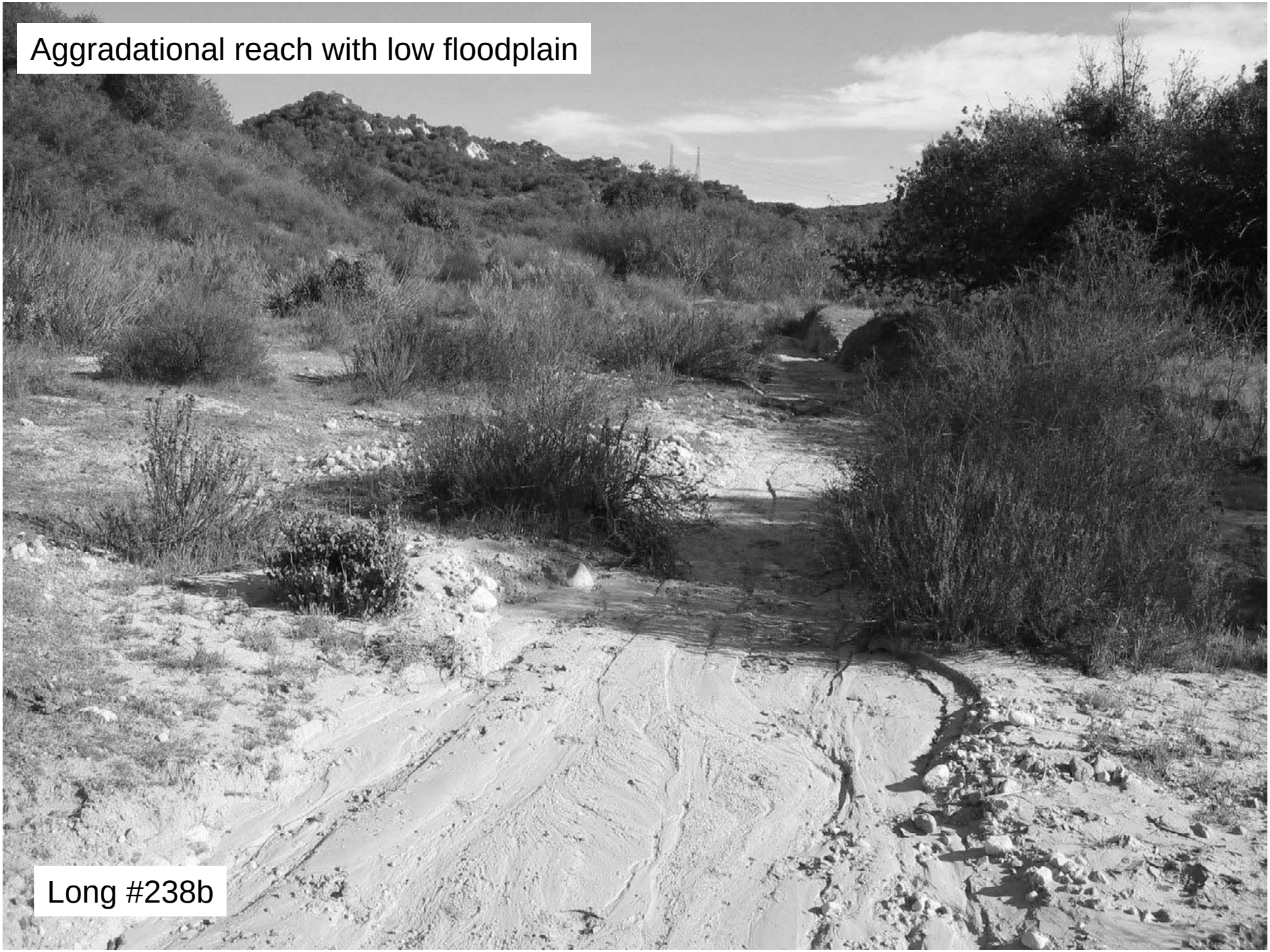

Sediment sample
LONG #240
BAR
Long #240

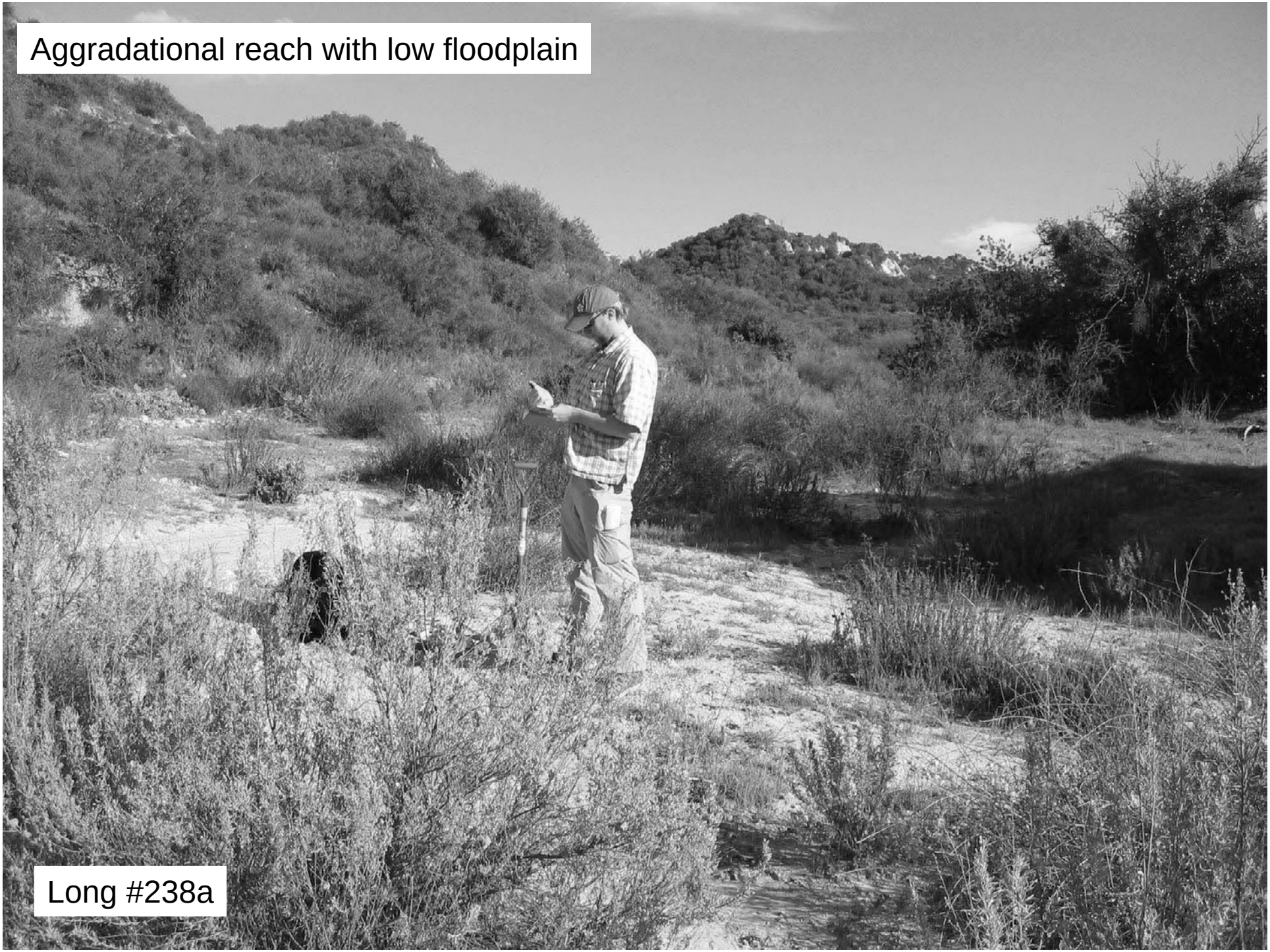
Entrenched reach with recent aggradation
Long #239b

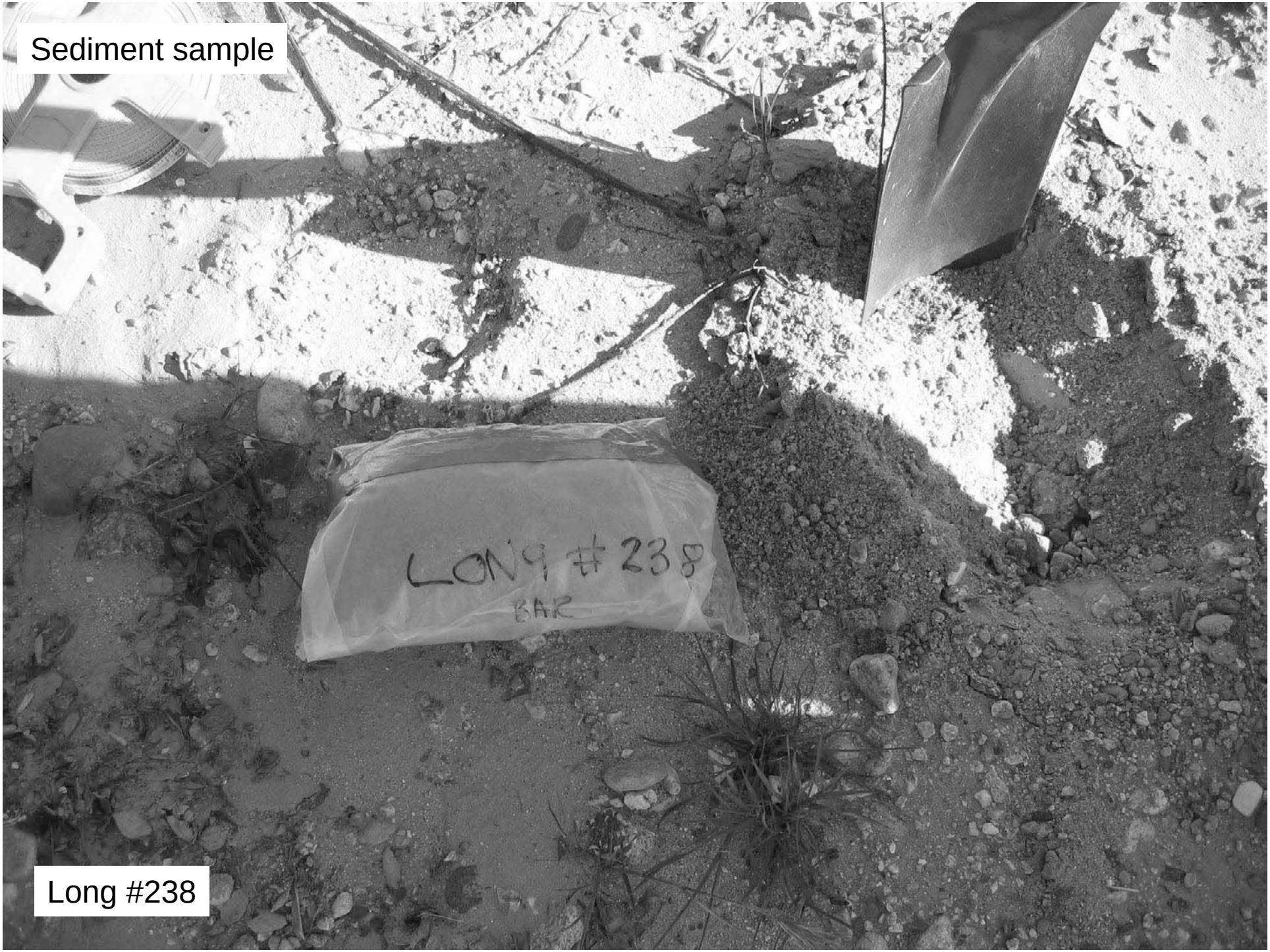
Entrenched reach with recent channel aggradation
Long #239a

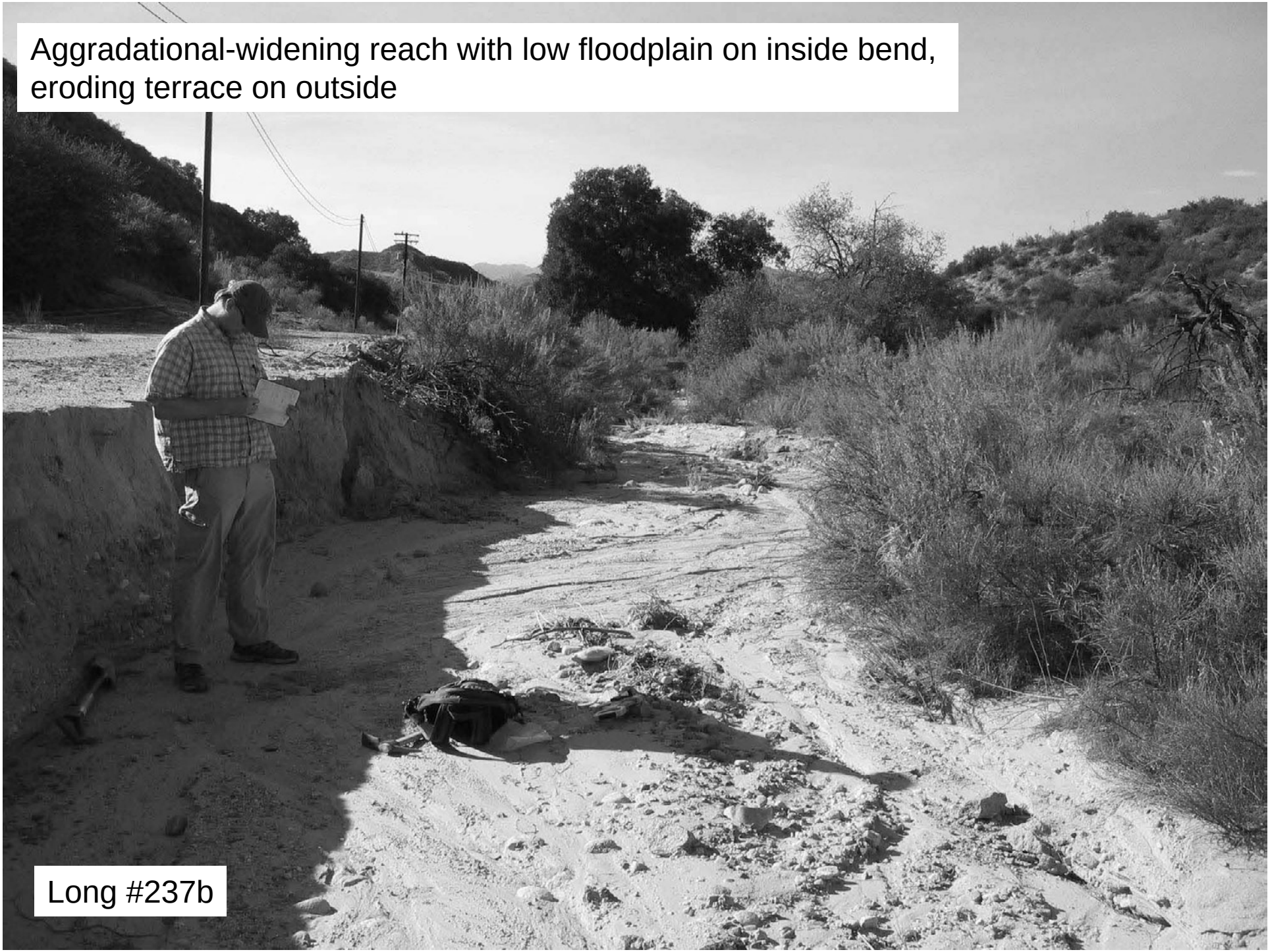
Sediment sample
LONG #239
BAR
Long #239

Aggradational reach with low floodplain
Long #238c

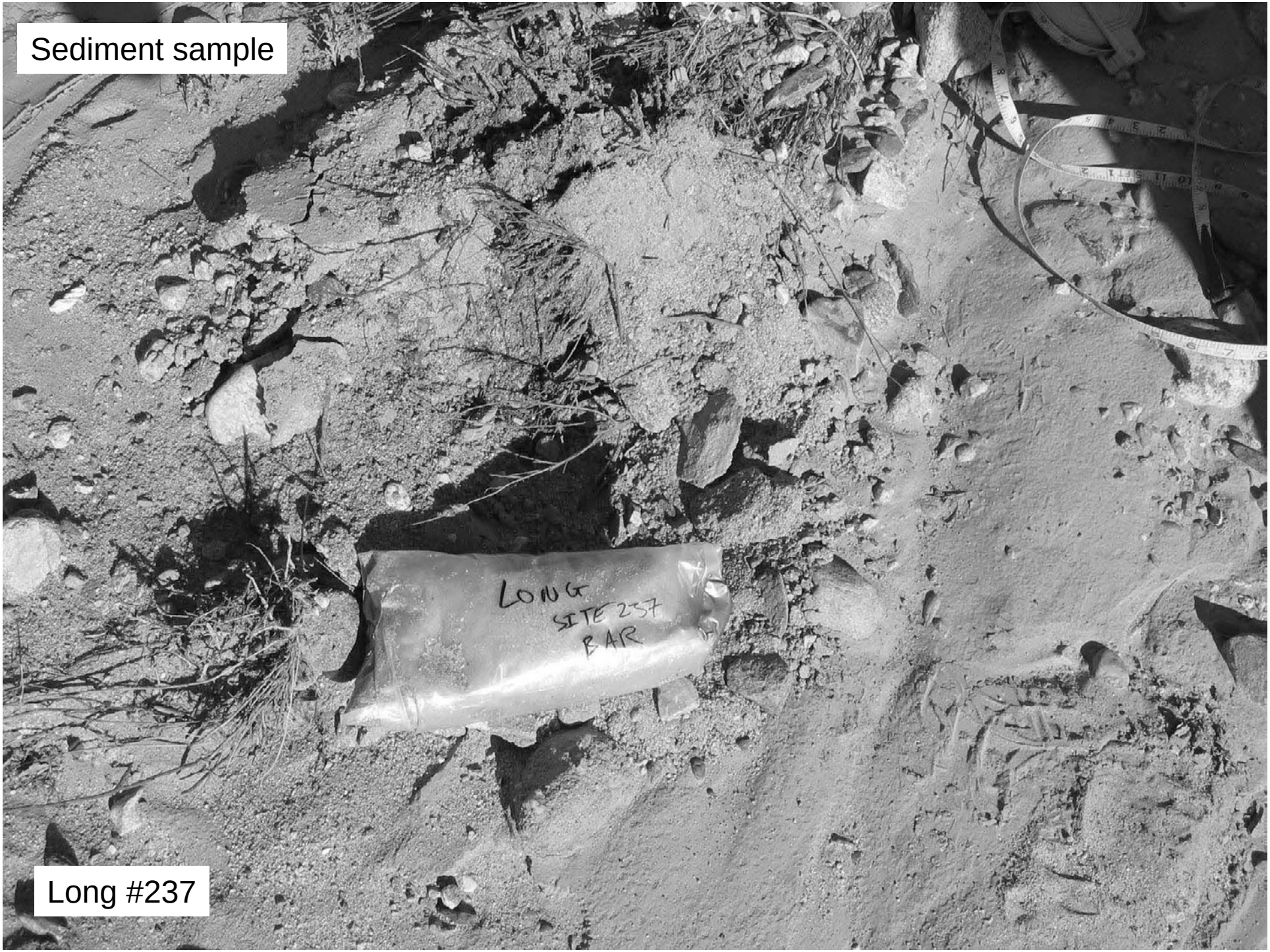

Aggradational reach with low floodplain
Long #238b


Aggradational reach with low floodplain
Long #238a


Sediment sample
LONG #238
BAR
Long #238

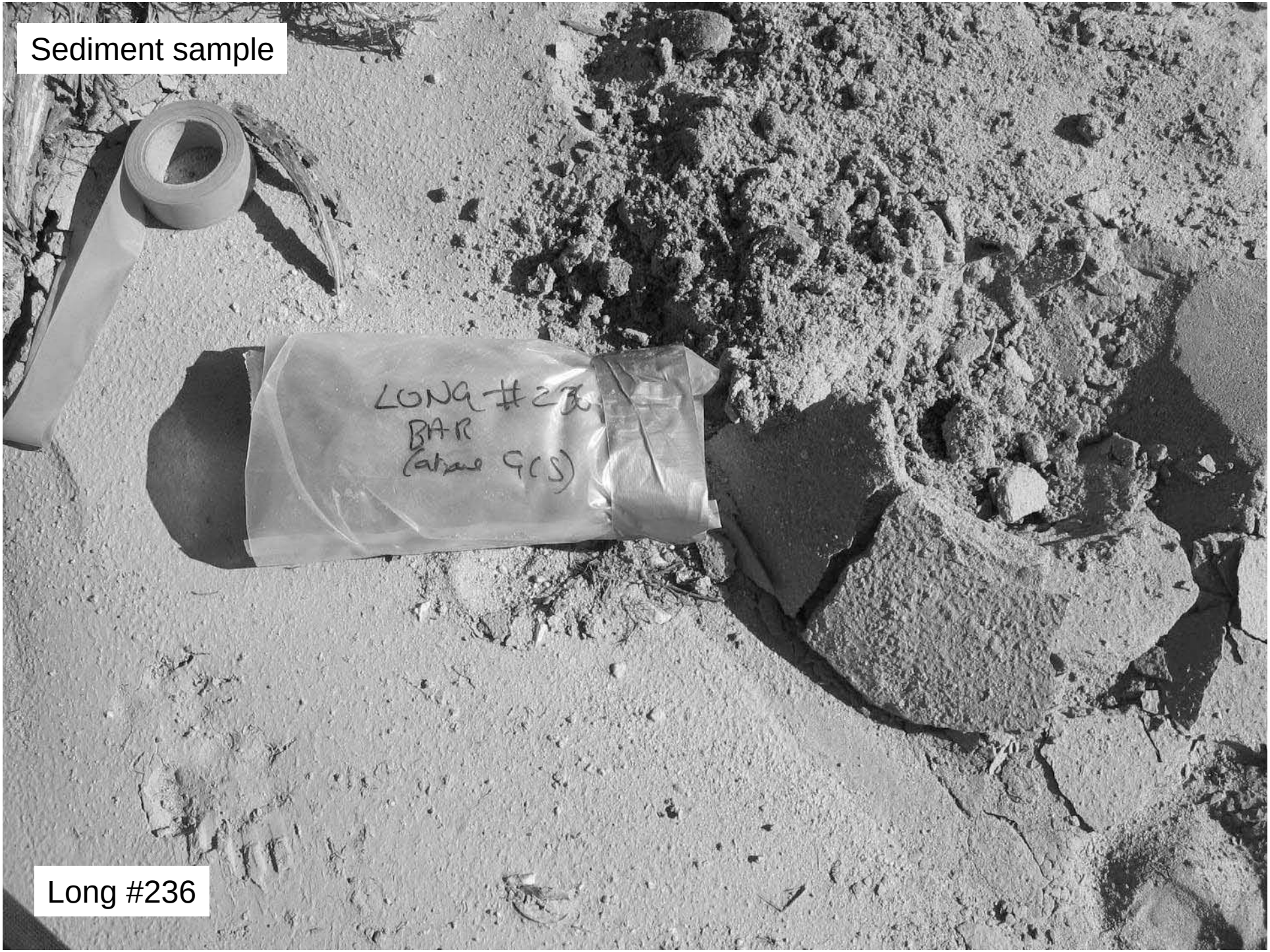

Aggradational-widening reach with low floodplain on inside bend, eroding terrace on outside
Long #237b

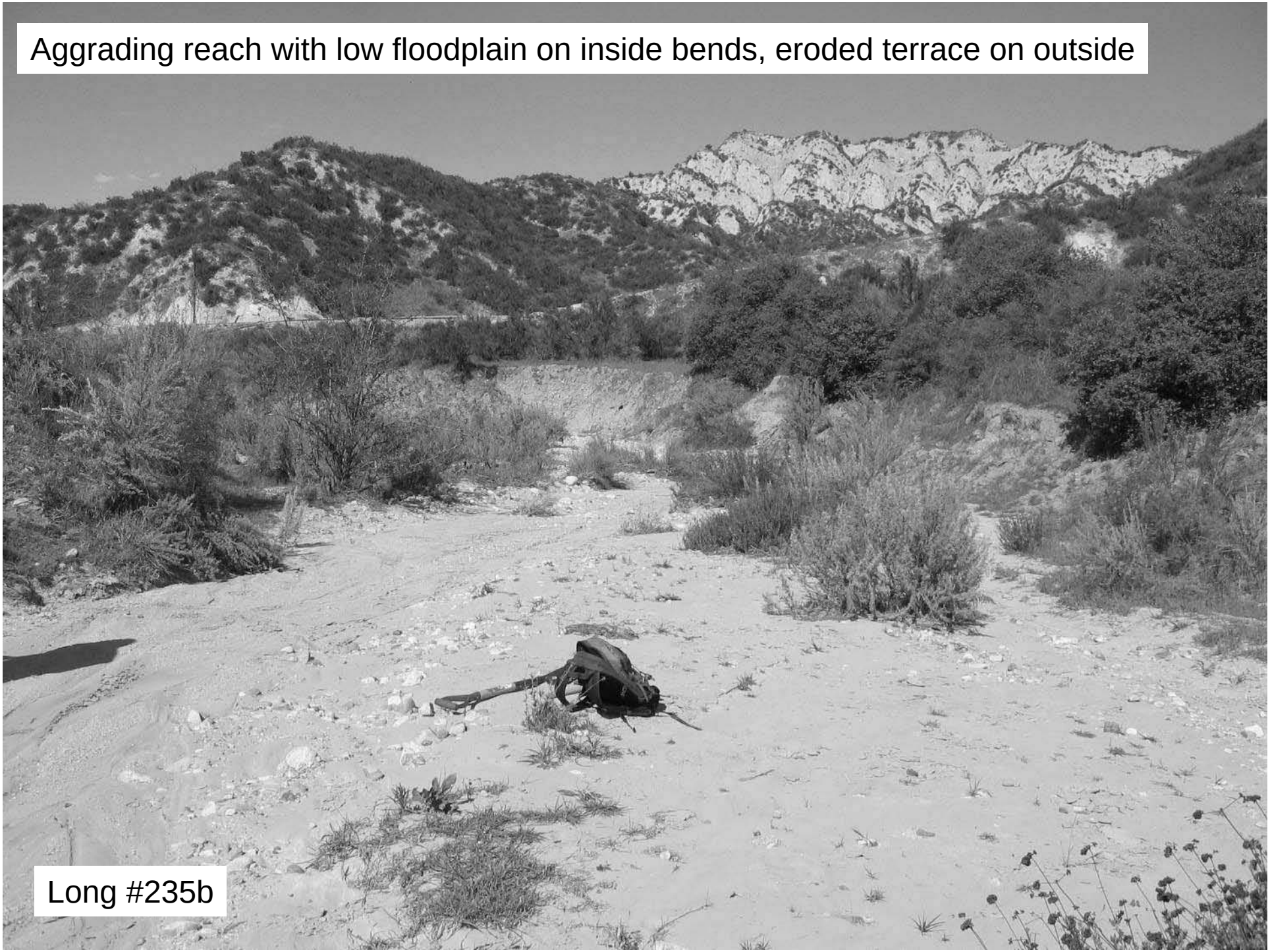
Aggradational-widening reach with low floodplain on inside bend, eroding terrace on outside
Long #237a


Sediment sample
LONG
SITE 237
BAR
Long #237

Aggrading reach with low floodplain
Long #236b

Aggrading reach with low floodplain
Long #236a

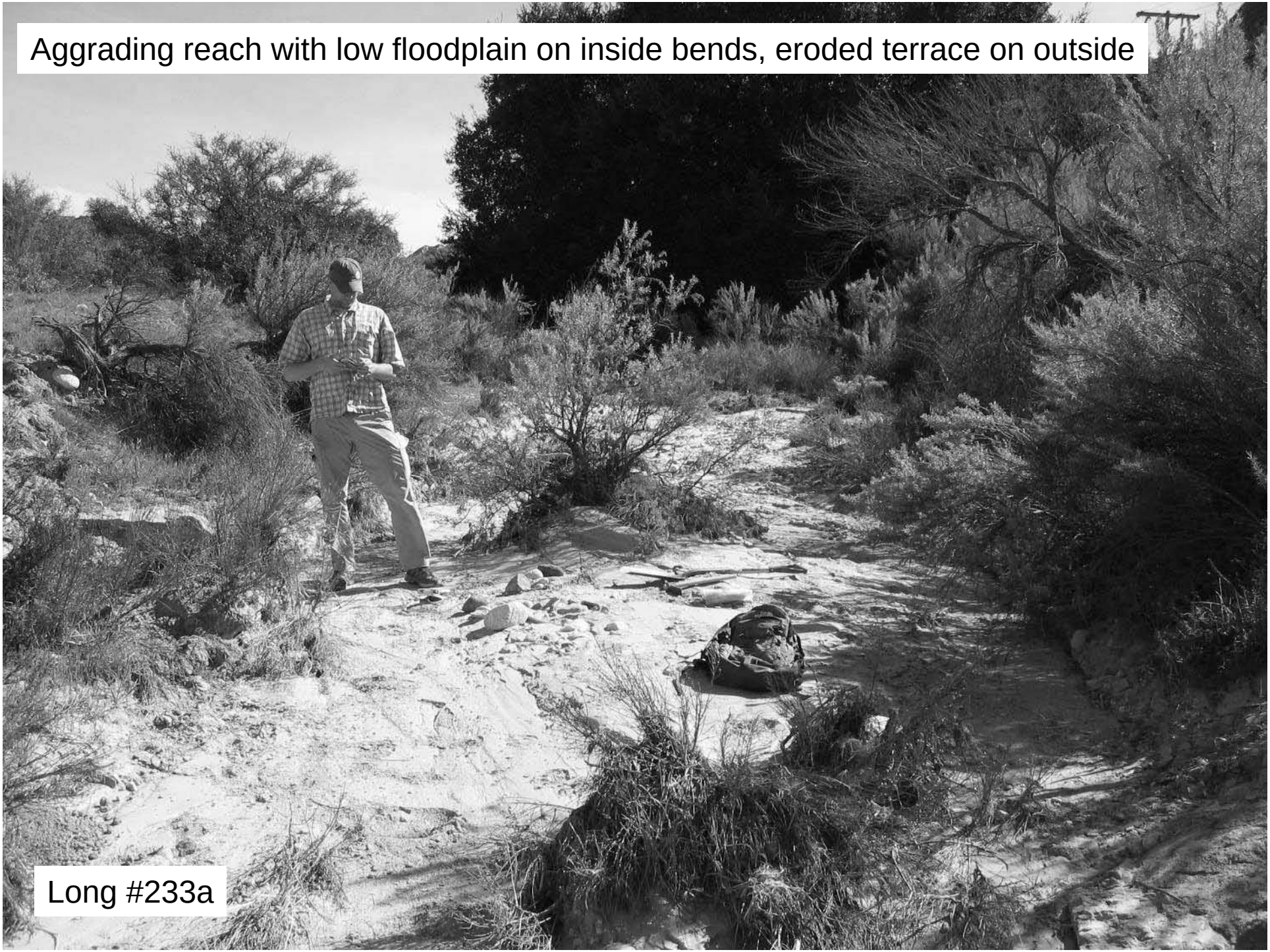

Sediment sample
LONG #236
BAR
(above 9(S)
Long #236


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

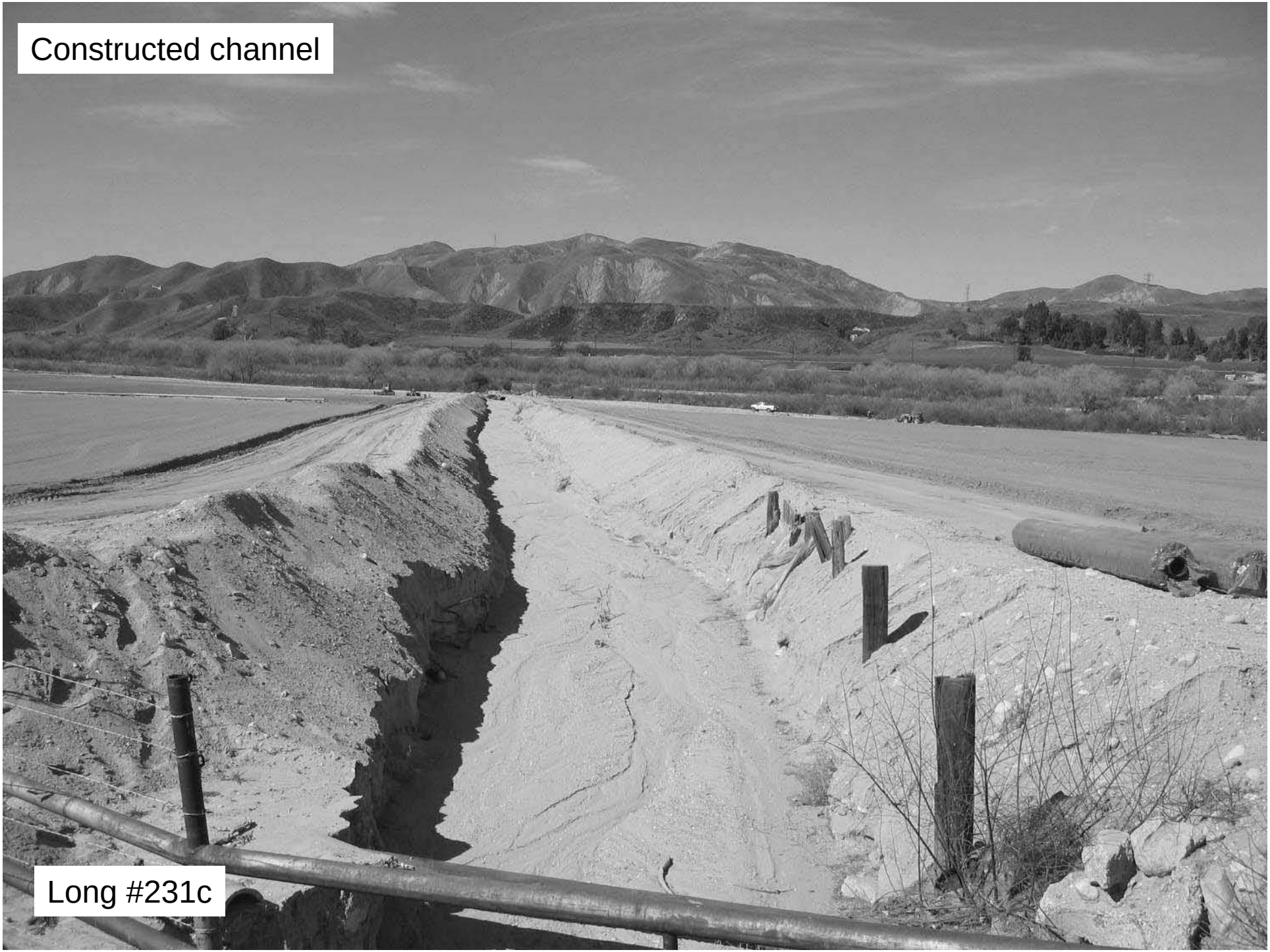
Aggrading reach with low floodplain on inside bends, laterally eroded terrace on outside
Long #233b

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

Geomorphic Reconnaissance

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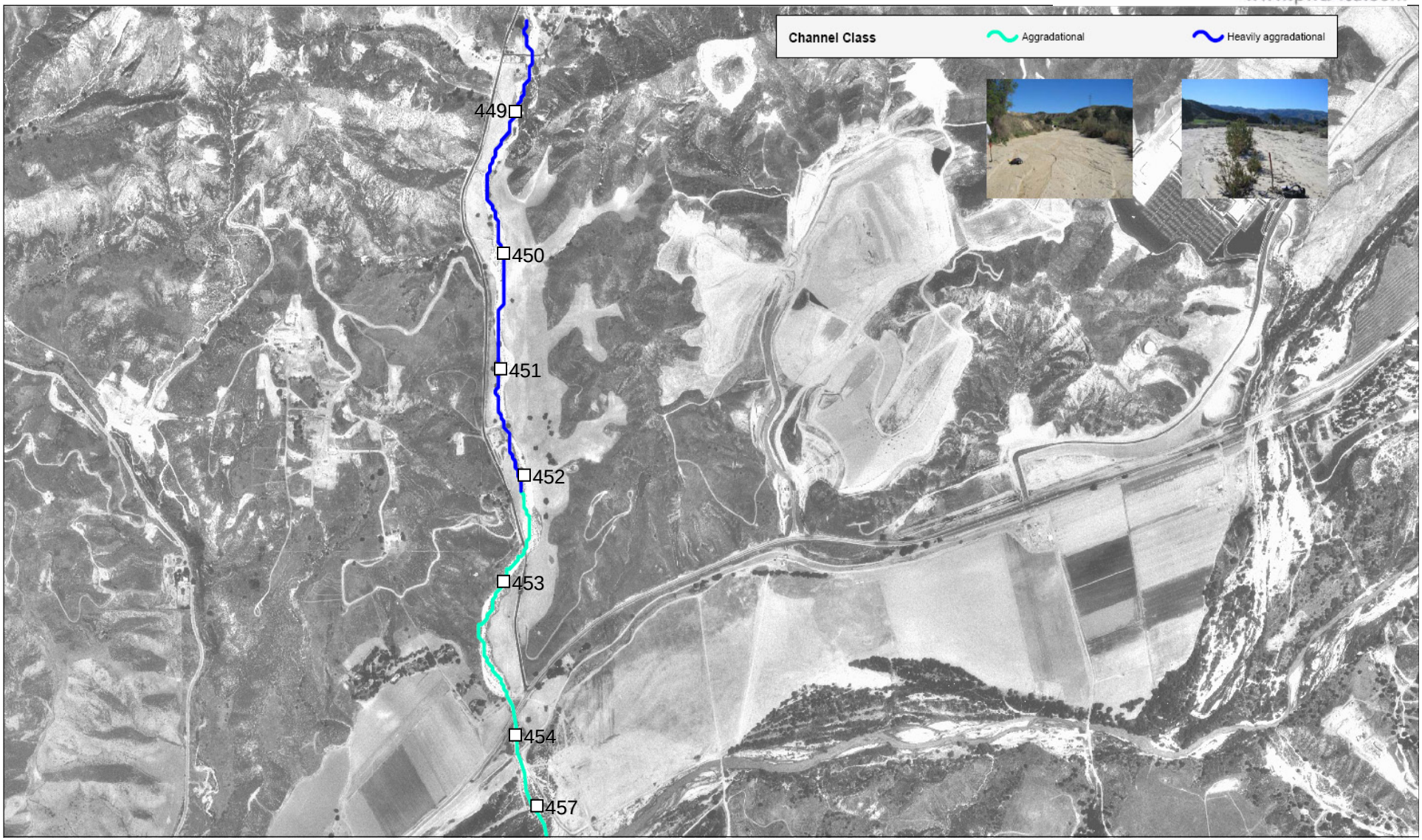

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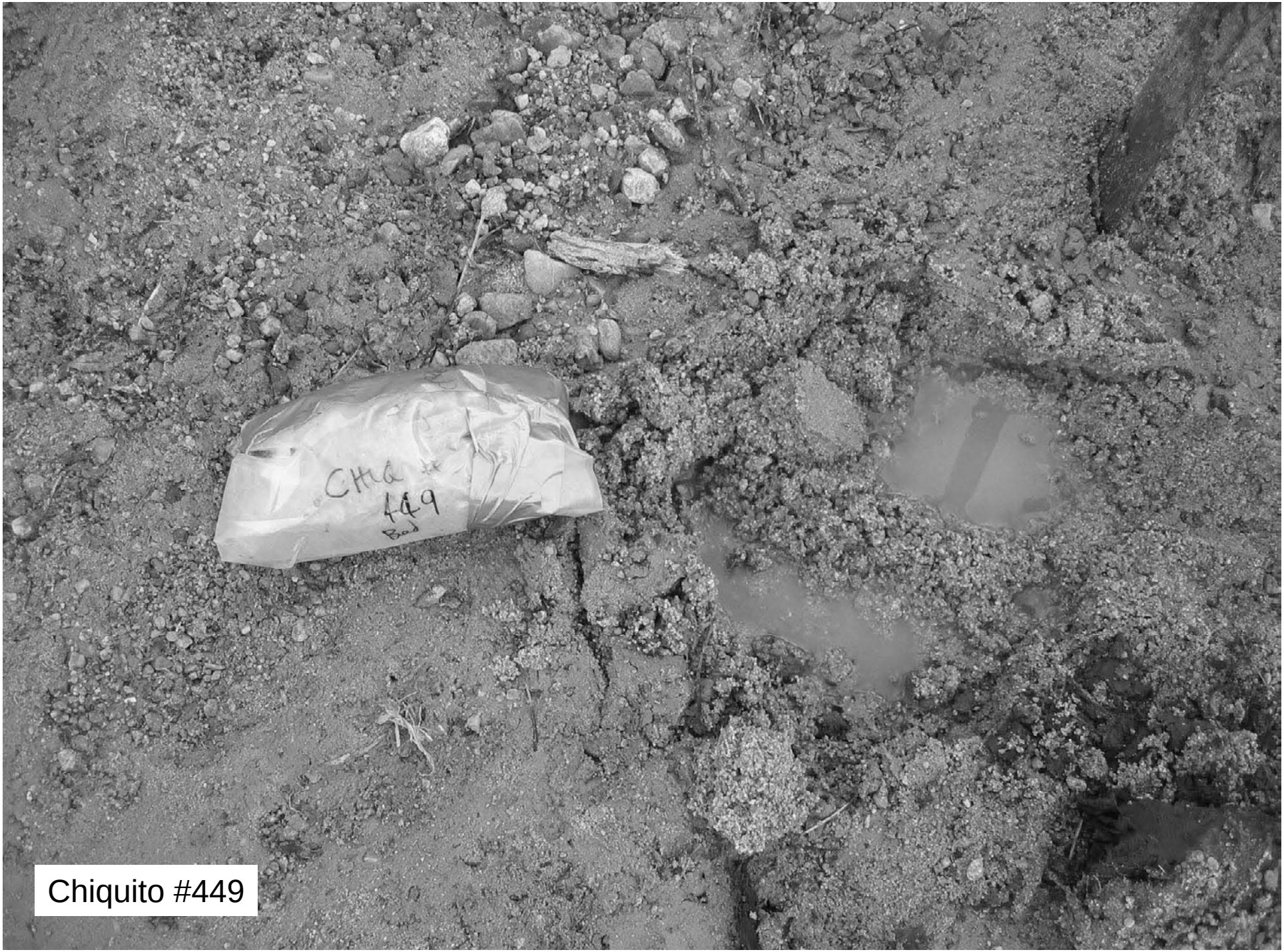
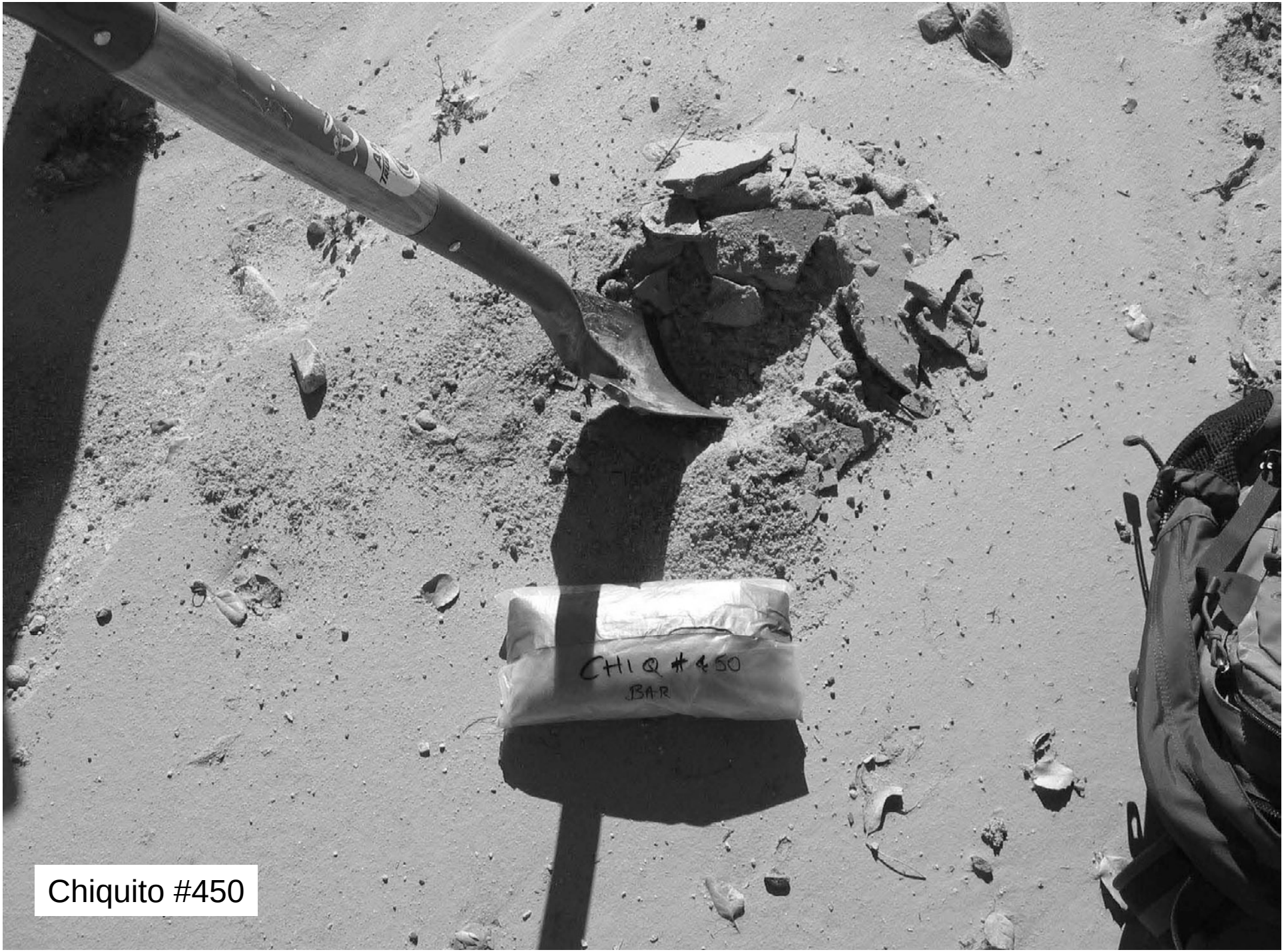


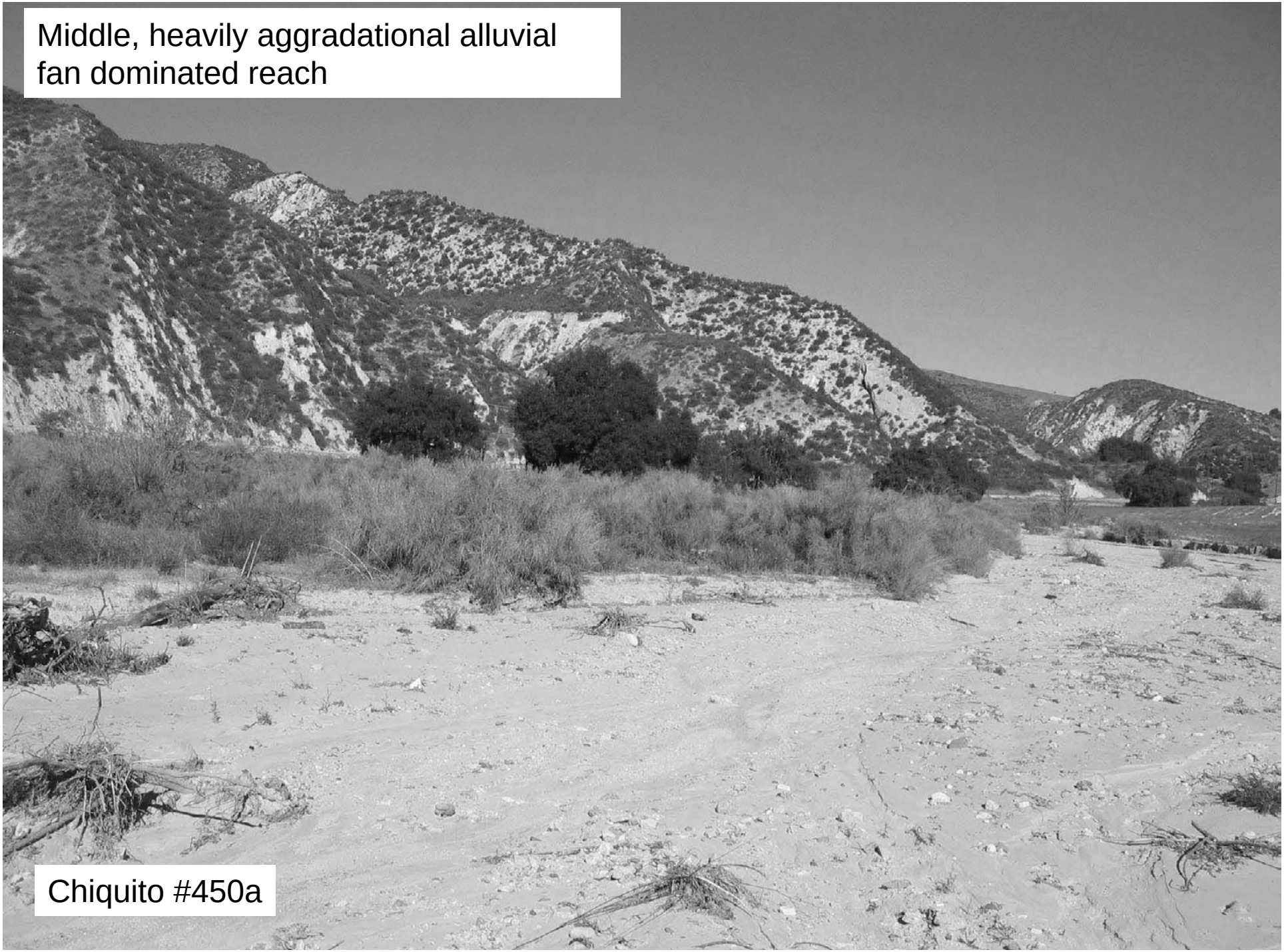
Chiquito #449

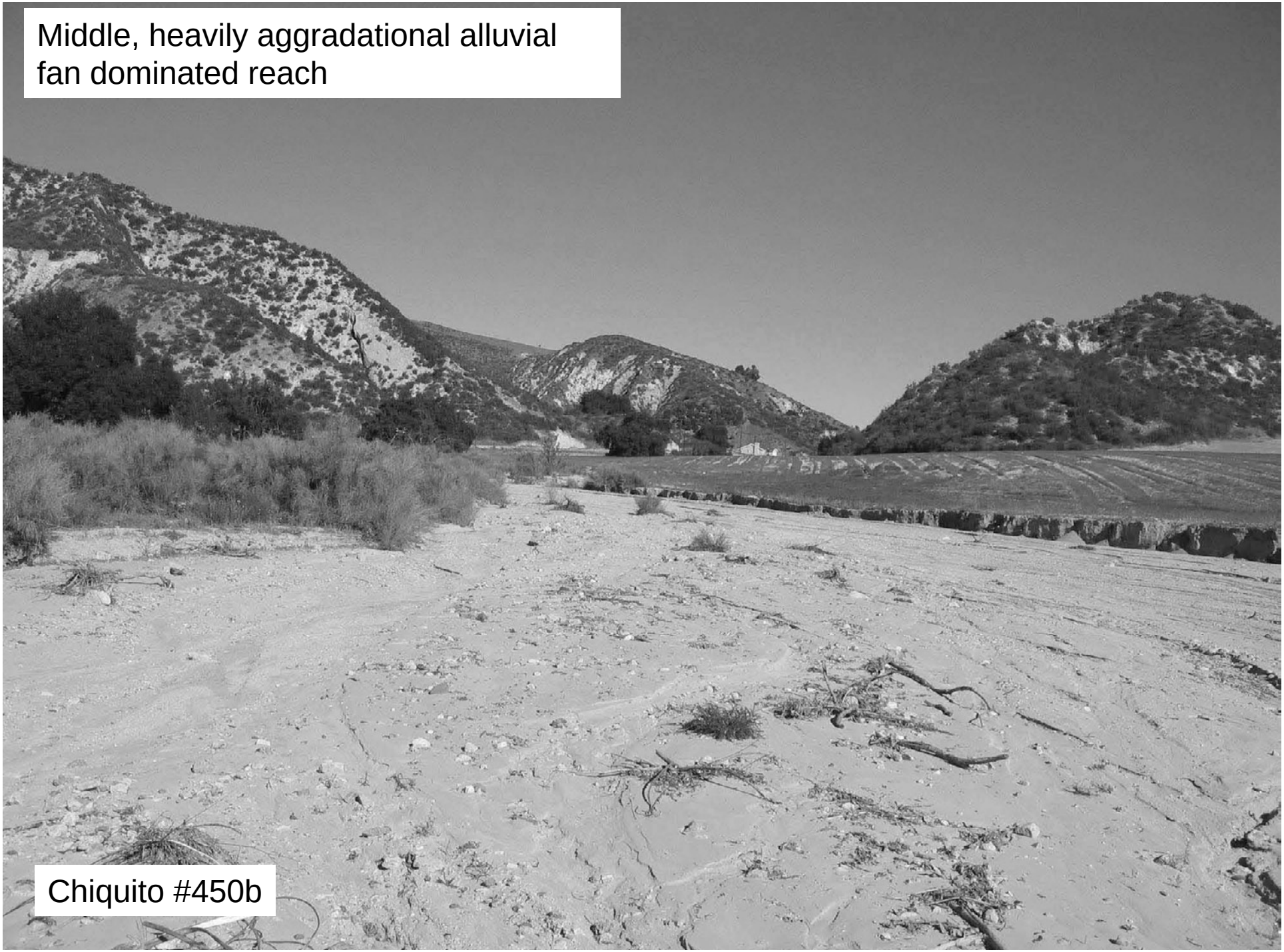
Bed sample

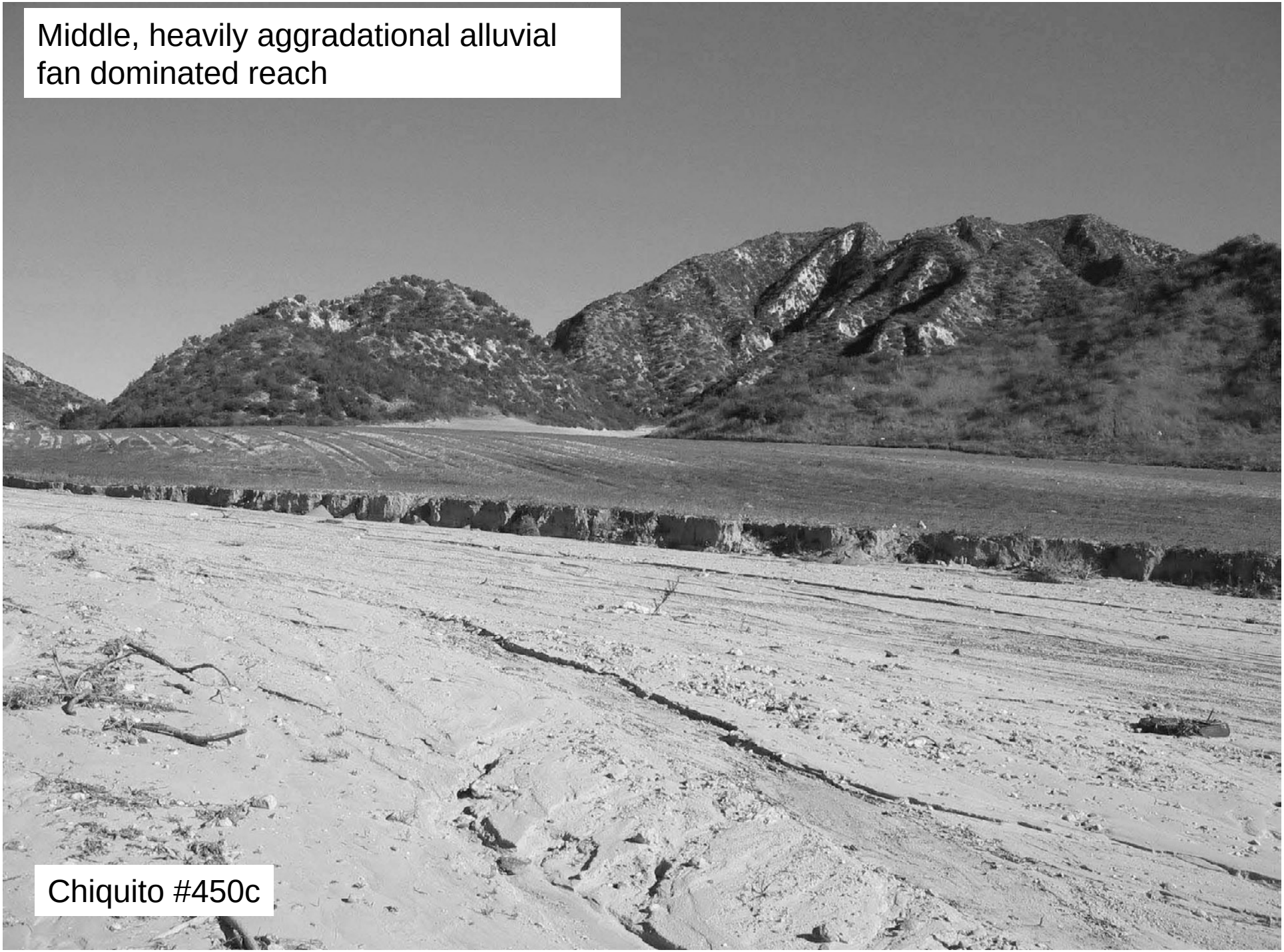
Slightly confined upper reach
Chiquito #449b

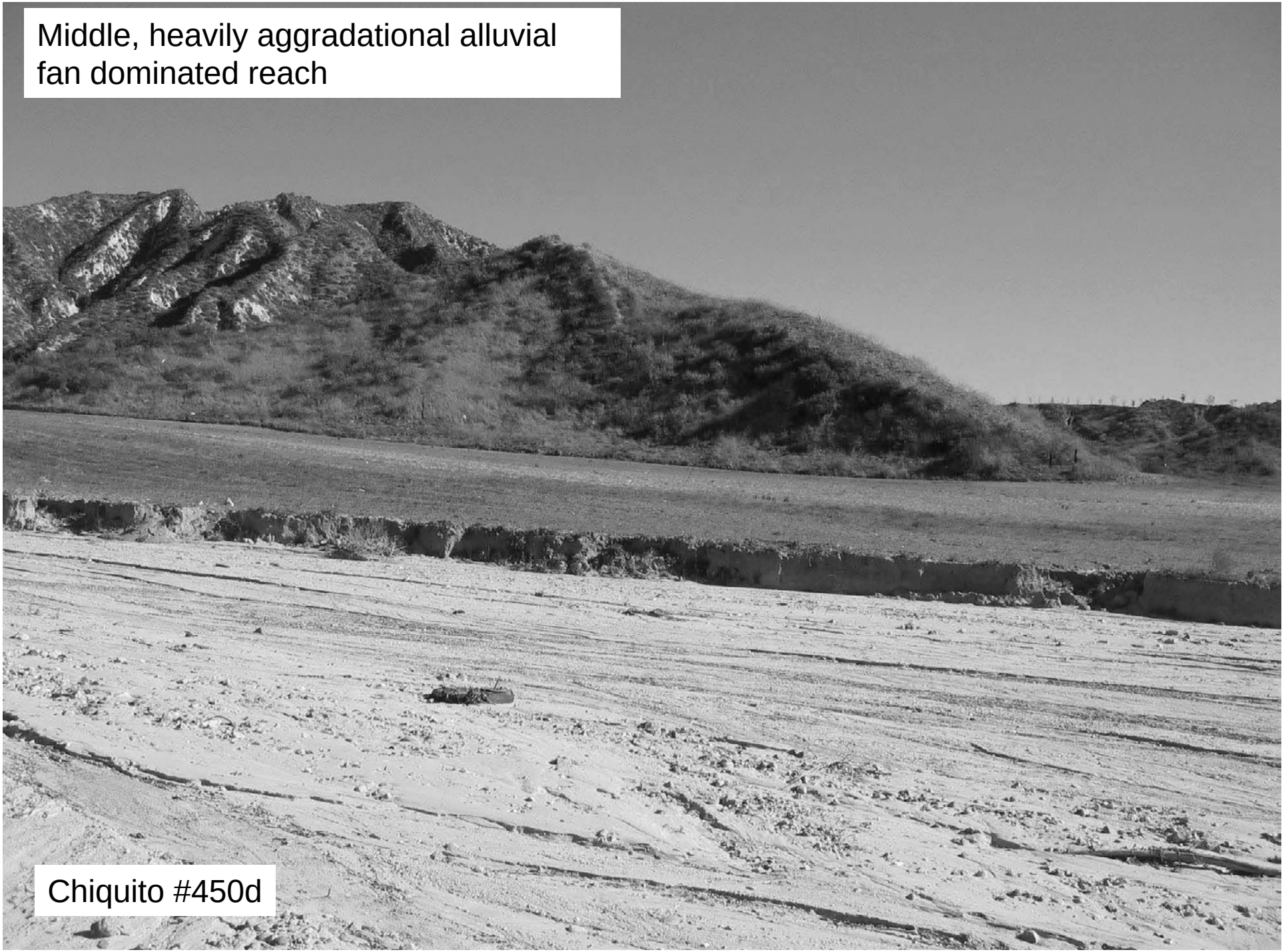


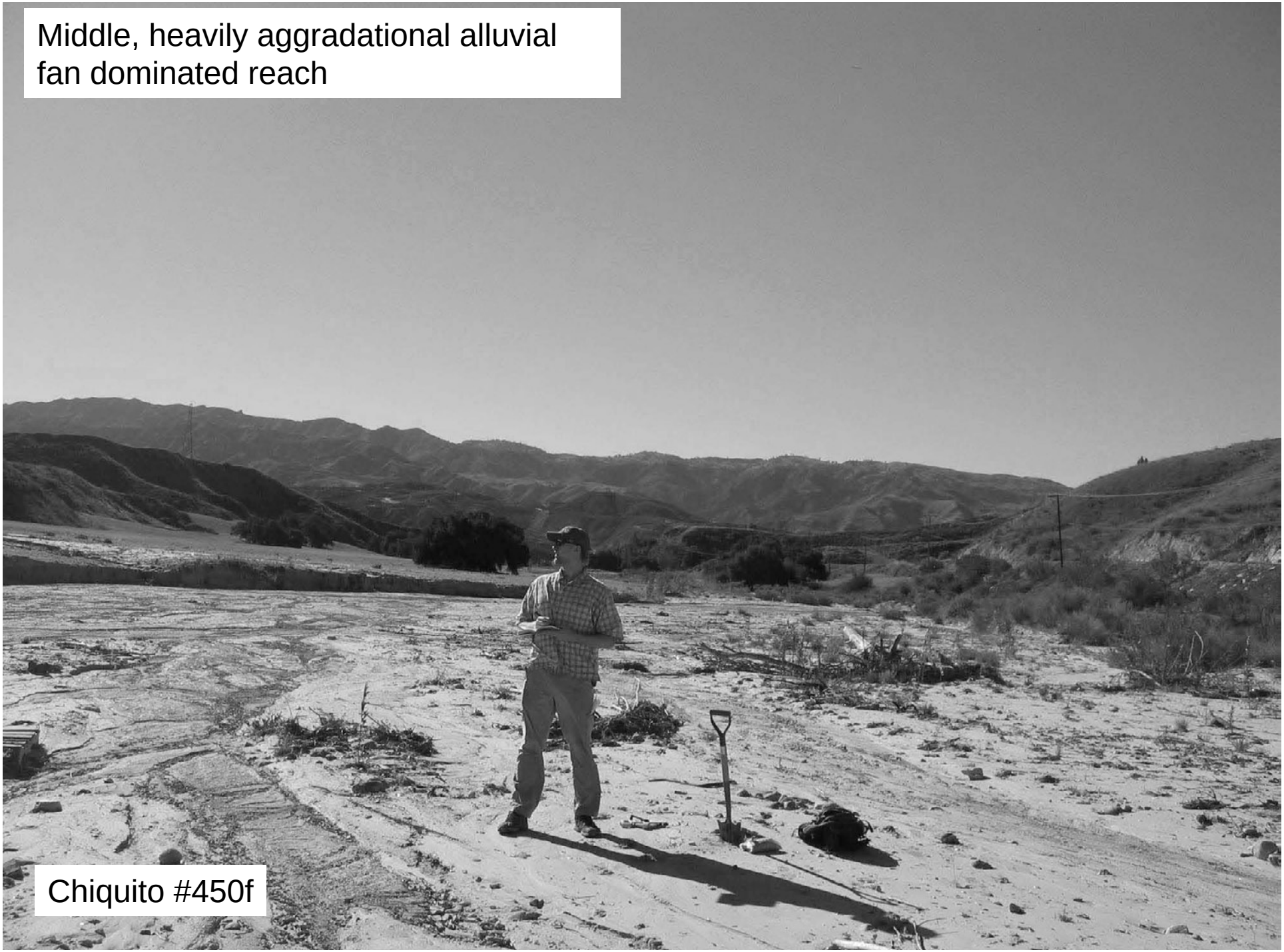
Chiquito #450

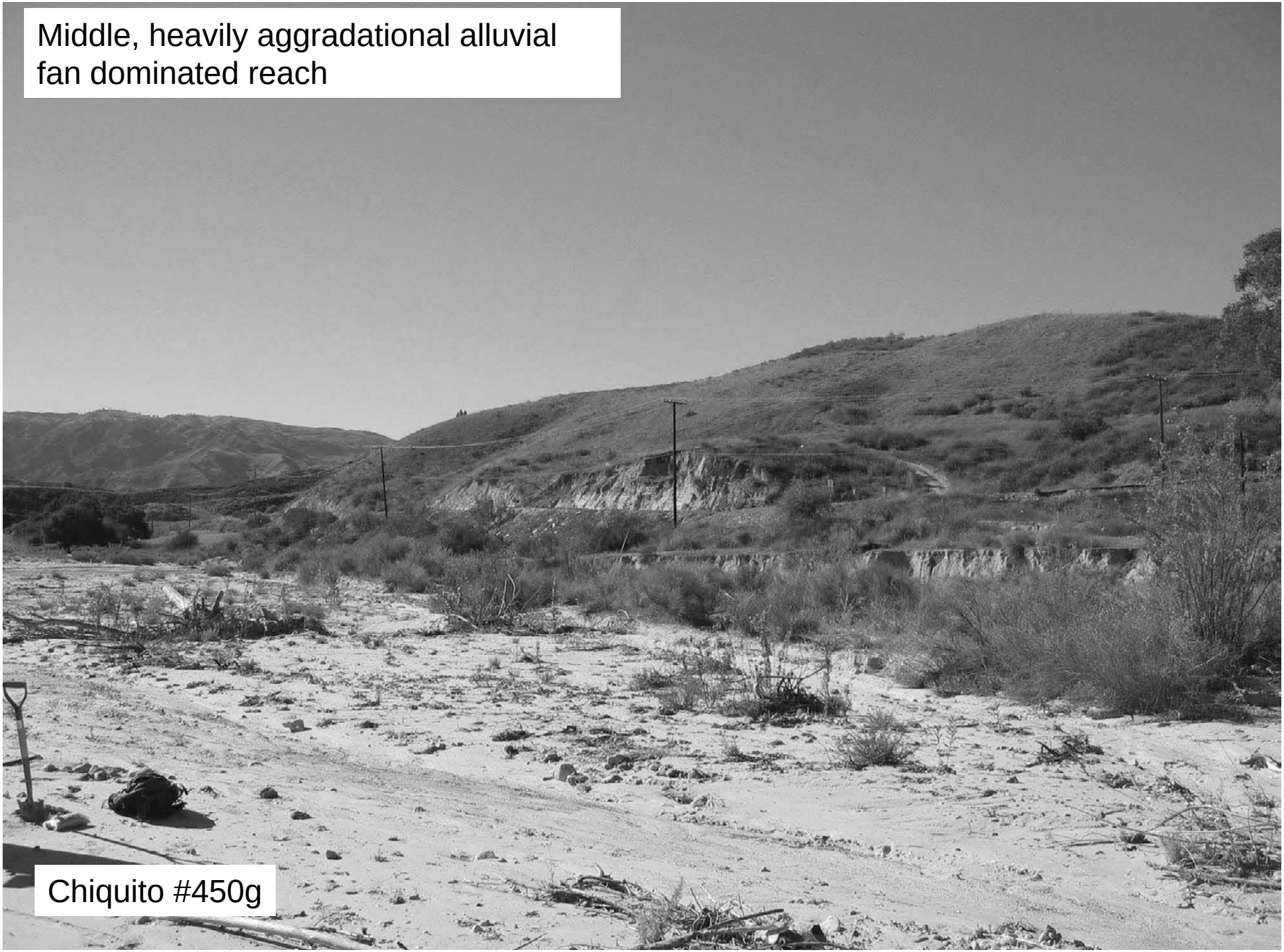

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450a

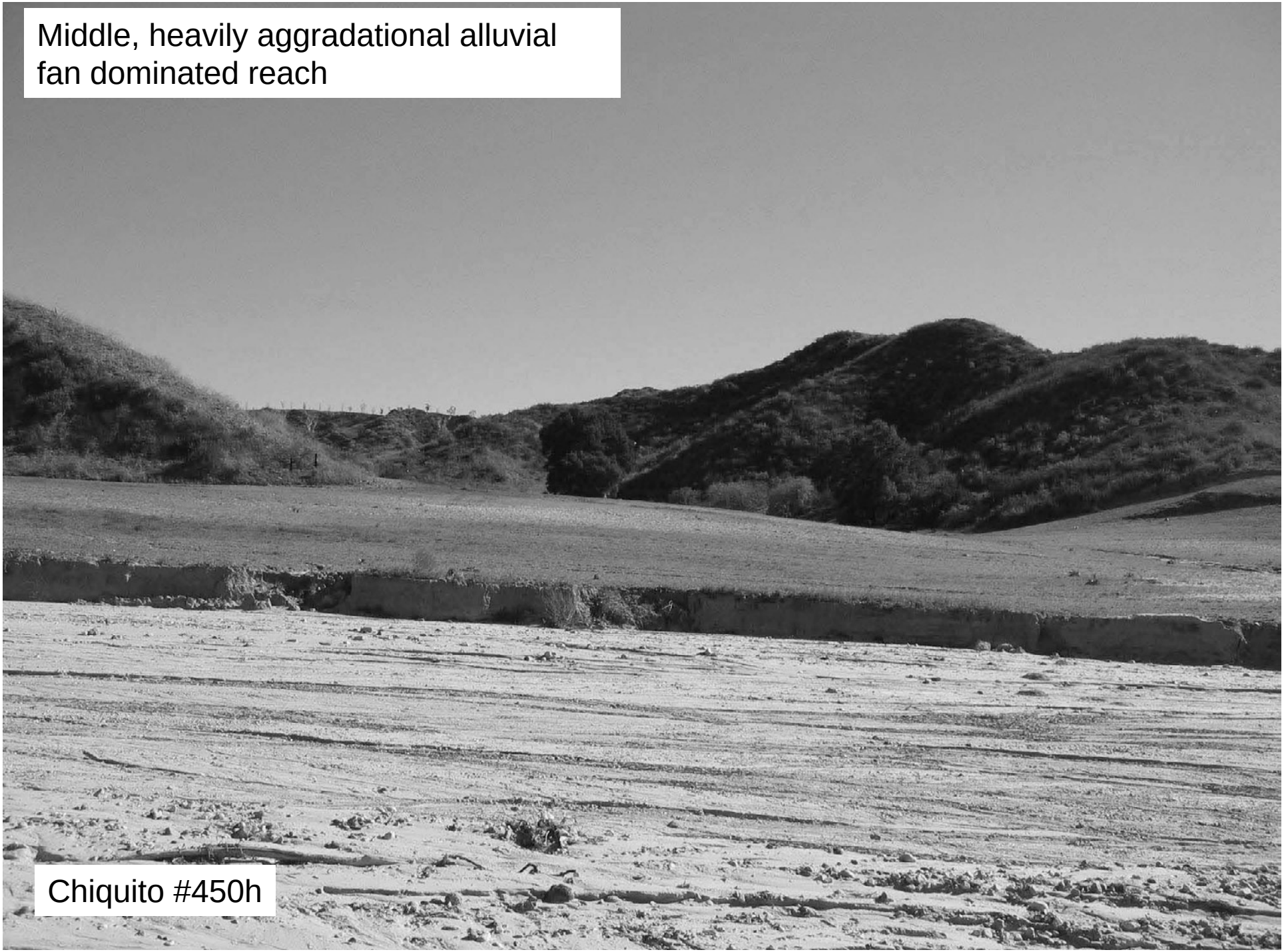

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450b

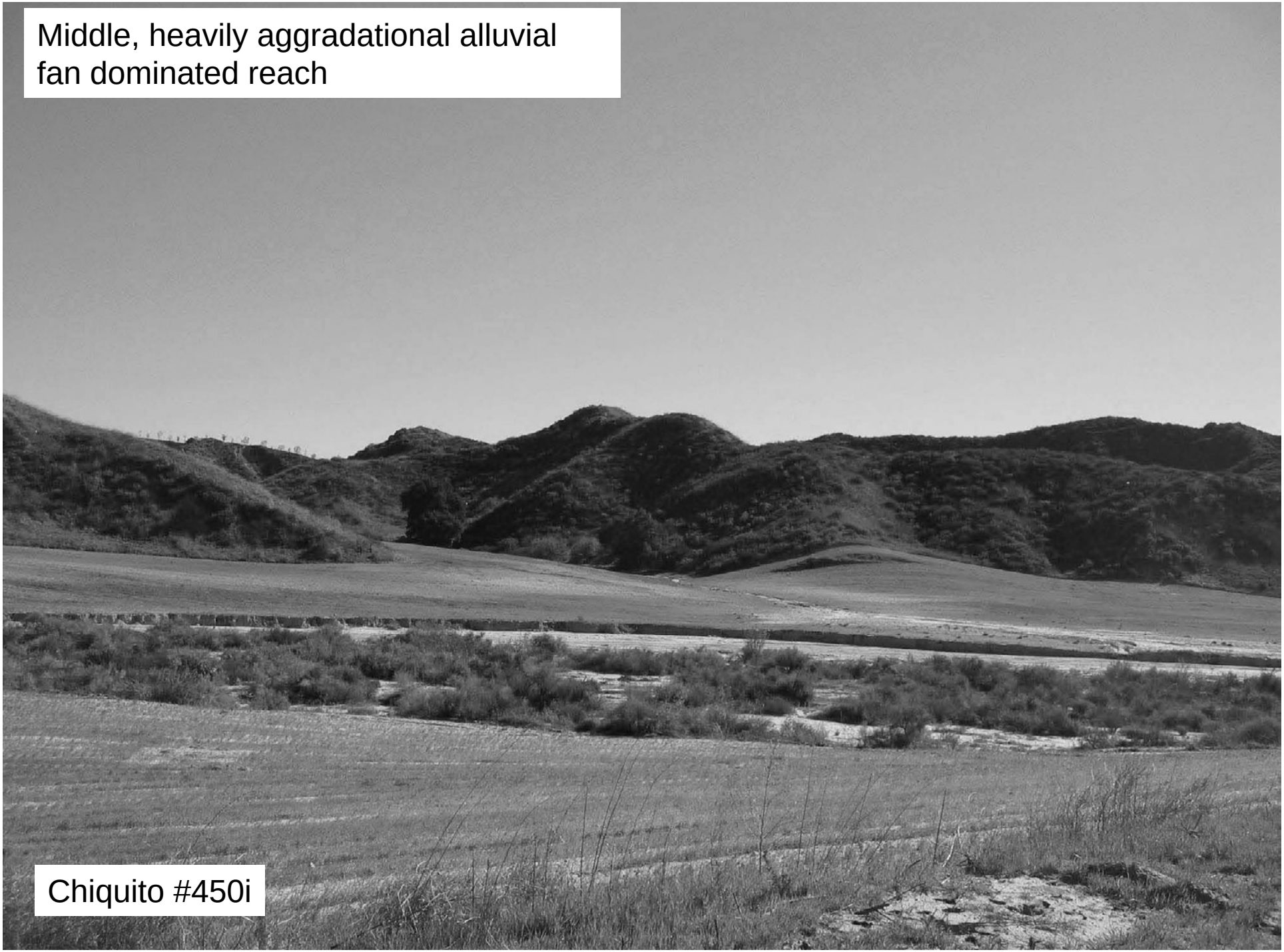

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450c

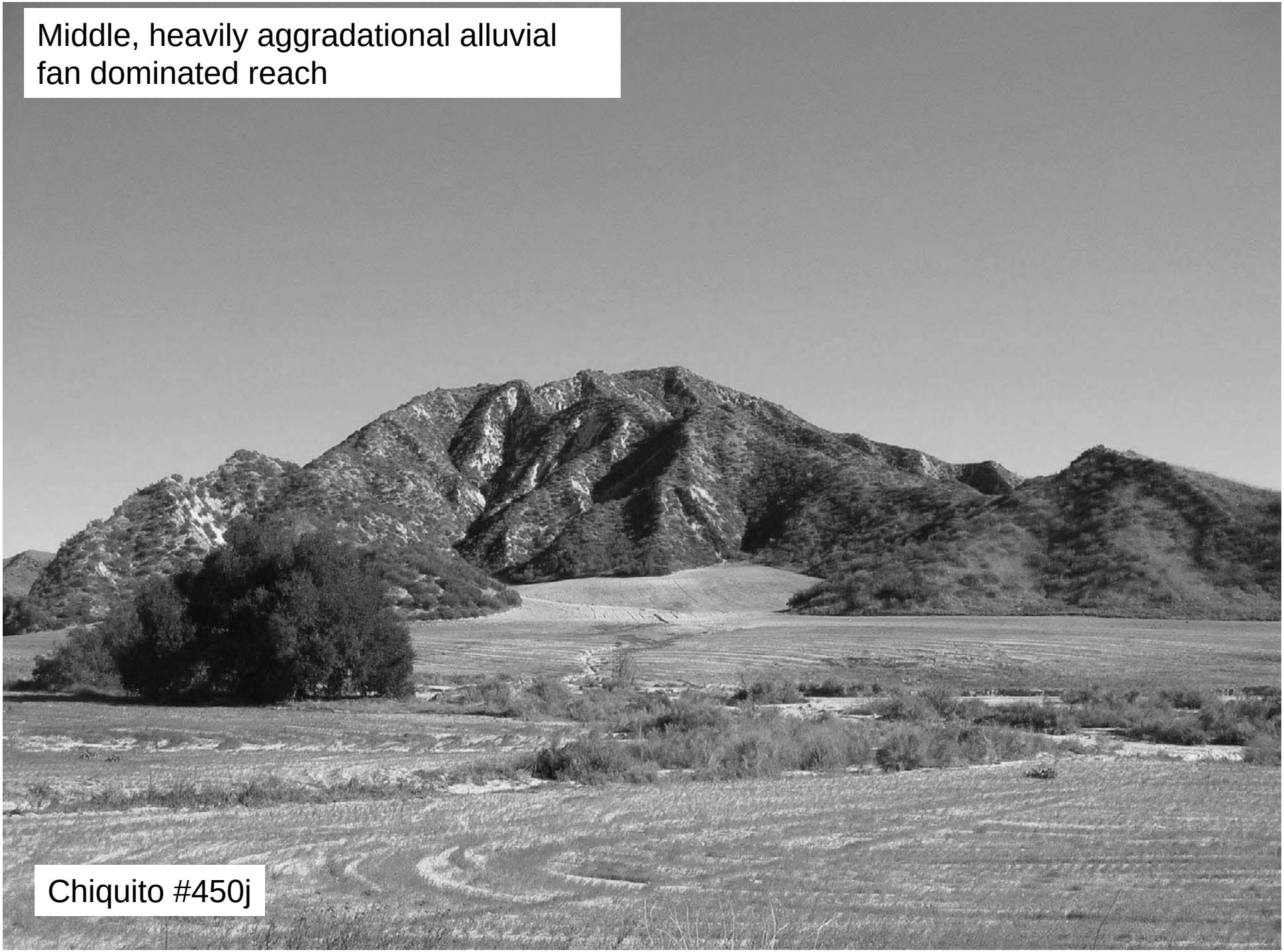

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450d

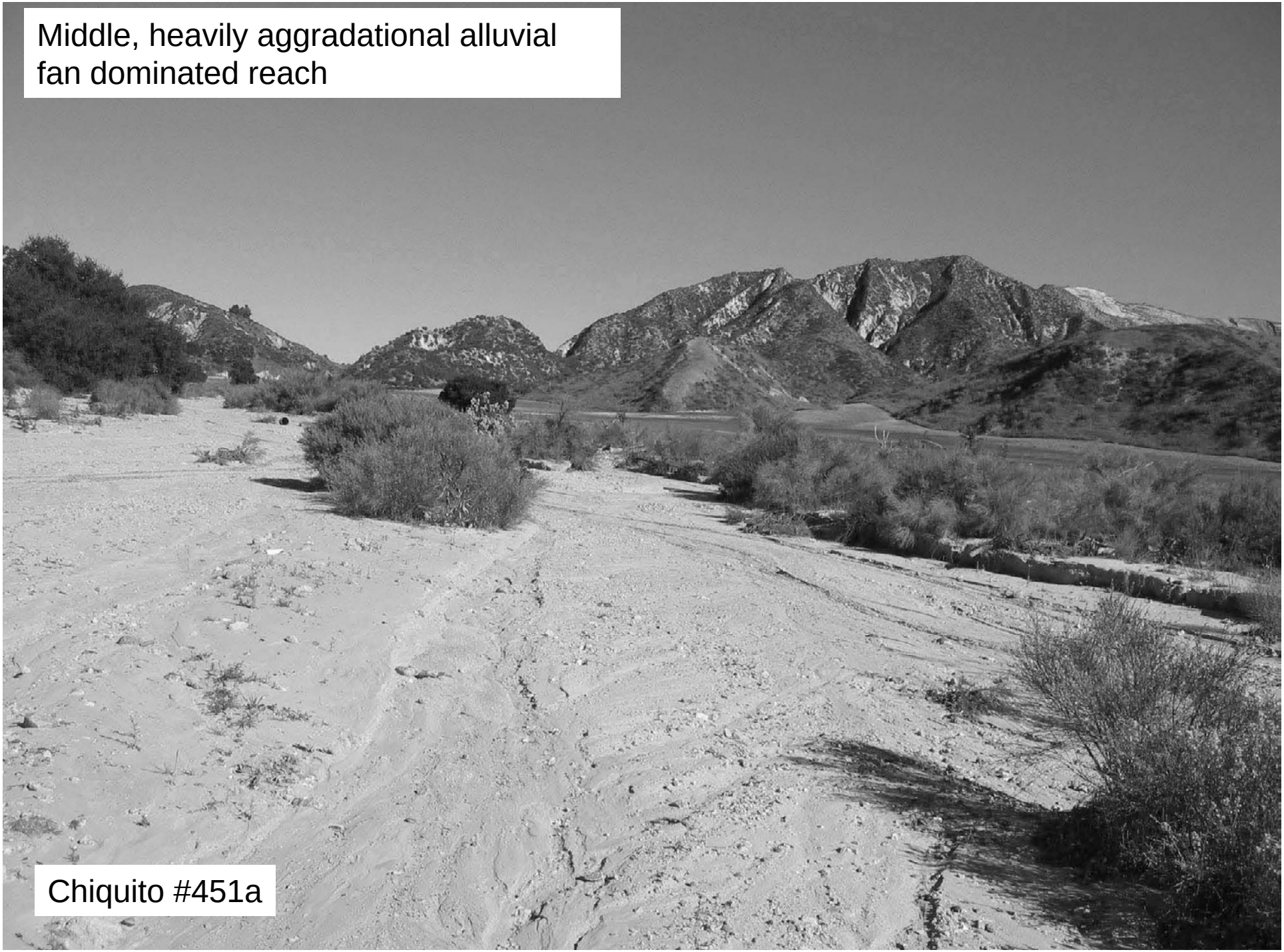

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450f


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450g


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450h

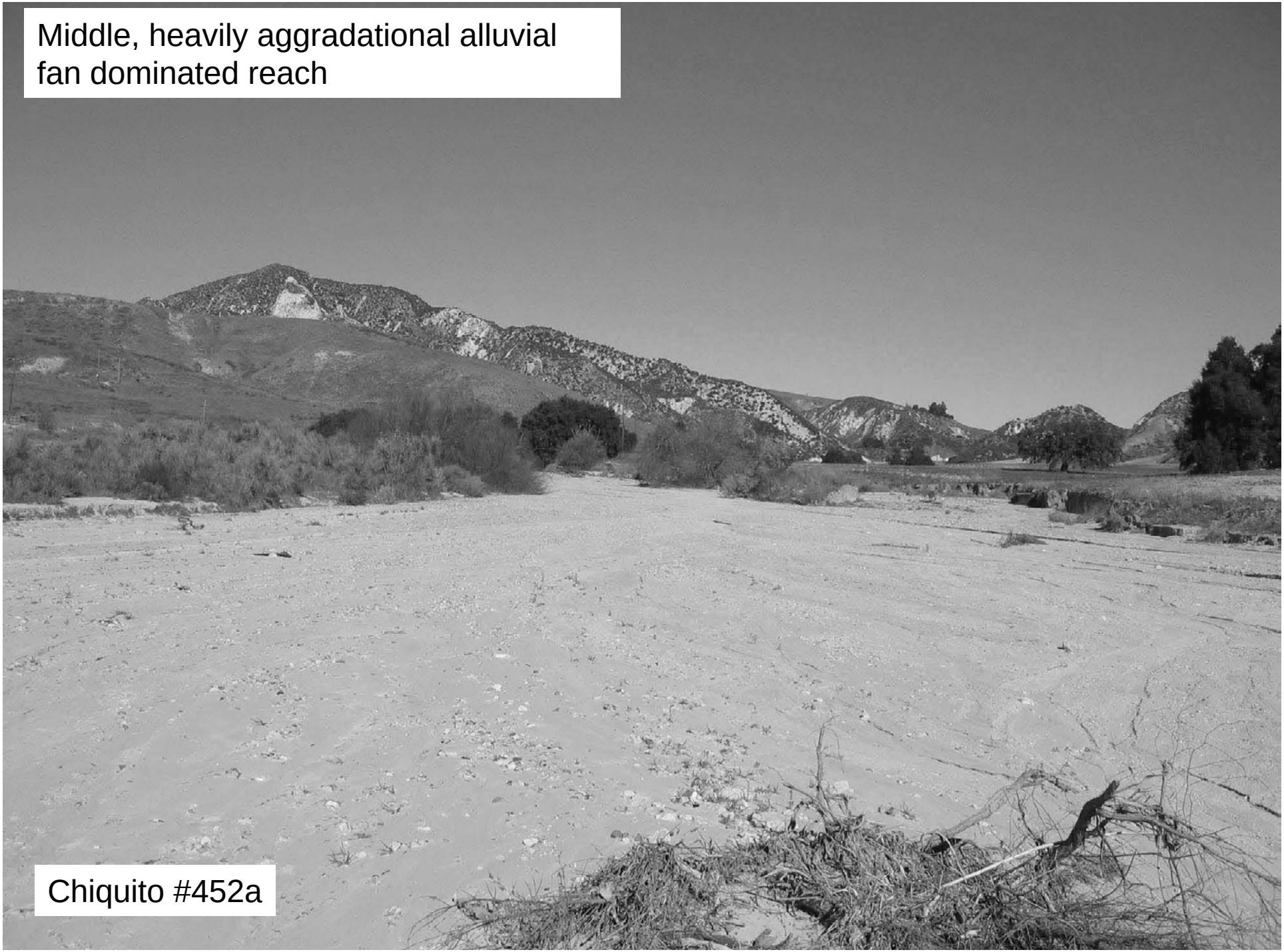

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450i


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

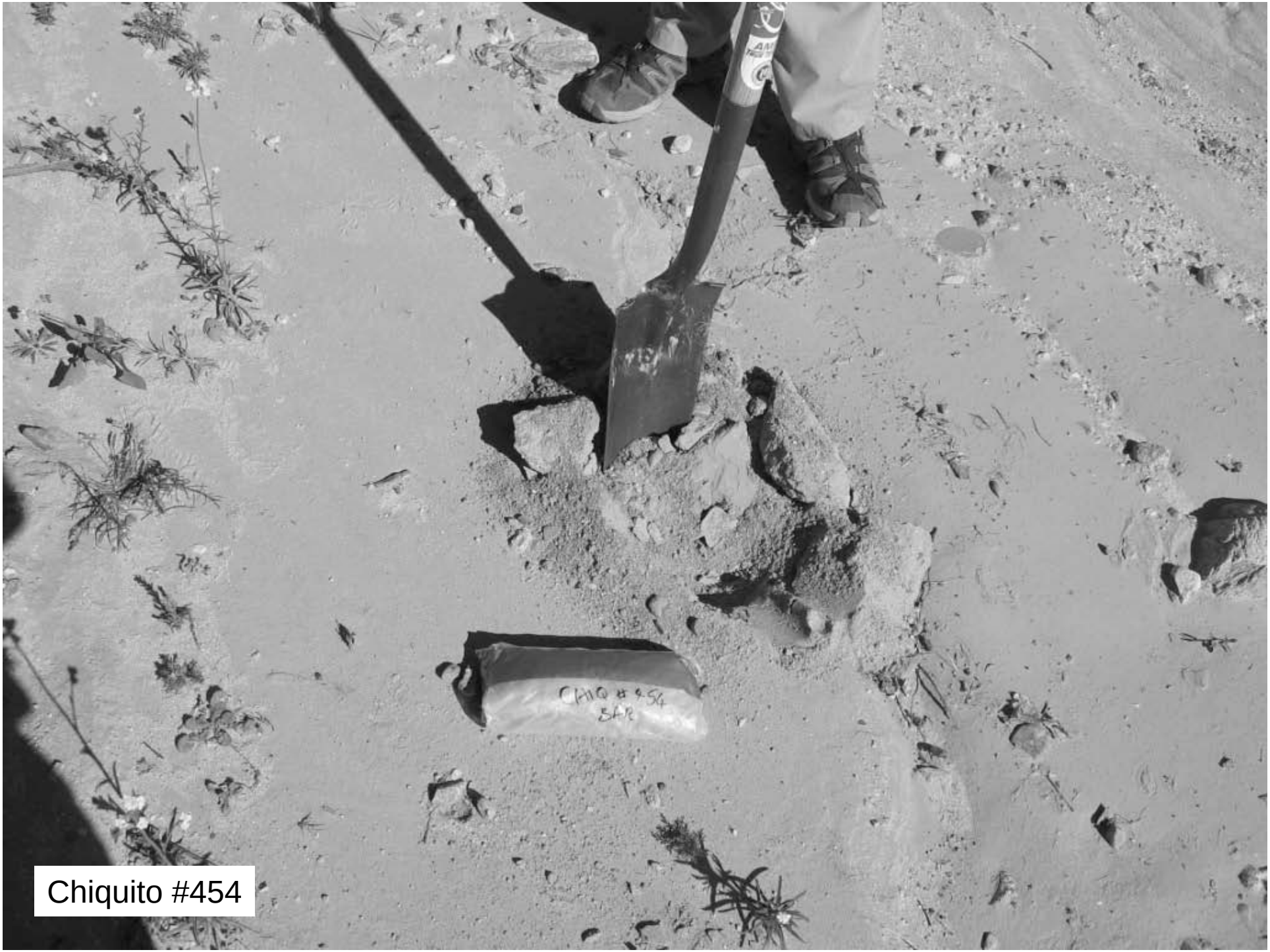
Middle, heavily aggradational alluvial fan dominated reach
Chiquito #452b

Middle, heavily aggradational alluvial fan dominated reach
Chiquito #452c

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



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

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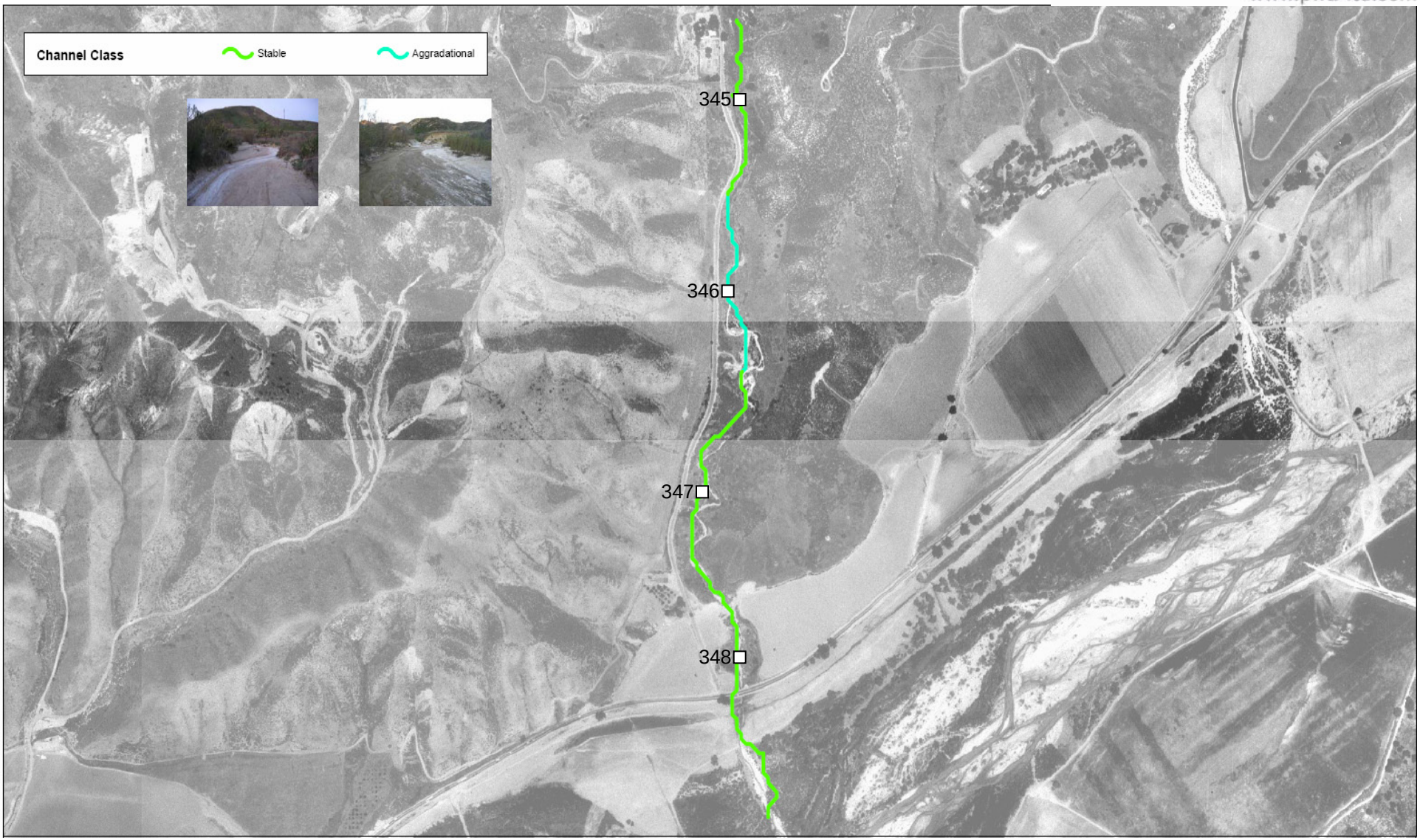


Reach Classification and Photo Points

Bed sample

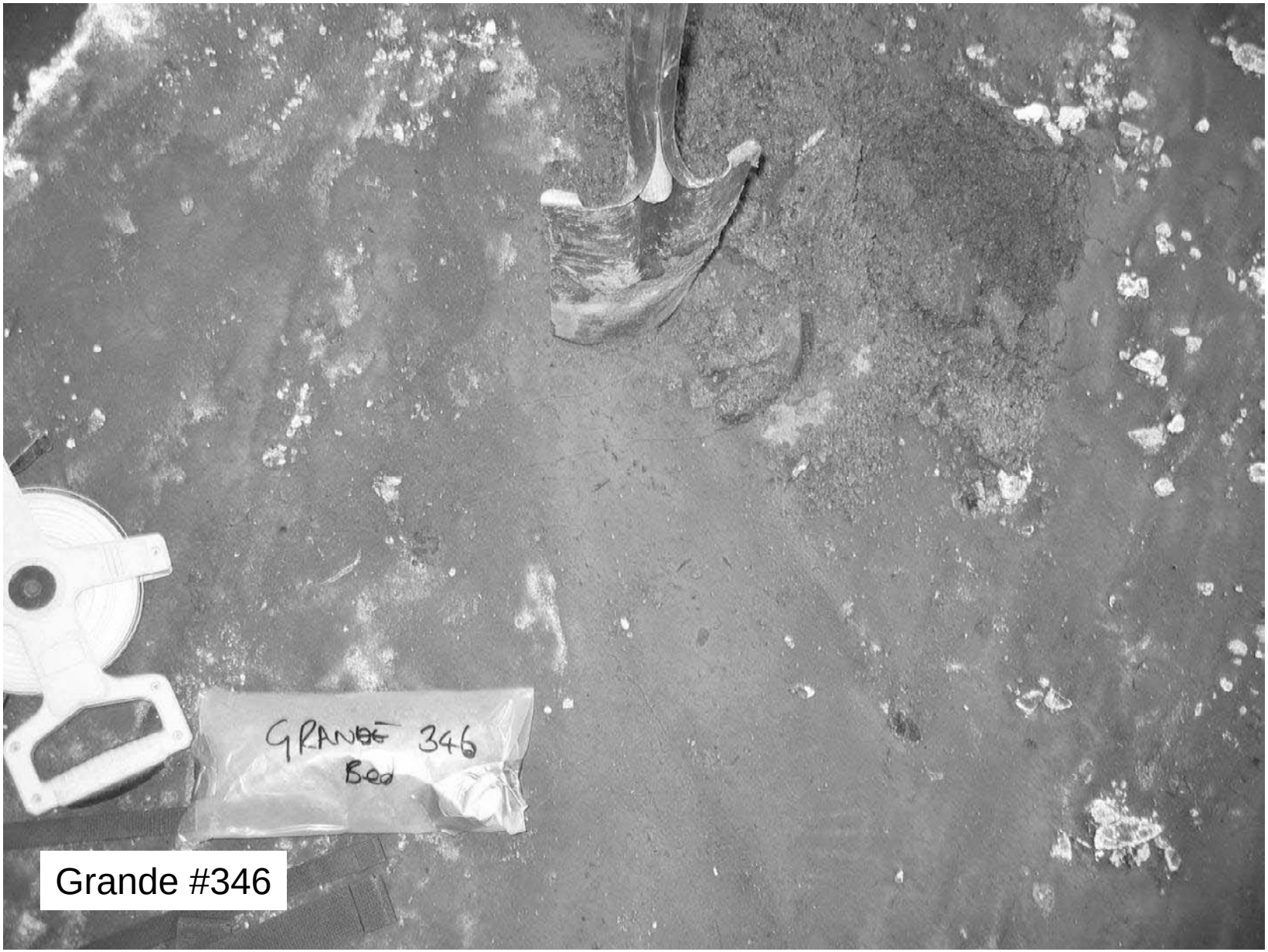
Grande #345

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

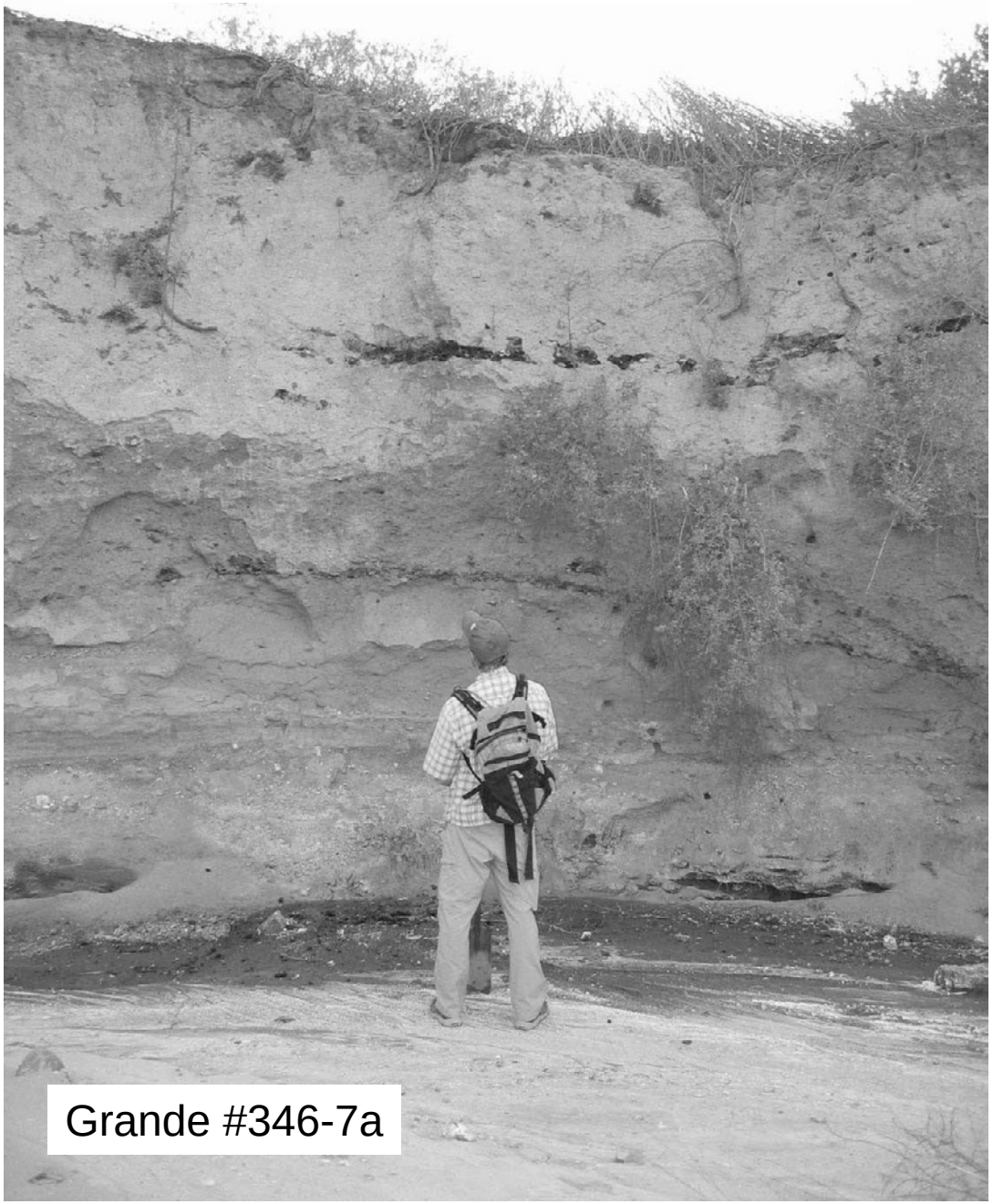


Grande #346

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



Grande #346-7a

Unstable – eroding outside bend condition

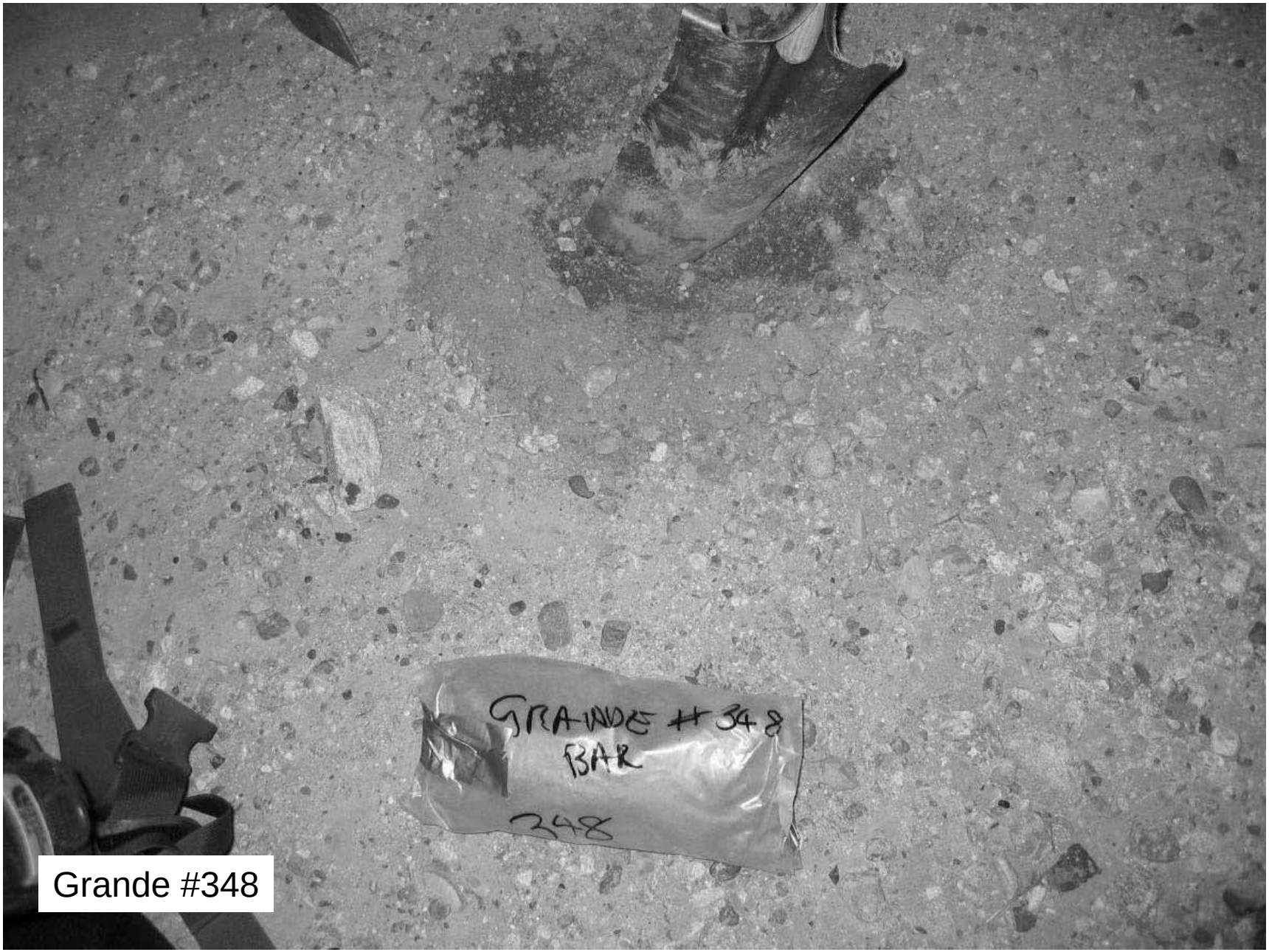
Sediment sample

Grande #347

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



Grande #348

Moderately stable
– slightly aggradational condition

Moderately stable
– slightly aggradational condition

ATTACHMENT F

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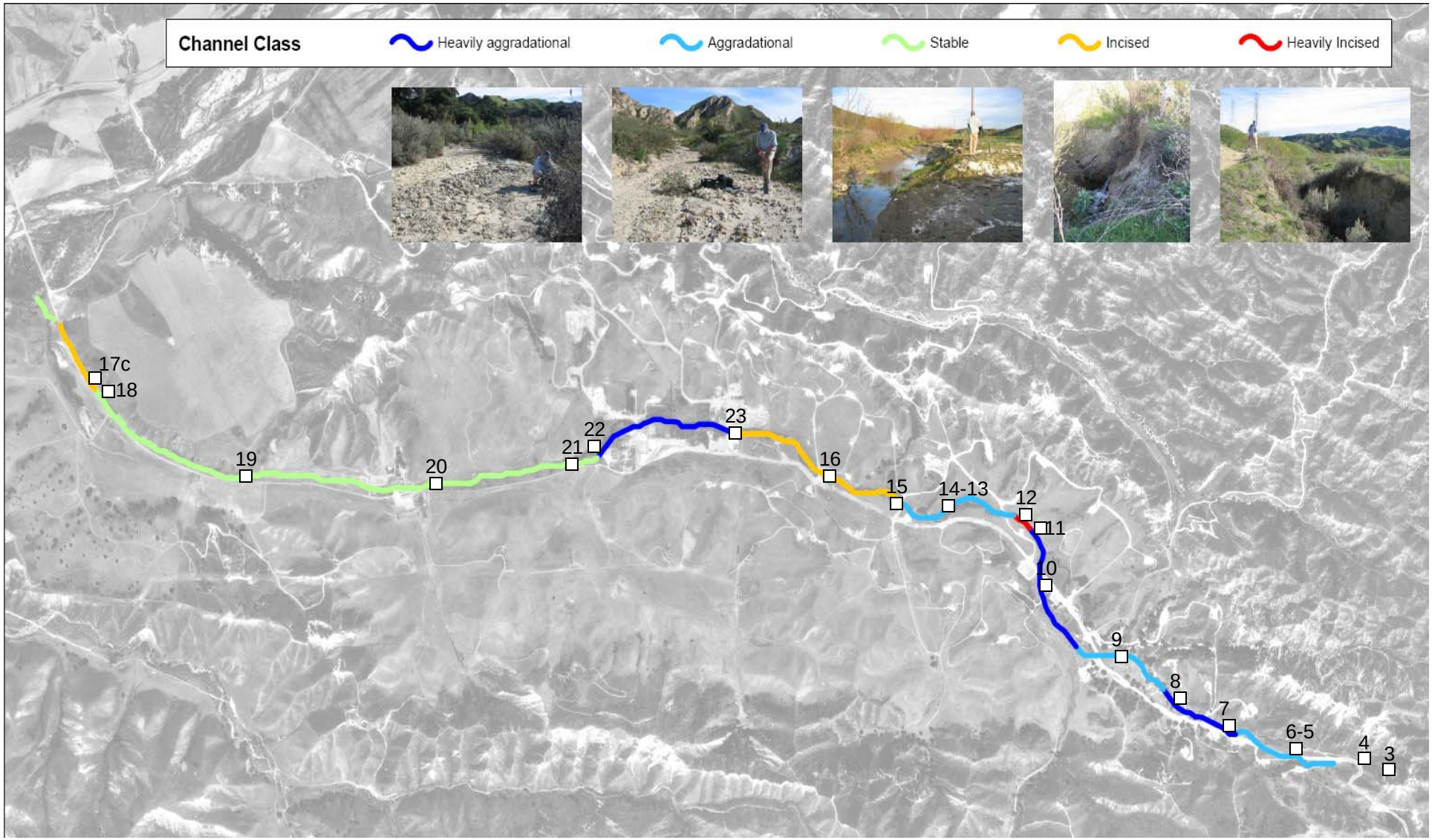
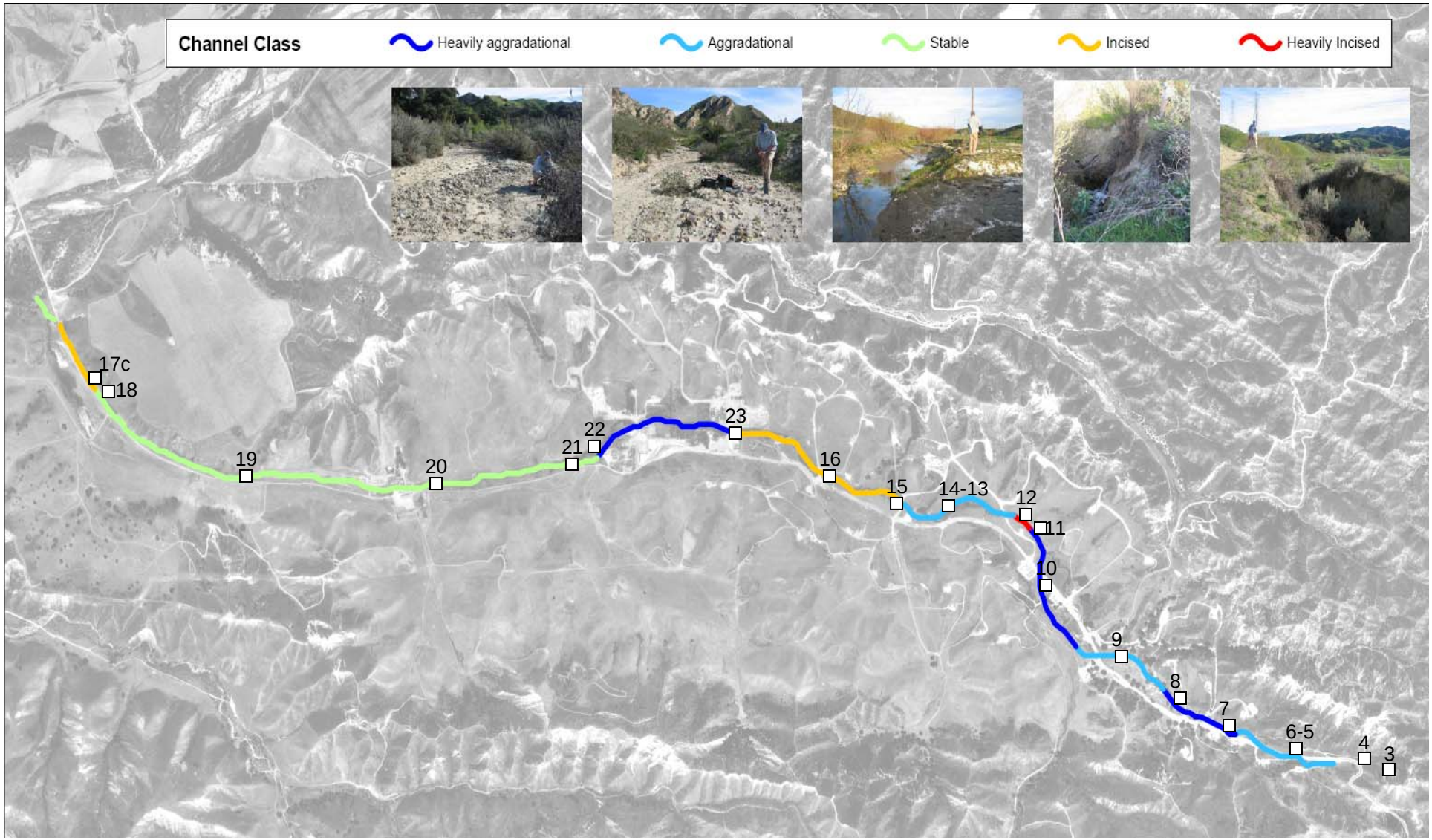
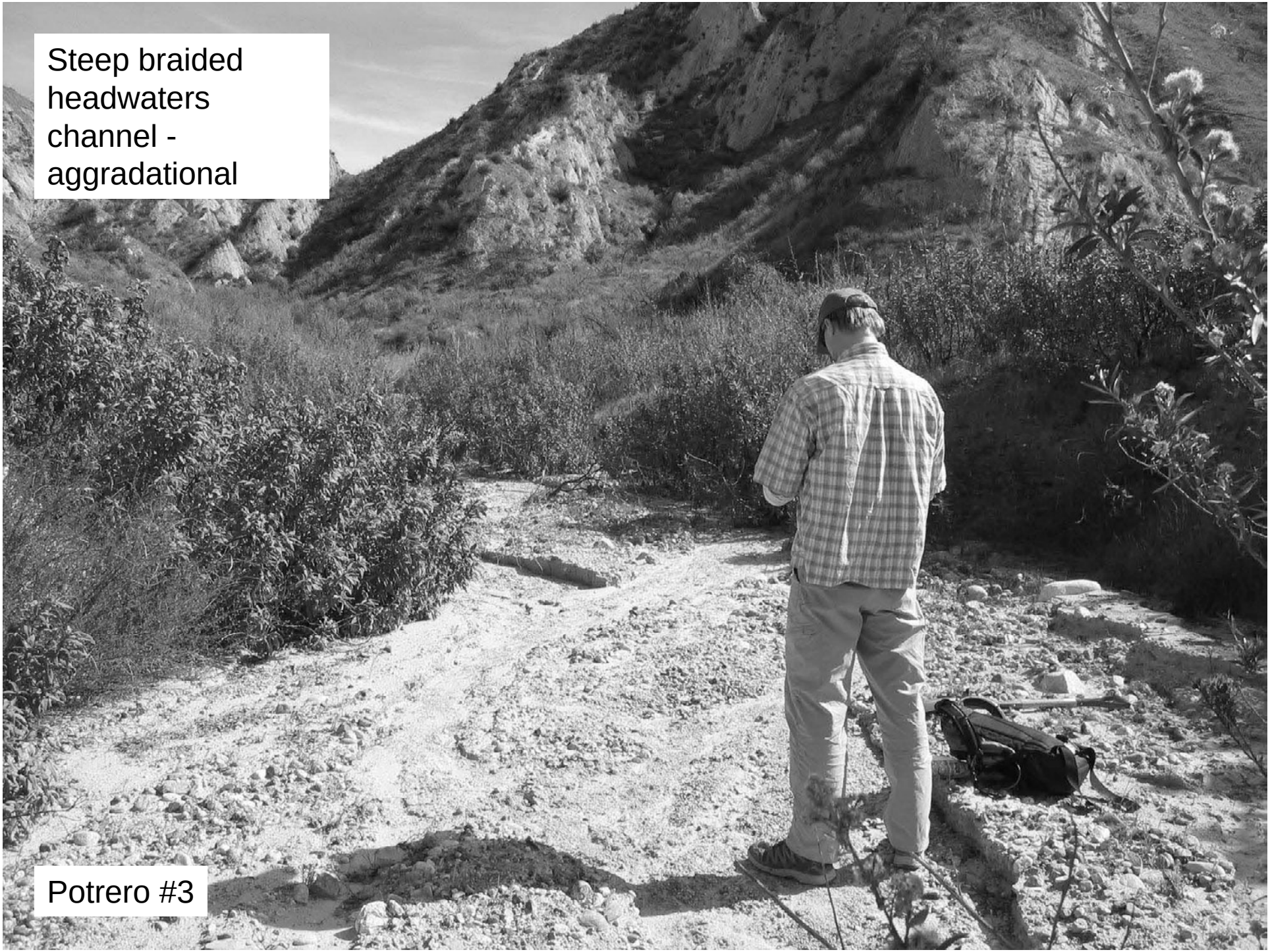


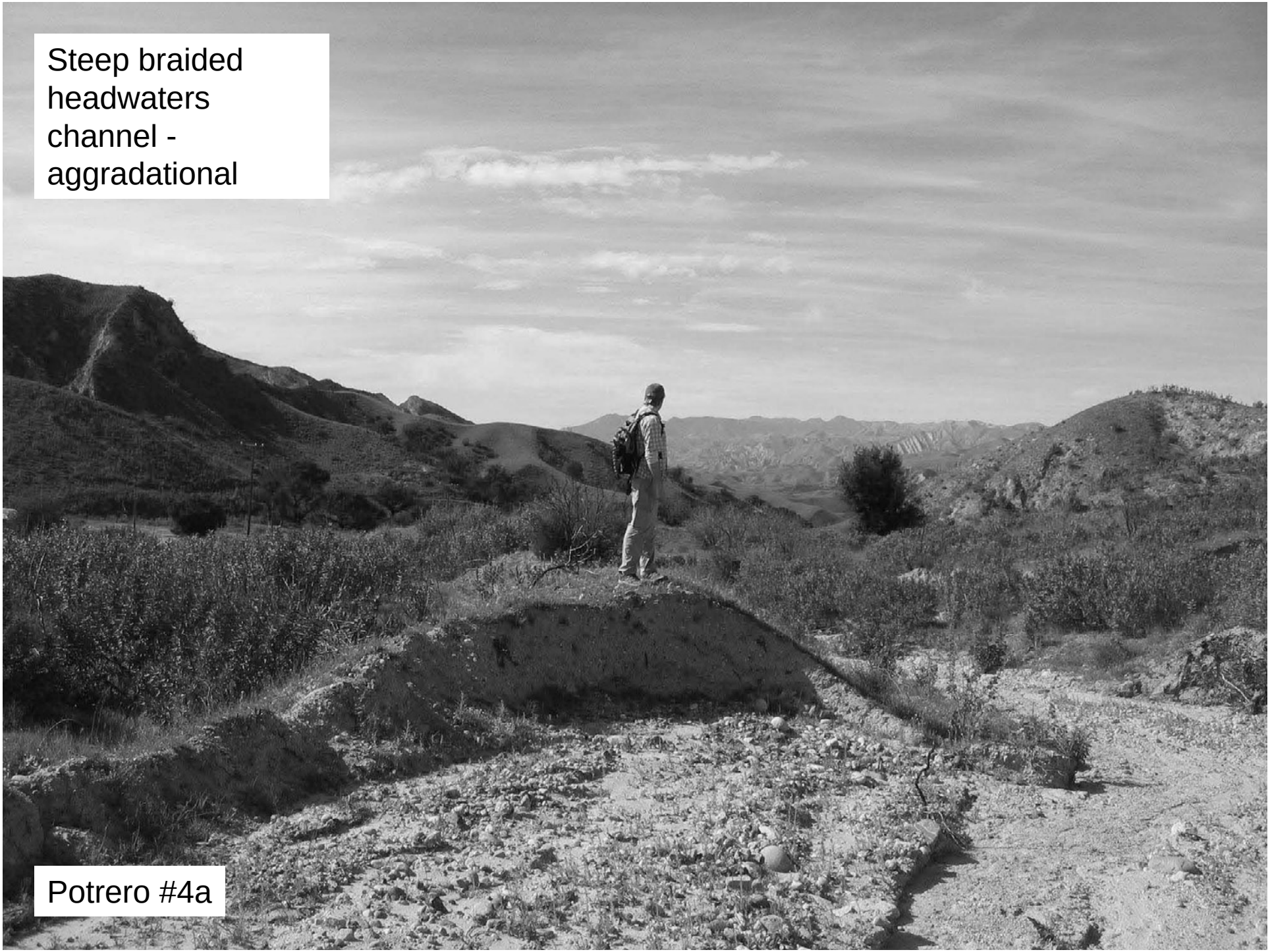
Reach distribution

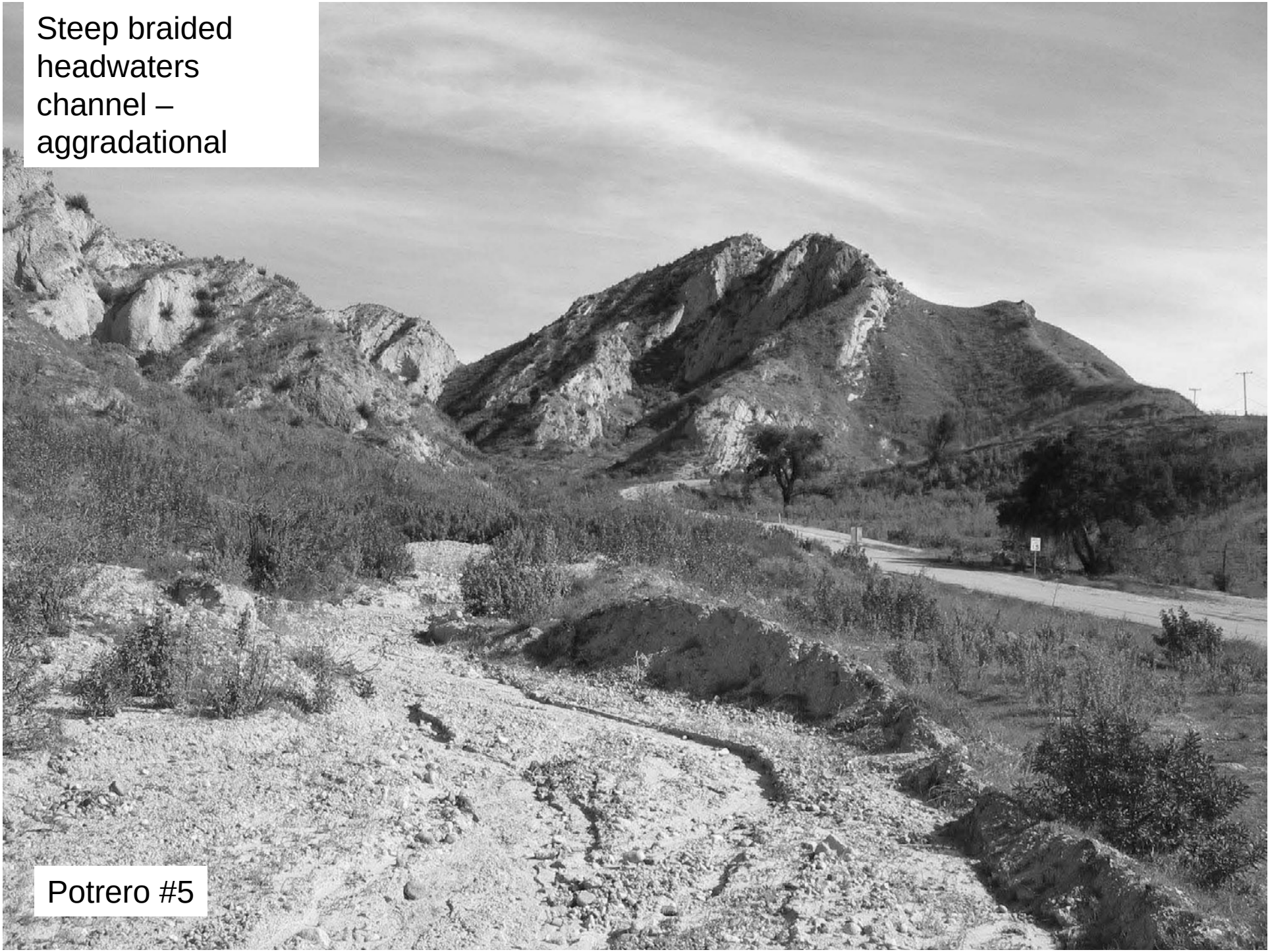


Steep, incised headwaters channel

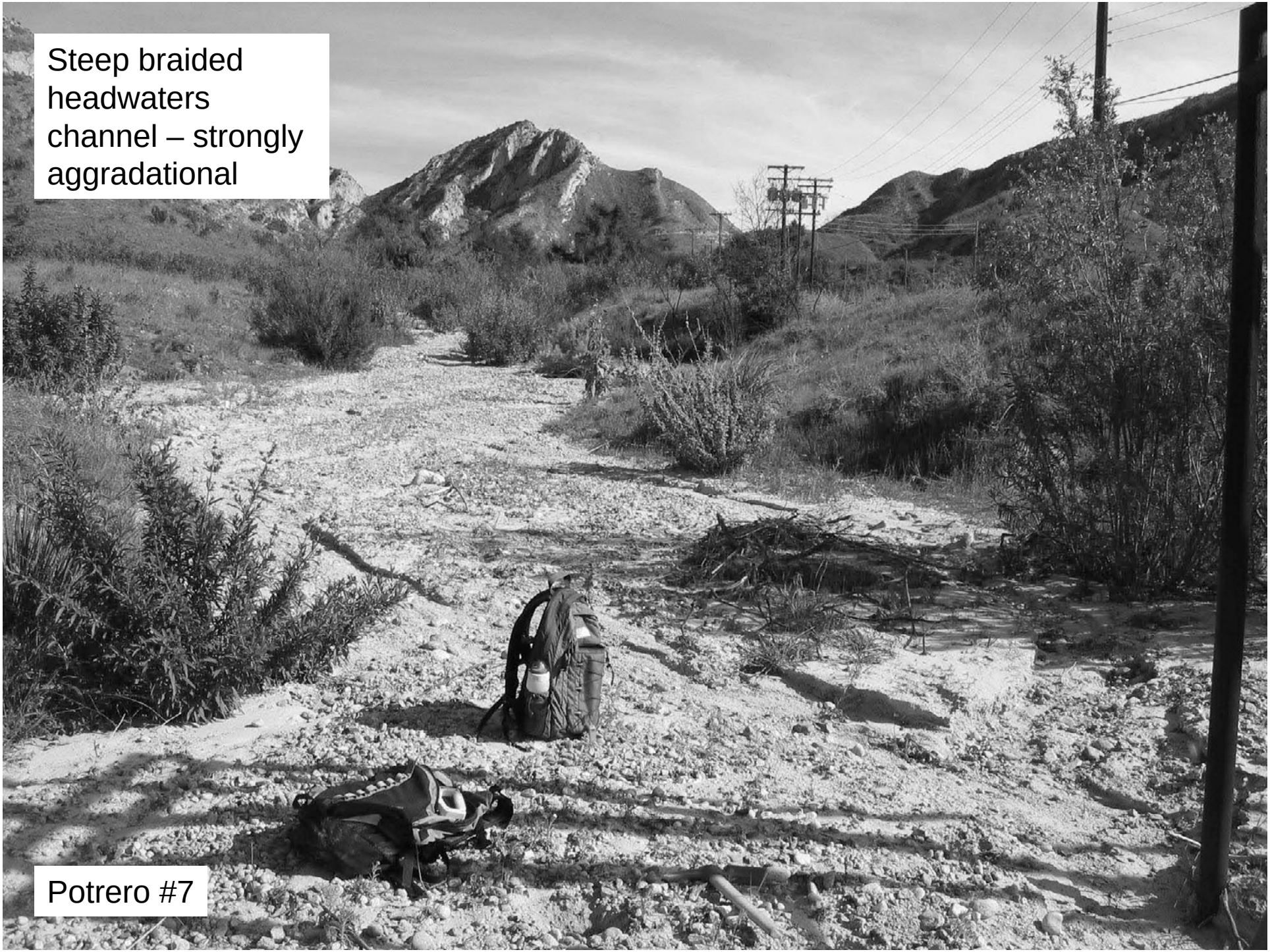
Potrero #1

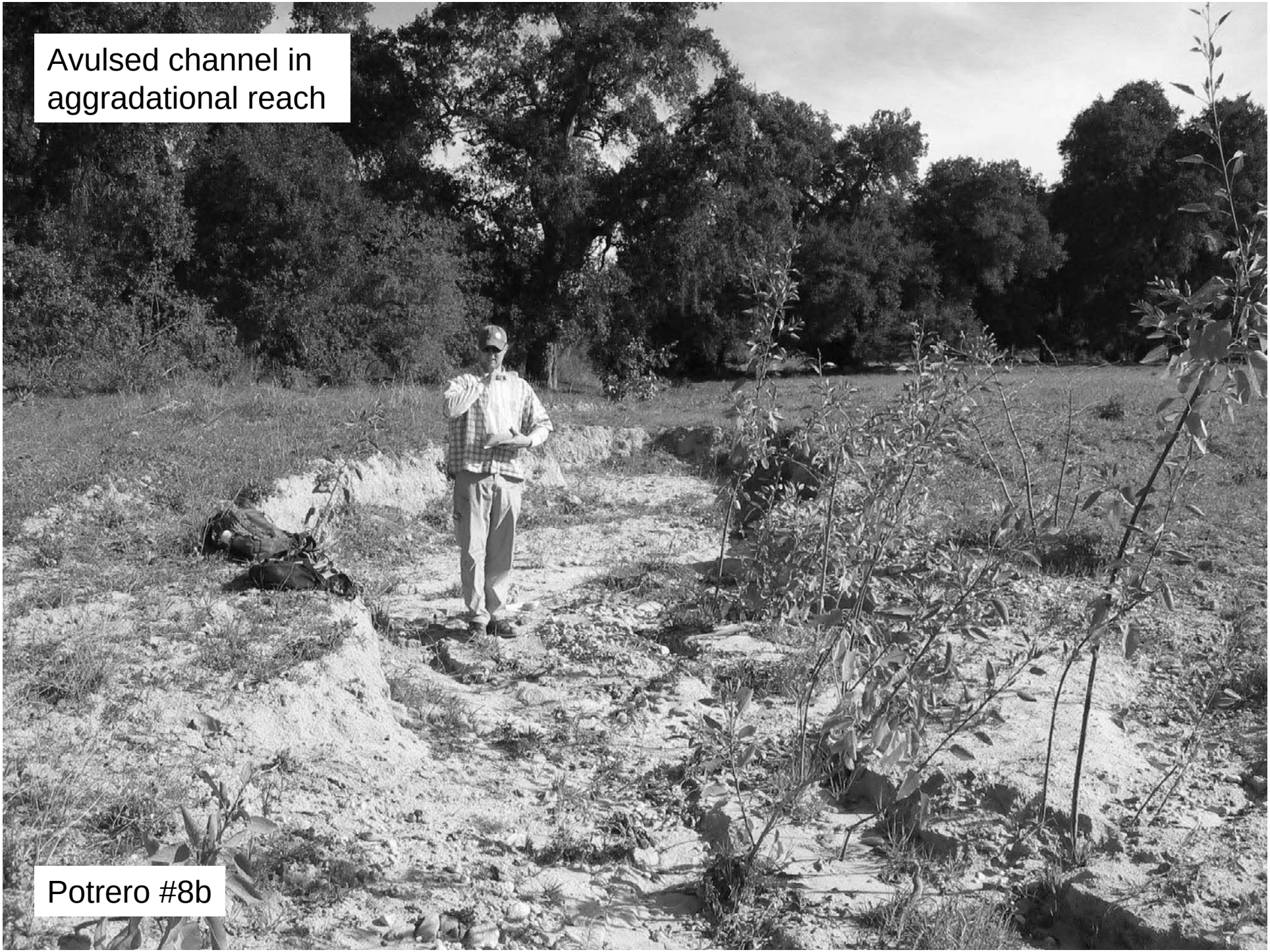

Steep braided headwaters channel - aggradational
Potrero #3


Steep braided headwaters channel - aggradational
Potrero #4a


Steep braided headwaters channel – aggradational
Potrero #5

Steep braided headwaters channel - aggradational
Potrero #6a

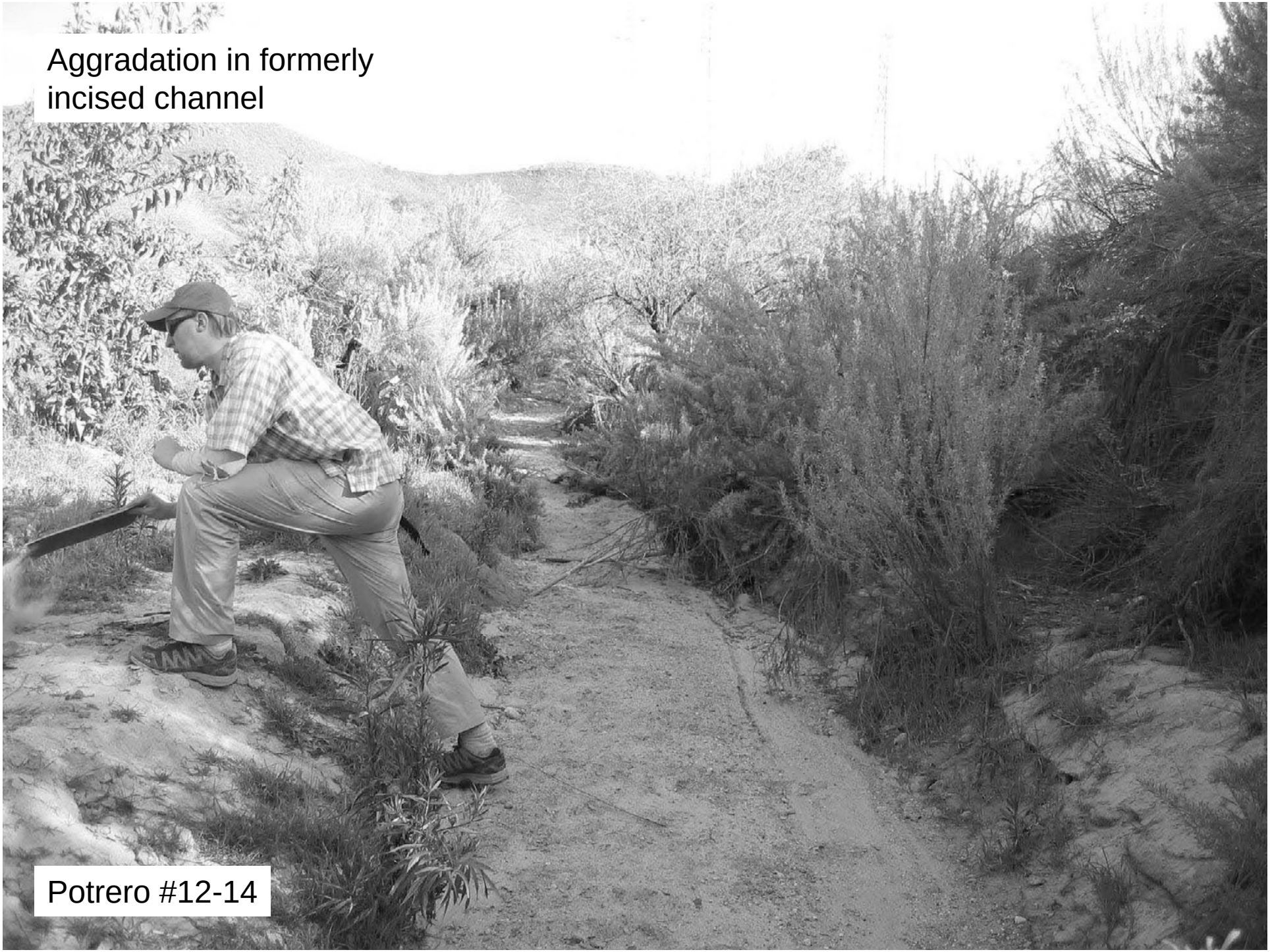

Steep braided headwaters channel – strongly aggradational
Potrero #7

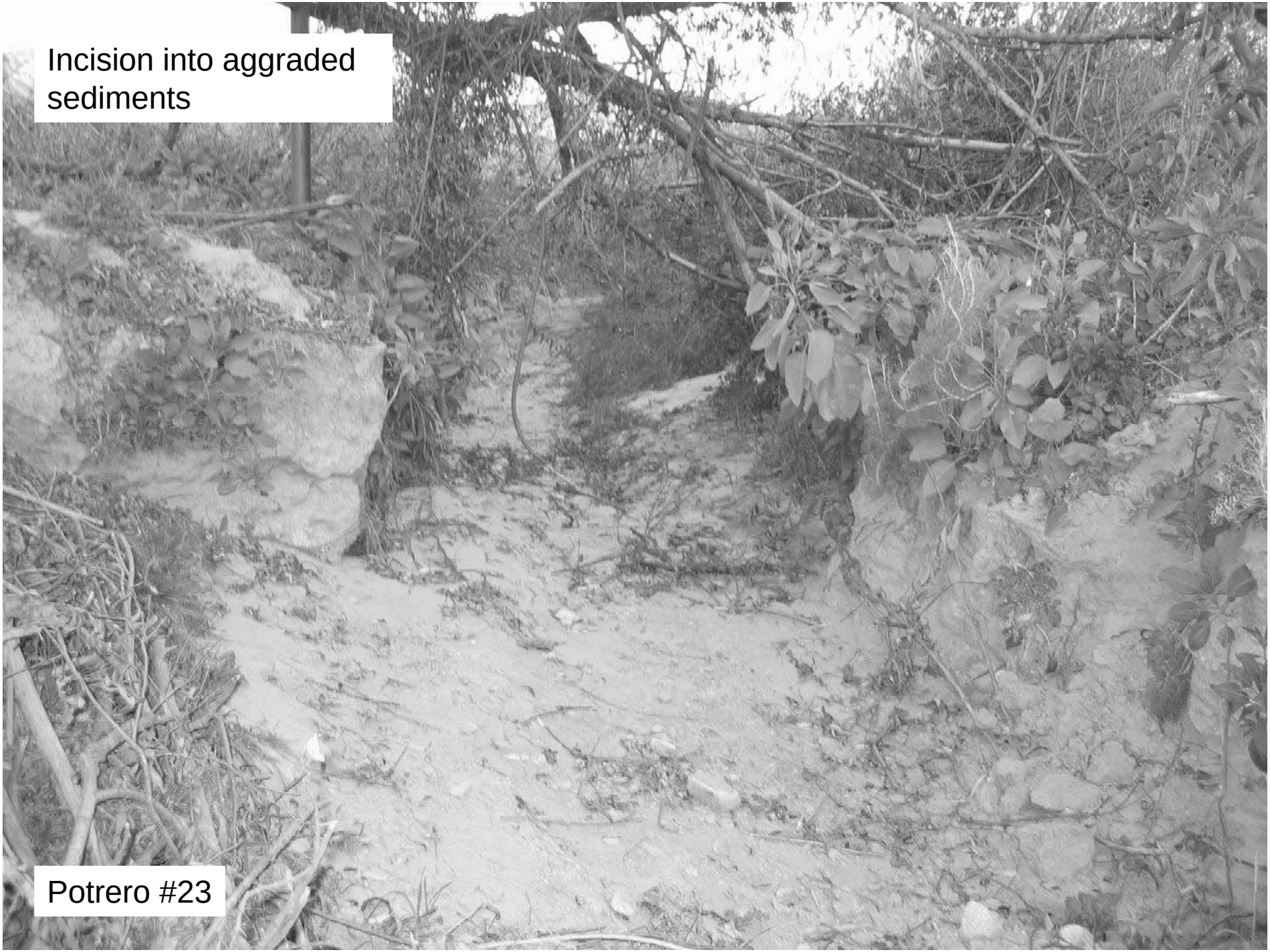

Avulsed channel in aggradational reach
Potrero #8b

Strongly aggradational channel
Potrero #9

Strongly aggradational channel
Potrero #10

Deeply incised channel
Potrero #11

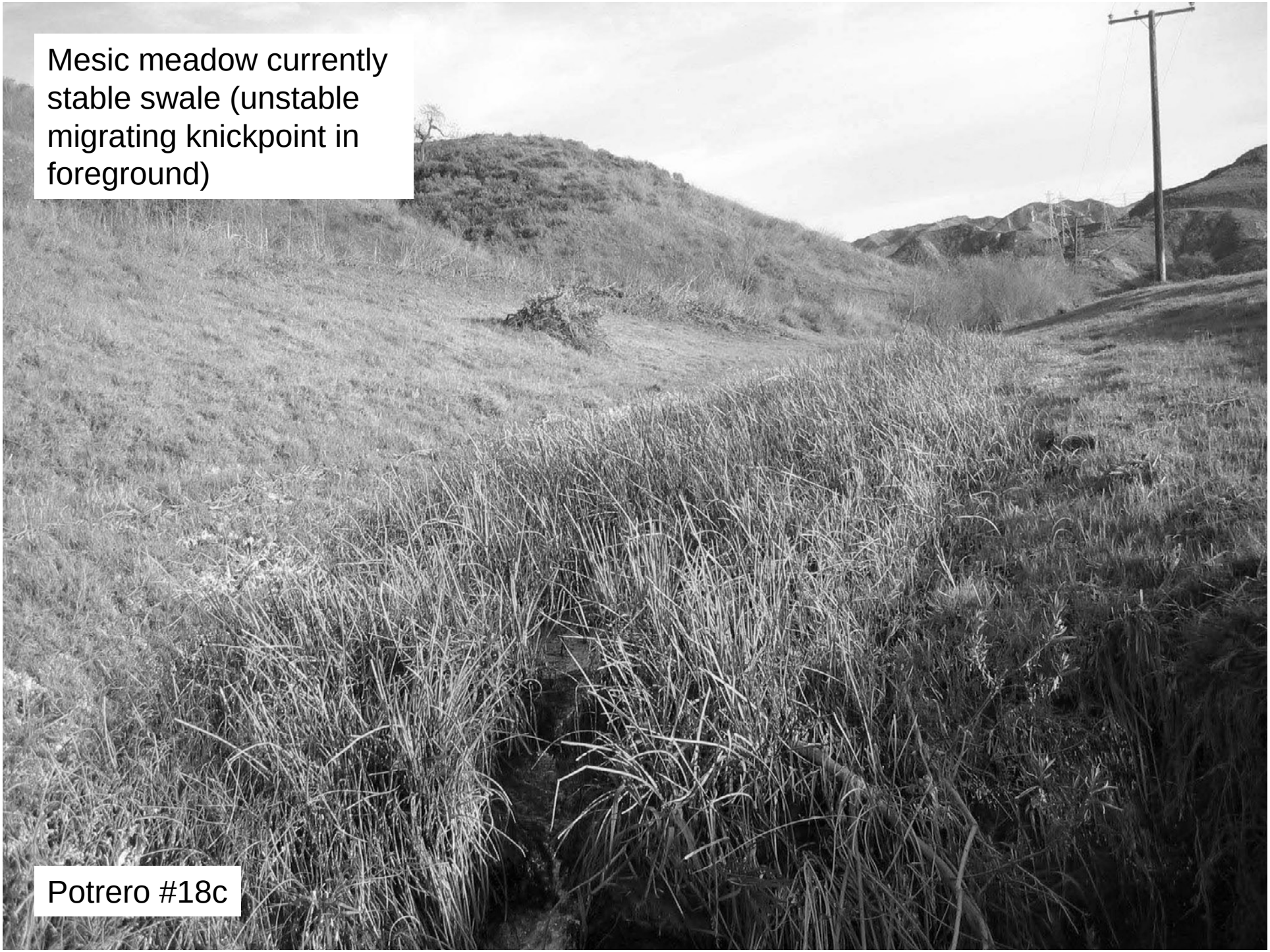

Aggradation in formerly
incised channel
Potrero #12-14


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

APPENDIX 4.23

Global Climate Change

Climate Change Technical Report
Mission Village

Prepared for:
The Newhall Land and Farming Company
Valencia, California

Prepared by:
ENVIRON International Corporation
Emeryville, California

Date:
August, 2010

Project Number:
03-17245C2

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Appendix E Utilities Technical Report
Appendix F Existing Conditions Analysis

Acronyms

ºF	degrees Fahrenheit
AB 1493	Assembly Bill No. 1493
AB 32	California Global Warming Solutions Act of 2006
AF	Acre feet
BAAQMD	Bay Area Air Quality Management District
CA	California
CAFE	Corporate Average Fuel Economy
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CARB 2020 NAT	California Air Resources Board Scoping Plan projections for 2020 if 'no actions are taken'
CCAR	California Climate Action Registry
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CEUS	California Commercial End-Use Survey
CF_4	tetrafluoromethane
CFC	chlorinated fluorocarbons
CH_4	methane
CO_2	carbon dioxide
CO_2e	CO_2 equivalents
CNRA	California Natural Resource Agency
DEIR	Draft Environmental Impact Report
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EISA	Energy Independence and Security Act
EMFAC	emissions estimation software programs
ENVIRON	ENVIRON International Corporation
FCV	fuel cell vehicle
FFV	flexible fuel vehicle
GGE	greenhouse gas equivalents
GHGs	greenhouse gases
GRP	General Reporting Protocol
GWP	global warming potential
HFC	hydrofluorocarbons
HVAC	Heating Ventilation and Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
kWh	kilowatt
LA	Los Angeles
lbs	pounds
LCA	Life Cycle Assessment
LCFS	Low Carbon Fuel Standard
LDA	light-duty auto
LEED	Leadership in Energy and Environmental Design

MA	Massachusetts
MIT	Massachusetts Institute of Technology
$MMTCO_2e$	Million metric tonnes of CO_2 equivalent
MN	Minnesota
mpg	miles per gallon
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
MWh	Megawatt-hour
NHTSA	National Highway Traffic Safety Administration
N_2O	nitrous oxide
O_2	oxygen
OFFROAD	emissions estimation software programs
OPR	Office of Planning and Research
PFC	perfluorocarbon
PHEVs	plug-in hybrid electric vehicles
ppb	parts per billion
ppm	parts per million
RASS	Residential Appliance Saturation Study
RFS	Renewable Fuels Standard
RPS	Renewable Portfolio Standard
RTP	Regional Transit Plan
SB	Senate Bill
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SF_6	sulfur hexafluoride
sq ft	square feet
TDV	Time Dependent Valuation
tonnes	Metric tonnes; 1,000 kilograms
UEC	unit energy consumption
UNEP	United Nations Environment Programme
URBEMIS	Urban Emissions Model
US	United States
USEPA	United States Environmental Protection Agency
VMT	vehicle miles traveled
WCI	Western Climate Initiative
WMO	World Meteorological Organization

Executive Summary

Mission Village is a proposed mixed use community within the approved Newhall Ranch Specific Plan area to be built in the northern, unincorporated area of Los Angeles County within the Santa Clarita Valley planning area. The Mission Village development will contain 4,412 residences, including 382 single-family homes and 4,030 multi-family units; up to 1,703,100 square feet of commercial and mixed-use space; as well as a library, schools, fire station, recreation facilities, and various road improvements.

This development will result in both one-time and annual direct and indirect emissions of greenhouse gases (GHGs). The term “direct emissions of GHGs” refers to GHGs that are emitted directly as a result of the project and include land use change and construction emissions. Indirect emissions are those emissions that the project entitlement will enable, but that are not controlled by the project proponent. This report discusses the scientific and regulatory developments surrounding global climate change and provides an inventory surveying the emissions that would result from approving Mission Village.

There is a general scientific consensus that most current global warming is the result of human activity on the planet. This man-made, or anthropogenic, warming is primarily caused by increased emissions of GHGs that keep the earth’s surface warm. This is called “the greenhouse effect” and contributes to global climate change.

Lawmakers at the national, state and local levels have introduced legislation and regulations aimed at better tracking and controlling GHGs. On the national level, there are some incentives for businesses and individuals to take voluntary steps to limit GHG emissions. On September 22, 2009, EPA Administrator Lisa Jackson signed a final rule mandating annual reporting of GHG emissions by suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions. This rule was created in response to the mandate established by the 2008 Consolidated Appropriations Act, on April 10, 2009. California has enacted the California Global Warming Solutions Act of 2006 (Assembly Bill 32 or AB 32), which established mandatory reductions in state-wide GHG emissions by 2020. The California Legislature passed Senate Bill (SB) 97, which addresses GHG analysis under the California Environmental Quality Act (CEQA). SB 97 required that the California Natural Resources Agency adopt guidelines for the mitigation of GHG emissions and their effects by January 1, 2010.

The development will be occupied by residents and by employees and patrons of commercial and municipal buildings. These occupants will use electricity, heating, and will be transported by motor vehicles. These activities directly or indirectly emit GHGs. The main GHG emissions resulting from such residential developments are emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHG emissions are typically measured in terms of metric tonnes of CO_2 equivalents (CO_2e), calculated as the product of the mass emitted of a given GHG and its specific global warming potential (GWP).

The emissions inventory presented in this report is consistent with the methodologies established by the California Climate Action Registry (CCAR), where possible. The Mission Village inventory considers eight categories of GHG emissions: emissions due to vegetation

changes, emissions from construction activities, residential building emissions, commercial building emissions, mobile source emissions, swimming pool operations emissions, area source emissions, and municipal emissions. The emissions from construction and vegetation/land use change are one-time emissions events. The other emissions occur annually throughout the life of the project. The electrical power for the Mission Village development will be supplied by Southern California Edison (SCE). Accordingly, indirect GHG emissions from electricity usage are calculated using the SCE carbon-intensity factor adjusted for future mandated renewable energy requirements.

A variety of methods are employed to develop a complete GHG emissions inventory. In addition to well-established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several emissions estimation software programs and survey databases are used. These include EMFAC, OFFROAD, Urban Emissions Model (URBEMIS), California Residential Appliance Saturation Survey, and California Commercial End-Use Survey.

Emissions from the various aspects of Mission Village at full buildout are presented in Table ES-1, which presents the one-time emissions and emissions that are expected to occur each year after build-out of the Mission Village development. There are 109,331 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to 61,284 tonnes CO_2e/year. Of the annual emissions, 64% result from vehicular emissions associated with residential and commercial activities, and 30% result from the energy use associated with residential and non-residential buildings. If the one-time emissions are annualized assuming a 40-year development life (which is likely low), then the one-time emissions account for approximately 2,733 tonnes, or 4.3% of the annualized emissions. Taking these annualized one-time emissions into account, the annual emissions are 64,017 tonnes CO_2e /year.

Mission Village emissions of CO_2e from all annual sources are 36.0% below the level that would be expected if the Project were constructed consistent with the assumptions in the California Air Resources Board (CARB) Scoping Plan ("Scoping Plan") projections for 2020 if 'no actions are taken' (CARB 2020 NAT). Even if annualized vegetation and construction emissions are included, Mission Village is still 35.0% below the level of CARB 2020 NAT. The Scoping Plan notes that a 28.4% reduction below CARB 2020 NAT is required to meet the goals of AB 32;[1] therefore this project will not impede the implementation of AB 32 as its reduction is greater than that required in the Scoping Plan. Mission Village's project design features, along with improved vehicle fuel efficiency and cleaner electricity generation, enable the project to exceed AB 32's 29% reduction, as shown in Table ES-1 below.

These inventories were prepared as a worst-case analysis. For example, it assumes that all emissions from Mission Village are "new," in the sense that, absent the development of Mission Village, these emissions would not occur. Given the global nature of GHG emissions, "new" global GHG emissions are those caused by economic growth and population growth (i.e., births); local development projects accommodate such growth.

[1] For this analysis, the AB 32 reduction is rounded up to 29% to provide a conservative comparison of project emissions to the Scoping Plan projections.

Table ES-1: Summary of Greenhouse Gas (GHG) Emissions for Mission Village

Source	GHG Emissions			Improvement over CARB 2020 NAT[9]
	Unit	Project	CARB 2020 NAT	(%)
Vegetation[1]	tonnes CO_2e / year	26,550	26,550	N/A
Construction[2]		82,781	82,781	N/A
Total (one-time emissions)		**109,331**	**109,331**	**N/A**
Residential[3]	tonnes CO_2e / year	12,609	15,563	19%
Non-Residential[4]		5,927	8,283	28%
Mobile[5]		39,355	64,907	39%
Municipal[6]		3,073	5,109	40%
Recreational (Pools)[7]		290	1,925	85%
Area[8]		31	31	0%
Total (annual emissions)		**61,284**	**95,818**	**36.0%**
Annualized Total[10]	**tonnes CO_2e / year**	**64,017**	**98,551**	**35.0%**

Notes:

1. Vegetation emissions are one-time emissions resulting from the removal of existing vegetation in Mission Village. The emissions are estimated assuming that all carbon currently sequestered in the biomass of the vegetation is released to the atmosphere upon removal of the vegetation. A total of 1,854 acres of existing vegetation is considered to be removed for development purposes. These emissions are partially offset by the planting of trees, which sequester CO_2. A total of 4,985 trees will be planted at Mission Village. Data for emissions calculations are primarily from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.
2. Construction emissions are one-time emissions reported in total metric tonnes. Sources of emissions include construction equipment and vehicles associated with worker commuting and vendor trips. Emissions were estimated by Impact Sciences using URBEMIS.
3. Residential emissions for single family, attached, and apartment dwelling units include emissions associated with electricity and natural gas use. Emissions estimates were developed using data from the 2004 California Energy Commission Residential Appliance Saturation Survey. As specified by Newhall, a total of 4,030 dwelling units are considered.
4. Non-Residential emissions for retail, offices, grocery, restaurants, hotel lodging, and schools account for electricity and natural gas use. Emissions estimates for non-residential buildings were developed from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission.
5. Mobile source emissions were calculated using EMFAC with model inputs prepared by Austin Foust Associates and Fehr & Peers. Mobile source emissions account for residential trips. CO_2 emissions were scaled to reflect CO_2e emissions based on data from the US Environmental Protection Agency (USEPA).
6. Municipal emissions account for emissions due to energy production associated with water supply, public/street lighting, and municipal vehicles. Energy use estimates for water supply are based primarily on a California Energy Commission (CEC) study of electricity required to supply, treat and distribute water in Southern California (Refining Estimates of Water-Related Energy Use in California, 2006). Emissions from street lighting and municipal vehicles were based upon studies of other cities.
7. ENVIRON assumed an outdoor competition-size swimming pool as the main source of GHGs in an aquatic/recreation center. The average energy consumption of five Oakland, CA pools was used to calculate the baseline energy use of a Mission Village pool. For both Project and CARB 2020 NAT scenarios, ENVIRON adjusted the natural gas usage to account for savings from the use of high-efficiency heaters and the temperature difference between Oakland and Newhall.
8. Area emissions were calculated using URBEMIS and include hearth fuel combustion from natural gas fireplaces and landscape fuel combustion from lawnmowers and other landscaping equipment.
9. Percentages only apply to annual CO_2e emissions; annual and one-time CO_2e emissions cannot be directly compared.
10. One-time emissions (vegetation and construction) are "annualized" by dividing by an annualization factor (40). One-time emissions are not annualized in their respective rows above.

1 Introduction

The Mission Village development will result in one-time and annual (direct and indirect) emissions of greenhouse gases (GHGs). Direct emissions of GHGs refer to GHGs that are emitted directly as a result of the project and include land use change and construction emissions. Indirect emissions are those emissions that the project entitlement will enable, but that are not controlled by the project proponent. This report discusses the scientific and regulatory developments surrounding global climate change and provides an estimate of an emissions inventory that would result from entitling Mission Village. This report also places the emissions inventory from Mission Village, at full buildout, into context.

Residents, employees, and patrons of commercial and municipal buildings use electricity, heat their homes and water (typically with natural gas), and are transported in motor vehicles, all of which directly or indirectly emit GHGs. The principal greenhouse gases resulting from such developments are emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). CO_2 is considered the most important GHG, due primarily to the large quantity of emissions produced by fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles. CH_4 and N_2O are also emitted by fossil fuel combustion, though their emissions are much less significant than CO_2. CH_4 is also emitted from the transmission, storage, and incomplete combustion of natural gas.

The effect that each of these gases can have on global warming is a combination of the mass of their emissions and their global warming potential (GWP). GWP indicates, on a pound for pound basis, how much a gas is predicted to contribute to global warming relative to how much warming would be predicted to be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent GHGs than CO_2, with GWPs of 21 and 310, respectively.[2] In emissions inventories, GHG emissions are typically reported in terms of pounds (lbs) or tonnes[3] of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific GWP. While CH_4 and N_2O have much higher GWPs than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e, both from residential developments and human activity in general.

The Mission Village project is located within the South Coast Air Quality Management District's (SCAQMD) jurisdiction. However, because SCAQMD guidelines for the preparation of GHG inventories have not yet been developed, this inventory has been developed consistent with the methodologies established by the California Climate Action Registry (CCAR) where possible. When guidance from the CCAR is lacking, methodologies established by the Intergovernmental Panel on Climate Change (IPCC)[4] and best available science are used. Legislation and rules regarding climate change, as well as the scientific understanding of the extent to which different activities emit GHGs, continue to evolve; as such, the inventory in this report is a reflection of the guidance and knowledge currently available.

[2] GWP values from IPCC's Second Assessment Report (SAR, 1996) are still used by international convention and are used in this protocol, even though more recent (and slightly different) GWP values were developed in the IPCC's Third Assessment Report (TAR, 2001)

[3] In this report, "tonnes" will be used to refer to metric tonnes (1,000 kilograms). "Tons" will be used to refer to short tons (2,000 pounds).

[4] The WMO and the UNEP established the IPCC in 1988; it is open to all members of the United Nations and WMO.

At the entitlement stage of a development, while the number of homes, the approximate size of commercial areas and the locations of both are known, the exact designs of the homes, businesses and facilities are not. Information on the types of buildings and the types of facilities at the future Mission Village site can be used for developing an estimate of the project's anticipated GHG emissions. Energy used in a building depends in part on the built environment; however, actual future emissions from the site will depend heavily upon the future homeowners' and business owners' habits. Because the actual future occupants and their habits are not yet known, average current behavior is assumed. That assumption is likely to be a "worst-case" assumption. Given the current regulatory environment and the media focus on global climate change, it is likely that the actual future occupants will be more sensitive to the GHG emissions caused by their activities and, therefore, their activities will result in lower GHG emissions than average current behavior shows.

1.1 Emissions Inventory

The Mission Village emissions inventory considers the following categories of GHG emissions:

- emissions due to land use (vegetation) changes,
- emissions from construction activities,
- residential building operations emissions,
- non-residential building operations emissions,
- mobile source operations emissions,
- swimming pool operations emissions,
- area source emissions, and
- municipal operations emissions.

In addition, an estimate of “life-cycle” GHG emissions from building materials is presented. Life cycle emissions include all of the emissions caused by the existence of a product or project; for example, GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure. This estimate is to be used for comparison purposes only and is not included in the final inventory as these emissions would be accounted for under California's Global Warming Solutions Act of 2006 (AB 32) in other industry sectors. For a life cycle analysis for building materials, somewhat arbitrary boundaries must be drawn to define the processes considered in the life cycle analysis.[5] Although life cycle emission estimates can provide a broader view of a project’s emissions, life cycle analyses often double count emissions that might be attributable to other sectors in a comprehensive analysis.

The inventory does not consider GHG emissions from sources outside of Mission Village that may indirectly service Mission Village residents (e.g., a landfill) or whether the emissions from Mission Village are “new” in the sense that, absent the development of Mission Village, these

[5] For instance, in the case of building materials, the boundary could include the energy to make the materials, the energy used to make the machine that made the materials, and the energy used to make the machine that made the machine that made the materials.

emissions may not occur. However, emissions from electricity use and construction worker commuting are included.

The timeframe over which GHGs are emitted varies from category to category, which is taken into consideration in the emissions inventory. For most of the categories, GHGs will be emitted every year that the development is inhabited. For these categories (residential buildings, non-residential buildings, mobile sources, swimming pools, area sources, and municipal services), the inventory includes estimates of annual GHG emissions from ongoing development operations. GHG emissions from two of the categories, construction and changes in vegetation, are one-time events that will not be part of the development's ongoing activity. These one-time emissions can be divided by the estimated lifetime of the project to allow direct comparison of these two emissions classes. The inventory presents estimates of these one-time emissions, converts them to annualized estimates, and integrates them into an annual inventory.

The GHG emissions estimates contained in this report incorporate reductions in emissions from electricity generation and vehicle travel that will occur between now and full buildout from promulgated regulations. For example, the emissions estimated for electricity consumption assumes that there will be an increase in energy production from renewables or non-GHG producing sources given the requirements of the Renewable Portfolio Standard (RPS). This is further discussed in Section 4 of this report.

A variety of methods are employed to develop a complete GHG emissions inventory. In addition to well established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several emissions estimation software programs are used. These include EMFAC, OFFROAD, Urban Emissions Model (URBEMIS), California Residential Appliance Saturation Survey, and the California Commercial End-Use Survey (CEUS). Later sections of the report describe these models and other estimation methods. The major emissions sources that exist in residential developments are described later in this report.

1.2 Comparison of GHG Emissions

To date, the SCAQMD and California Air Resources Board (CARB) have not established significance thresholds for GHG emissions under the California Environmental Quality Act (CEQA) [6].

However, recent amendments to the CEQA Guidelines adopted by the California Natural Resources Agency became effective on March 18, 2010. [7] Specifically, CEQA Guidelines section 15064.4, subdivision (b) provides the following:

> A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:

[6] Both SCAQMD and ARB have recently released proposed significance thresholds, but these have not been finalized at this time.

[7] Available at: http://ceres.ca.gov/ceqa/docs/Adopted_and_Transmitted_Text_of_SB97_CEQA_Guidelines_Amendments.pdf

(1) The extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting;

(2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;

(3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an environmental impact report (EIR) must be prepared for the project.

The proposed GHG emissions from Mission Village are compared to other inventories to gain perspective on the impact these emissions may have. To evaluate the significance of Mission Village's GHG emissions, the Mission Village inventory is compared with the California Air Resources Board Scoping Plan projections for 2020 if "no actions are taken" (CARB 2020 NAT) scenario.

1.3 Report Description

This report contains seven sections. Following this introduction, Sections 2 and 3 detail the regulatory setting and the state of climate change science. Section 4 presents the results of the Mission Village GHG Inventory at full buildout. Section 4 also includes the quantitative effects of currently promulgated regulations on Mission Village's GHG emissions. Section 5 benchmarks these results to gain perspective on what impact the Mission Village development at full buildout will have on overall GHG emissions. Section 6 outlines the expected de-carbonization of the fuel supply and its relationship to California's 2050 GHG goals. Finally, the main findings from the report are summarized in the conclusion.

2 Regulatory Setting

Climate change has only recently been widely recognized as a threat to the global climate, economy and population. As a result, the climate change regulatory setting – federal, state and local – is complex and evolving. This section identifies key legislation, executive orders, and seminal court cases related to climate change germane to the Mission Village project GHG emissions.

2.1 Federal Action on Greenhouse Gas Emissions

2.1.1 Federal Action on Greenhouse Gas Emissions

In 2002, President George W. Bush set a national policy goal of reducing the GHG emission intensity (tons of GHG emissions per million dollars of gross domestic product) of the US economy by 18% by 2012. No binding reductions were associated with the goal. Rather, the United States Environmental Protection Agency (USEPA) administers a variety of voluntary programs and partnerships with GHG emitters in which the USEPA partners with industries producing and utilizing synthetic GHGs to reduce emissions of these particularly potent GHGs.

2.1.2 Supreme Court Endangerment Ruling

A 2007 U.S. Supreme Court decision also has influenced federal action on climate change (Massachusetts v. Environmental Protection Agency (2007) 549 U.S. 497). In that case, the Court ruled that the USEPA is authorized under the Clean Air Act (CAA) to regulate CO_2e emissions from new motor vehicles. While the Court did not mandate that the USEPA enact regulations to reduce GHG emissions, it found that the USEPA could only avoid taking action if it found that GHGs do not contribute to climate change or if it offered a "reasonable explanation" for not determining that GHGs contribute to climate change. The Court rejected the USEPA's arguments that: (1) voluntary programs already in place were sufficient to address global warming; and (2) the USEPA should not take action on climate change because it may conflict with the initiatives or negotiations of the Executive Branch.

In response to the Supreme Court decision, the USEPA issued an Advanced Notice of Proposed Rulemaking (ANPRM) in July 2008, subject to a 120-day comment period, to seek further comment on the regulation of GHG emissions pursuant to the Clean Air Act. Subsequently, on April 24, 2009, the USEPA issued proposed endangerment and cause or contribute findings, stating that high atmospheric levels of greenhouse gases "are the unambiguous result of human emissions, and are very likely the cause of the observed increase in average temperatures and other climatic changes." The USEPA further found that "atmospheric concentrations of greenhouse gases endanger public health and welfare within the meaning of Section 202 of the Clean Air Act." The USEPA announced that the proposed finding was adopted on December 7, 2009; while the finding itself does not impose any requirements on industry or other entities, it does enable the USEPA to adopt regulations designed to reduce greenhouse gas emissions. Legal actions have been filed, including by the State of Texas and industry groups, challenging adoption of the USEPA's findings.

The USEPA issued the proposed Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas Tailoring Rule. This rule proposes a different, higher threshold for carbon

dioxide equivalents than exists for other pollutants under the PSD program. On May 13, 2010, the USEPA issued a final rule that establishes a common sense approach to addressing greenhouse gas emissions from stationary sources under the CAA permitting programs. This final rule sets thresholds for GHG emissions that define when permits under the New Source Review PSD and Title V Operating Permit programs are required for new and existing industrial facilities. The tailoring rule currently has multiple thresholds ranging from 75,000 metric tonnes per year to 100,000 metric tonnes per year to determine when a facility must take action under these programs.

2.1.3 Corporate Average Fuel Efficiency Standards

In response to the *Massachusetts et al. vs. Environmental Protection Agency et al.* ruling, the Bush Administration issued an executive order on May 14, 2007, directing the USEPA and Departments of Transportation (DOT) and Energy (DOE) to establish regulations that reduce GHG emissions from motor vehicles, non-road vehicles, and non-road engines by 2008. On December 19, 2007, the Energy Independence and Security Act of 2007 (EISA) (discussed below) was signed into law, which requires an increased Corporate Average Fuel Economy (CAFE) standard of 35 miles per gallon for the combined fleet of cars and light trucks by model year 2020. EISA requires establishment of interim standards (from 2011 to 2020) that will be the "maximum feasible average fuel economy" for each fleet. On October 10, 2008, the National Highway Traffic Safety Administration (NHTSA) released a final environmental impact statement analyzing proposed interim standards for model years 2011 to 2015 passenger cars and light trucks. NHTSA issued a final rule for model year 2011 on March 23, 2009.[8]

During his presidential election campaign, President Barack Obama indicated he would support a national cap-and-trade program. In addition, on May 19, 2009, President Obama announced a national policy for fuel efficiency and emission standards in the U.S. auto industry. In response, on September 15, 2009, the U.S. Department of Transportation and USEPA issued a proposed rule that would apply to passenger cars, light-duty trucks, and medium duty passenger vehicles built in model years 2012 through 2016. As finalized in April 2010, the rule will improve average fuel economy standards to 35.5 miles per gallon by 2016. In addition, the rule will require model year 2016 vehicles to meet an estimated combined average emission level of 250 grams of carbon dioxide per mile. The implications of the rule include: (1) a 960 million metric tons reduction in carbon dioxide emissions over the lifetime of the vehicles regulated, which is equivalent to taking 50 million cars and light trucks off the road in 2030; (2) conservation of about 1.8 billion barrels of oil; and (3) enabling car buyers of 2016 models to enjoy a net savings of $3,000 over the lifetime of the vehicle.[9] Most recently, in late January 2010, President Obama pledged to reduce greenhouse gas emission from federal government operations by 28 percent over the next 10 years.

2.1.4 Energy Independence and Security Act of 2007

In addition to setting increased CAFE standards for motor vehicles, the EISA includes other provisions:

[8] See http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.43ac99aefa80569eea57529cdba046a0/

[9] For more information, please see http://www.epa.gov/otaq/climate/regulations.htm (last visited April 7, 2010).

- Renewable Fuel Standard (RFS) (Section 202);
- Appliance and Lighting Efficiency Standards (Section 301–325);
- Building Energy Efficiency (Sections 411–441).

Additional provisions of the EISA address energy savings in government and public institutions, promoting research for alternative energy, additional research in carbon capture, international energy programs, and the creation of "green jobs."

2.1.5 Reporting Requirements

Congress passed "The Consolidated Appropriations Act of 2008" (HR 2764) in December 2007, which includes provisions requiring the establishment of mandatory GHG reporting requirements. The measure directs USEPA to publish draft rules by September 2008, and final rules by June 2009 mandating reporting "for all sectors of the economy." On September 22, 2009, EPA Administrator Jackson signed a final rule mandating annual reporting of GHG emissions by suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions. This rule was created in response to the mandate established by the 2008 Consolidated Appropriations Act, on April 10, 2009. The USEPA issued the final reporting regulation on October 30, 2009. Effective December 29, 2009, the regulation requires suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of greenhouse gas emissions to submit annual reports to the USEPA.

2.2 Regional Agreements

2.2.1 Western Regional Climate Action Initiative (WCI)

The WCI is a partnership among seven states, including California, and four Canadian provinces that are implementing a regional, economy-wide cap-and-trade system to reduce global warming pollution. The WCI will cap the region's electricity, industrial, and transportation sectors with the goal of reducing the heat-trapping emissions that cause global warming 15% below 2005 levels by 2020. California is working closely with the other states and provinces to design a regional GHG reduction program that includes a cap-and-trade approach. CARB plans to develop a cap-and-trade program that will link California and the other member states and provinces.

2.3 California Legislation

California has enacted a variety of legislation that relates to climate change, much of which sets aggressive goals for GHG reductions within the state. However, none of this legislation provides definitive direction regarding the treatment of climate change in environmental review documents prepared under the CEQA.

2.3.1 Assembly Bill 32 (Statewide GHG Reductions)

The California Global Warming Solutions Act of 2006, widely known as AB 32, requires CARB to develop and enforce regulations for the reporting and verification of statewide greenhouse gas emissions. CARB is directed to set a greenhouse gas emission limit, based on 1990 levels,

to be achieved by 2020. The bill sets a timeline for adopting a scoping plan for achieving greenhouse gas reductions in a technologically and economically feasible manner.

The heart of the bill is the requirement that statewide GHG emissions must be reduced to 1990 levels by 2020. California needs to reduce GHG emissions by approximately 29% below business-as-usual predictions of year 2020 GHG emissions to achieve this goal.[10] The bill requires CARB to adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective GHG reductions. Key AB 32 milestones are as follows:

- June 30, 2007—Identification of discrete early action greenhouse gas emissions reduction measures. On June 21, 2007, CARB satisfied this requirement by approving three early action measures. These were later supplemented by adding six other discrete early action measures.
- January 1, 2008—Identification of the 1990 baseline GHG emissions level and approval of a statewide limit equivalent to that level. Adoption of reporting and verification requirements concerning GHG emissions. On December 6, 2007, CARB approved a statewide limit on GHG emissions levels for the year 2020 consistent with the determined 1990 baseline.
- January 1, 2009—Adoption of a scoping plan for achieving GHG emission reductions. On October 15, 2008, CARB issued a "discussion draft" Scoping Plan entitled "Climate Change Draft Scoping Plan: A Framework for Change" (Draft Scoping Plan). CARB adopted the Draft Scoping Plan at its December 11, 2008 meeting.
- January 1, 2010—Adoption and enforcement of regulations to implement the “discrete” actions.
- January 1, 2011—Adoption of GHG emissions limits and reduction measures by regulation.
- January 1, 2012—GHG emissions limits and reduction measures adopted in 2011 become enforceable.

2.3.2 Executive Order S-3-05 (Statewide GHG Targets)

California Executive Order S-03-05 (June 1, 2005) mandates a reduction of GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80% below 1990 levels by 2050. Although the 2020 target is the core of AB 32, and has effectively been incorporated into AB 32, the 2050 target remains the goal of the Executive Order.

[10] (596 - 427) / 596 = 28.35%. In this report we may sometimes conservatively state 28.5% or 29%. “[C]ARB staff estimated 2020 business-as-usual GHG emissions, which represent the emissions that would be expected to occur in the absence of any GHG reductions actions. [C]ARB staff estimates the statewide 2020 business-as-usual greenhouse gas emissions will be 596 $MMTCO_2E$. Emission reductions from the recommended measures in the Scoping Plan total 169 $MMTCO_2E$, allowing California to attain the 2020 emissions limit of 427 $MMTCO_2E$.” http://www.arb.ca.gov/cc/inventory/data/forecast.htm

2.3.3 Low Carbon Fuel Standard (LCFS)

Executive Order S-01-07 (January 18, 2007) requires a 10% or greater reduction in the average fuel carbon intensity for transportation fuels in California regulated by CARB. CARB identified the LCFS as a Discrete Early Action item under AB 32, and the final resolution (09-31) was issued on April 23, 2009.[11]

2.3.4 Senate Bill 1368 (GHG Emissions Standard for Baseload Generation)

Senate Bill (SB) 1368 prohibits any retail seller of electricity in California from entering into a long-term financial commitment for baseload generation if the GHG emissions are higher than those from a combined-cycle natural gas power plant. This performance standard applies to electricity generated out-of-state as well as in-state, and to publicly owned as well as investor-owned electric utilities.

2.3.5 Assembly Bill 1493 (Mobile Source Reductions)

AB 1493 requires CARB to adopt regulations by January 1, 2005, to reduce GHG emissions from noncommercial passenger vehicles and light-duty trucks of model year 2009 and thereafter. The bill requires the CCAR to develop and adopt protocols for the reporting and certification of greenhouse gas emissions reductions from mobile sources for use by CARB in granting emission reduction credits. The bill authorizes CARB to grant emission reduction credits for reductions of greenhouse gas emissions prior to the date of enforcement of regulations, using model year 2000 as the baseline for reduction.

In 2004, CARB applied to the USEPA for a waiver under the federal Clean Air Act to authorize implementation of these regulations. The waiver request was formally denied by the USEPA in December 2007 after California filed suit to prompt federal action. In January 2008 the State Attorney General filed a new lawsuit against the USEPA for denying California's request for a waiver to regulate and limit GHG emissions from these automobiles. In January 2009, President Barack Obama issued a directive to the USEPA to reconsider California's request for a waiver. On June 30, 2009, the USEPA granted the waiver for California for its greenhouse gas emission standards for motor vehicles. As part of this waiver, EPA specified the following provision: CARB may not hold a manufacturer liable or responsible for any noncompliance caused by emission debits generated by a manufacturer for the 2009 model year.

2.3.6 Senate Bills 1078 and 107 (Renewables Portfolio Standard)

Established in 2002 under SB 1078 and accelerated in 2006 under SB 107, California's RPS requires retail suppliers of electric services to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 20% by 2010.

2.3.7 Executive Order S-14-08 (Renewables Portfolio Standard)

California Executive Order S-14-08 (November 11, 2008) mandates retail suppliers of electric services to increase procurement from eligible renewable energy resources to 33% by 2020. This is a further increase in RPS over SBs 1078 and 107.

[11] See http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

2.3.8 Executive Order S-21-09 (Renewables Portfolio Standard)

California Executive Order S-21-09 (September 15, 2009) mandates that "the ARB, under its AB 32 authority, shall adopt a regulation consistent with the 33 percent renewable energy target established in Executive Order S-14-08 by July 31, 2010."[12]

2.3.9 Senate Bill 375 (Land Use Planning)

Senate Bill 375 (SB 375) was passed by the California Legislature on September 1, 2008, and chaptered into law on September 30, 2008. SB 375 requires CARB, working in consultation with California's metropolitan planning organizations (MPOs), to set regional GHG reduction targets for the automobile and light truck sector for 2020 and 2035. CARB must provide each MPO with its reduction target by September 30, 2010. Each MPO then must incorporate the assigned GHG reduction target into its Regional Transportation Plan (RTP), which is used for long-term transportation planning, via a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS). Certain transportation planning and programming activities will need to be consistent with the SCS; however, SB 375 expressly provides that the SCS does not regulate the use of land, and further provides that local land use plans and policies (e.g., general plan) are not required to be consistent with either the RTP or SCS.

In accordance with SB 375, on January 23, 2009, CARB appointed a Regional Targets Advisory Committee (RTAC) to provide recommendations and methodologies to be used in the target setting process. The RTAC provided its recommendations in a report to CARB on September 29, 2009. On June 30, 2010, CARB staff issued the Draft Regional Greenhouse Gas Emission Reduction Targets For Automobiles And Light Trucks Pursuant To Senate Bill 375. With respect to the SCAG region, CARB staff proposed a draft reduction target of 5 to 10 percent for 2020, and a placeholder reduction target of 3 to 12 percent for 2035. The emissions reduction will be measured relative to 2005 levels and as a percent reduction in per capita emissions associated with passenger vehicles and light trucks. Of note, the proposed reduction targets explicitly exclude emission reductions expected from the AB 1493 and low carbon fuel standard regulations.

SB 375 includes CEQA streamlining provisions for "transit priority projects," so long as the projects are consistent with the SCS. As defined in SB 375, a "transit priority project" shall: (1) contain at least 50 percent residential use, based on total building square footage and, if the project contains between 26 and 50 percent nonresidential uses, a floor area ratio of not less than 0.75; (2) provide a maximum net density of at least 20 dwelling units per acre; and (3) be within 0.5 mile of a major transit stop or high quality transit corridor.

2.3.10 Energy Conservation Standards

The Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24), found in the California Code of Regulations, originally were established in 1978 in response to a legislative mandate to reduce California's energy consumption. Title 24 governs energy consumed by the built environment for commercial and residential buildings in California. This includes the heating, ventilation and air conditioning (HVAC) system, water heating, and some fixed lighting. (Non-building energy use, or "plug-in" energy use, is not covered by Title 24.) The

[12] http://gov.ca.gov/executive-order/13269/

Title 24 standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods. The CEC adopted a new set of standards on April 23, 2008, and the California Building Standards Commission approved them for publication on September 11, 2008. These new 2008 standards became effective on January 1, 2010, such that all applications for building permits submitted after that date will be subject to the 2008 standards.

Title 24 does not specify building dimensions (e.g., size, height, or orientation) and provides significant flexibility for window types, window amounts, insulation choice, and other parameters. Software is often used to calculate whether a building is Title 24 compliant by quantifying the built-environment energy use per square foot per year and the Time Dependent Valuation (TDV) of the energy use per square foot per year.[13] Title 24 compliance is based on TDV and not on annual energy use.

California's 2009 Appliance Efficiency Regulations were adopted by the CEC on December 3, 2008, and approved by OAL on July 10, 2009. The regulations include standards for both federally regulated appliances and non-federally regulated appliances, and reduce greenhouse emissions by reducing energy demand.

In early January 2010, the California Building Standards Commission unanimously adopted the first-in-the-nation mandatory statewide green building code—referred to as, CALGREEN. Taking effect on January 1, 2011, these comprehensive regulations will achieve major reductions in emissions, energy consumption and water use to create a greener California. CALGREEN will require that every new building constructed in California reduce water consumption by 20 percent, divert 50 percent of construction waste from landfills and install low pollutant-emitting materials. It also requires separate water meters for nonresidential buildings' indoor and outdoor water use, with a requirement for moisture-sensing irrigation systems for larger landscape projects and mandatory inspections of energy systems (e.g., heat furnace, air conditioner and mechanical equipment) for nonresidential buildings over 10,000 square feet to ensure that all are working at their maximum capacity and according to their design efficiencies. CARB estimates that the mandatory provisions will reduce greenhouse gas emissions by 3 million metric tons equivalent in 2020.[14]

2.3.11 Senate Bill 97 (CEQA Guidelines)

SB 97 required that California Natural Resource Agency (CNRA) coordinate on the preparation of amendments to the CEQA Guidelines regarding feasible mitigation of greenhouse gas

[13] TDV energy use is a parameter that speaks to the electricity burden that a building puts on the electric system. In general, there is a larger demand on the electricity supply system during the day (peak times) than at night (off peak). This results in a higher stress on the electricity delivery system per marginal unit electricity delivered at peak times. Therefore, the calculation of TDV weights energy used at different times at different values. For instance, for the same annual electricity use, a building that uses more electricity during the peak mid-day electrical usage period will have a higher TDV value.

[14] See Governor Schwarzenegger's Press Release regarding Statewide Green Building Standards Code, available at http://gov.ca.gov/press-release/14186/ (last visited March 10, 2010).

emissions or the effects of greenhouse gas emissions. Pursuant to SB 97, CNRA adopted CEQA Guidelines amendments on December 30, 2009. The amendments were approved by the Office of Administrative Law on February 16, 2010, and became effective on March 18, 2010.

With respect to the significance assessment, newly added CEQA Guidelines section 15064.4, subdivision (b), provides:

> A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:
>
> (1) The extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting;
>
> (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;
>
> (3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

The Guidelines apply retroactively to any incomplete environmental impact report, negative declaration, mitigated negative declaration, or other related document.[15]

The amendments also provide that lead agencies should consider all feasible means of mitigating greenhouse gas emissions that substantially reduce energy consumption or GHG emissions. These potential mitigation measures may include carbon sequestration. If off-site or carbon offset mitigation measure are proposed they must be part of reasonable plan of mitigation that the agency itself is committed to implementing. No threshold of significance or any specific mitigation measures are indicated.

Among other things, CNRA noted in its Public Notice for these changes that impacts of GHG emissions should be considered in the context of a cumulative impact, rather than a project impact. The Public Notice states:

> "While the Proposed Amendments do not foreclose the possibility that a single project may result in greenhouse gas emissions with a direct impact on the environment, the

[15] Senate Bill No. 97. CHAPTER 185. An act to add Section 21083.05 to, and to add and repeal Section 21097 of, the Public Resources Code, relating to the California Environmental Quality Act. http://www.opr.ca.gov/ceqa/pdfs/SB_97_bill_20070824_chaptered.pdf

evidence before [CNRA] indicates that in most cases, the impact will be cumulative. Therefore, the Proposed Amendments emphasize that the analysis of greenhouse gas emissions should center on whether a project's incremental contribution of greenhouse gas emissions is cumulatively considerable."

2.3.12 CARB Preliminary Draft Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases Under the California Environmental Quality Act (Draft CARB Thresholds)

In October 2008, CARB released a draft proposal for identifying CEQA thresholds of significance for industrial, commercial and residential developments. The Draft CARB Thresholds propose a framework for developing thresholds of significance that rely upon the incorporation of a variety of performance measures to reduce GHG emissions associated with a project, as well as a numerical threshold of significance above which a project must include detailed GHG analysis in an EIR and incorporate all feasible mitigation measures. Although CARB proposed a 7,000 tons per year threshold for industrial projects, a numerical threshold for commercial and residential projects was not proposed, but is under development. In addition, the Draft CARB Thresholds incorporate SB 375 by providing that commercial and residential projects that comply with a previously approved plan, which, essentially, satisfies SB 375 and for which a certified final CEQA document has been prepared, is presumed to have a less than significant impact related to climate change. As of this time, CARB has suspended its work on CEQA thresholds.

2.4 Local Air Quality Management District (SCAQMD) Policies

On December 5, 2008, the SCAQMD Governing Board adopted its staff proposal for an interim CEQA GHG significance threshold for projects where the SCAQMD is the lead agency (i.e., industrial (stationary source) projects). To achieve a policy objective of capturing 90% of GHG emissions from new residential/commercial development projects and implement a "fair share" approach to reducing emission increases from each sector, SCAQMD staff has proposed combining performance standards and screening thresholds. The performance standards suggested have primarily focused on energy efficiency measures beyond Title 24 Part 6, California's building energy efficiency standards, and an undetermined screening level of tonnes CO_2e per year based on direct operational emissions. Above this screening level, project design features designed to reduce GHGs must be implemented to reduce the impact to below a level of significance. SCAQMD staff are performing additional analyses to further define the performance standards and quantitative screening level.

2.5 Los Angeles County Policies

Los Angeles County (LA County) does not have any rules or regulations directly governing the emission of GHGs. However, there are several LA County policies and regulations that bear on GHG emissions. These are described below.

2.5.1 Countywide Energy and Environmental Policy (January 2007)

In January 2007, the LA County Board of Supervisors adopted the Countywide Energy and Environmental Policy which provides guidelines for sustainability and green building design within County departments. The Policy states that the County will join the CCAR to establish

goals for reducing GHG emissions. In addition, the policy incorporates a sustainable building program into County capital improvement projects and seeks to integrate energy efficient and sustainable designs into future County building plans.[16]

For example, as of January 16, 2007, the County's Capital Construction Program must achieve Leadership in Energy and Environmental Design (LEED) Silver Certification for new County (government) buildings greater than 10,000 square feet (sq ft); this included 53 projects in the 2007-2008 Capital Program.

2.5.2 Los Angeles County's Green Building Ordinances

In November 2008, LA County adopted green building, low impacted development, and drought-tolerant landscaping ordinances. With respect to green building, the County requires buildings to consume 15% less energy than authorized per the 2005 Title 24 standards. In addition, for building permit applications filed on or after January 1, 2010, the ordinance requires that LEED or LEED-equivalent ratings be met. In sum, the various requirements imposed by the green building ordinance conserve water, conserve energy, conserve natural resources, divert waste from landfills, minimize impacts to existing infrastructure, and promote a healthier environment. For more information, please see Title 21 and 22 of the LA County Code.

2.5.3 Los Angeles County Board of Supervisors Meeting, January 13, 2009

In 2009, LA County Board of Supervisors directed the Chief Executive Officer to take actions towards increasing the use of the renewable energy.[17] The actions focused upon cost-benefit analyses. One study would examine Los Angeles County offsetting between 10% and 100% of current electrical needs through the use of renewable energy, including the purchase of renewable energy credits. Another would compare costs and benefits of purchasing electricity from renewable energy sources to the costs and benefits of investing money in improving the energy efficiency of the County's operations.

The county would also conduct a cost analysis, feasibility assessment and recommendations regarding constituent-focused initiatives to be included in the Program. The proposal would include an analysis of community choice aggregation, home energy audits, financing of residential renewable energy products, and other initiatives as deemed appropriate.

[16] http://lacounty.info/bos/sop/supdocs/29480.pdf and http://lacounty.info/bos/sop/supdocs/29932.pdf (ENVIRON 2008).

[17] Board minutes on January 13, 2009. http://file.lacounty.gov/bos/supdocs/47117.pdf

3 State of Science

This section summarizes the scientific issues surrounding climate change and global warming. It also provides a discussion of the actions and phenomena that contribute to climate change and puts into context global, national, and state emissions of GHGs.

3.1 Global Climate Change

Global warming and *global climate change* are both terms that describe changes in the earth's climate. *Global climate change* is a broad term used to describe any worldwide, long-term change in the earth's climate. This change could be, for example, an increase or decrease in temperatures, the start or end of an ice age, or a shift in precipitation patterns. The term *global warming* is more specific than *global climate change* and refers to a general increase in temperatures across the earth. Though global warming is characterized by rising temperatures, it can cause other climatic changes, such as a shift in the frequency and intensity of rainfall or hurricanes. Global warming does not necessarily imply that all locations will be warmer. Some specific, unique locations may be cooler even though the world, on average, is warmer. All of these changes fit under the umbrella of global climate change.[18]

While global warming can be caused by natural processes, there is a general scientific consensus that most current global warming is the result of human activity on the planet.[19] This man-made, or anthropogenic, warming is primarily caused by increased emissions of "GHGs" that keep the earth's surface warm. This is called "the greenhouse effect." The greenhouse effect and the role GHGs play in it are described below.

3.2 The Greenhouse Effect

Greenhouses allow sunlight to enter and then capture some of the heat generated by the sunlight's impact on the earth's surface. The earth's atmosphere acts like a greenhouse by allowing sunlight in, but trapping some of the heat that reaches the earth's surface. When solar radiation from the sun reaches the earth, much of it penetrates the atmosphere to ultimately reach the earth's surface; this solar radiation is absorbed by the earth's surface and then re-emitted as heat in the form of infrared radiation.[20] Whereas the GHGs in the atmosphere let solar radiation through, the infrared radiation is trapped by greenhouse gases, resulting in the warming of the earth's surface.[21] This phenomenon is referred to as the "greenhouse effect".

The earth's greenhouse effect has existed far longer than humans have and has played a key role in the development of life. Concentrations of major GHGs, such as CO_2, CH_4, N_2O, and water vapor have been naturally present for millennia at relatively stable levels in the

[18] Other definitions of "Greenhouse Effect" and "Global Warming" can be found on Merriam-Webster online: http://www.m-w.com/. A definition for "Climate Change" can be found on dictionary.com which uses Webster's New Millennium™ Dictionary of English, Preview Edition (v 0.9.6).

[19] From the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers." Available online at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

[20] All light, be it visible, ultraviolet, or infrared, carries energy.

[21] Infrared radiation is characterized by longer wavelengths than solar radiation. Greenhouse gases reflect radiation with longer wavelengths. As a result, instead of escaping back into space, greenhouse gases reflect much infrared radiation (i.e., heat) back to Earth.

atmosphere, adequate to keep temperatures on Earth hospitable. Without these GHGs, the earth's temperature would be too cold for life to exist.

As human industrial activity has increased, atmospheric concentrations of certain GHGs have grown dramatically. Figure 2-1 shows the increase in concentrations of CO_2 and CH_4 over time. In the absence of major industrial human activity, natural processes have maintained atmospheric concentrations of GHGs, and, therefore, global temperatures at constant levels over the last several centuries.[22] As the concentrations of GHGs increase due to human activity, more infrared radiation is trapped, and the earth is heated to higher temperatures. This is the process that is described as human-induced global warming.

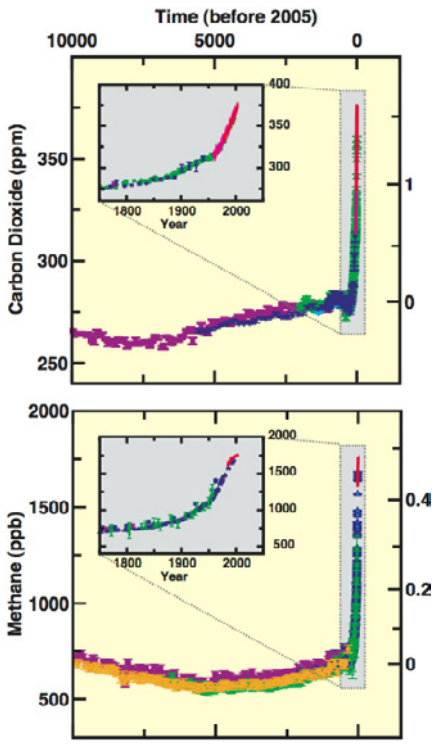

Figure 2-1. Carbon dioxide and methane concentrations have increased dramatically since the industrial revolution.[23]

In 2007, the IPCC began releasing components of its Fourth Assessment Report on climate change. In February 2007, the IPCC provided a comprehensive assessment of climate change science in its Working Group I Report.[24] It states that there is a scientific consensus that the global increases in GHGs since 1750 are mainly due to human activities such as fossil fuel use, land use change (e.g., deforestation), and agriculture. In addition, the report states that it is likely that these changes in greenhouse gas concentrations have contributed to global warming.

[22] Examples of natural processes include the addition of GHGs to the atmosphere from respiration, fires, and decomposition of organic matter. The removal of greenhouse gases is mainly from plant and algae growth and absorption by the ocean.

[23] Adapted from figure SPM-1 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers." Available online at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

[24] Available online at: http://www.ipcc.ch/ipccreports/ar4-wg1.htm

Confidence levels of claims in this report have increased since 2001 due to the large number of simulations run and the broad range of available climate models.

3.3 Greenhouse Gases and Sources of Their Emissions

The term "GHGs" includes gases that contribute to the natural greenhouse effect, such as CO_2, CH_4, N_2O, and water, as well as gases that are only man-made and that are emitted through the use of modern industrial products, such as hydrofluorocarbons (HFCs), chlorinated fluorocarbons (CFCs), and sulfurhexafluoride (SF_6). These last three families of gases, while not naturally present in the atmosphere, have properties that also cause them to trap infrared radiation when they are present in the atmosphere, thus making them GHGs. These six gases comprise the major GHGs that are recognized by the Kyoto Accords (water is not included).[25] There are other GHGs that are not recognized by the Kyoto Accords, due either to the smaller role that they play in climate change or the uncertainties surrounding their effects. Atmospheric water vapor is not recognized by the Kyoto Accords because there is not an obvious correlation between water concentrations and specific human activities. Water appears to act in a positive feedback manner; higher temperatures lead to higher water concentrations, which in turn cause more global warming.[26]

The effect each of these gases has on global warming is a combination of the volume of their emissions and their GWP. GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent than CO_2, with GWPs of 21 and 310, respectively. However, these natural GHGs are nowhere near as potent as SF_6 and fluoromethane, which have GWPs of up to 23,900 and 6,500 respectively.[27] GHG emissions are typically measured in terms of mass of CO_2e. CO_2e are calculated as the product of the mass of a given GHG and its specific GWP.

The most important greenhouse gas in human-induced global warming is CO_2. While many gases have much higher GWPs than the naturally occurring GHGs, CO_2 is emitted in such vastly higher quantities that it accounts for 85% of the GWP of all GHGs emitted by the United States.[28] Fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles, has led to substantial increases in CO_2 emissions and thus substantial increases in atmospheric CO_2 concentrations. In 2005, atmospheric CO_2 concentrations were about 379 parts per million (ppm), over 35 percent higher than the pre-industrial concentrations of about 280 ppm.[29] In addition to the sheer increase in the volume of its emissions, CO_2 is a major factor in human-induced global warming because of its lifespan in the atmosphere of 50 to 200 years.

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[25] This Kyoto Protocol sets legally binding targets and timetables for cutting the greenhouse-gas emissions of industrialized countries. The US has not approved the Kyoto treaty.

[26] From the IPCC Third Assessment Report: http://www.grida.no/climate/ipcc_tar/wg1/143.htm and http://www.grida.no/climate/ipcc_tar/wg1/268.htm

[27] California Climate Action Registry General Reporting Protocol - Reporting Entity-Wide Greenhouse Gas Emissions. SAR values, Appendix C. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

[28] Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006, US Environmental Protection Agency. Available online at: http://epa.gov/climatechange/emissions/downloads/08_CR.pdf

[29] Page 2 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."

Concentrations of the second most prominent GHG, CH_4, have also increased due to human activities such as rice production, degradation of waste in landfills, cattle farming, and natural gas mining. In 2005, atmospheric levels of CH_4 were more than double pre-industrial levels, up to 1774 parts per billion (ppb) as compared to 715 ppb.[30] CH_4 has a relatively short atmospheric lifespan of only 12 years, but has a higher GWP than CO_2.

Nitrous oxide concentrations have increased from about 270 ppb in pre-industrial times to about 319 ppb by 2005.[31] Most of this increase can be attributed to agricultural practices (such as soil and manure management), as well as fossil-fuel combustion and the production of some acids. Nitrous oxide's 120-year atmospheric lifespan increases its role in global warming.

Besides CO_2, CH_4, and N_2O; there are several gases and categories of gases that were not present in the atmosphere in pre-industrial times but now exist and contribute to warming. These include CFCs, used often as refrigerants, and their more stratospheric-ozone-friendly replacements, HFCs. Fully fluorinated species, such as SF_6 and tetrafluoromethane (CF_4), are present in the atmosphere in relatively small concentrations, but have extremely long life spans of 50,000 and 3,200 years each, making them potent GHGs.

3.4 Current and Projected Climatic Impacts of Global Warming

A strong indication that global warming is currently taking place is the fact that the top seven warmest years since the 1890s occurred after 1997. Furthermore, a warming of about 0.2°C per decade is projected by currently accepted models.

There is a scientific consensus that global climate change will increase the frequency of heat extremes, heat waves, and heavy precipitation events. Other likely direct effects include an increase in the areas affected by drought and by floods, an increase in tropical cyclone activity, a rise in sea level, and recession of polar ice caps. The impacts of global warming have already been demonstrated by substantial ice loss in the Arctic.[32] Figure 2-2 shows the rise of global temperatures, the global rise of sea level, and the loss of snow cover from 1850 to the present.

[30] Page 4 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."
[31] Page 4 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."
[32] Statistics from IPCC Working Group I and II Reports.

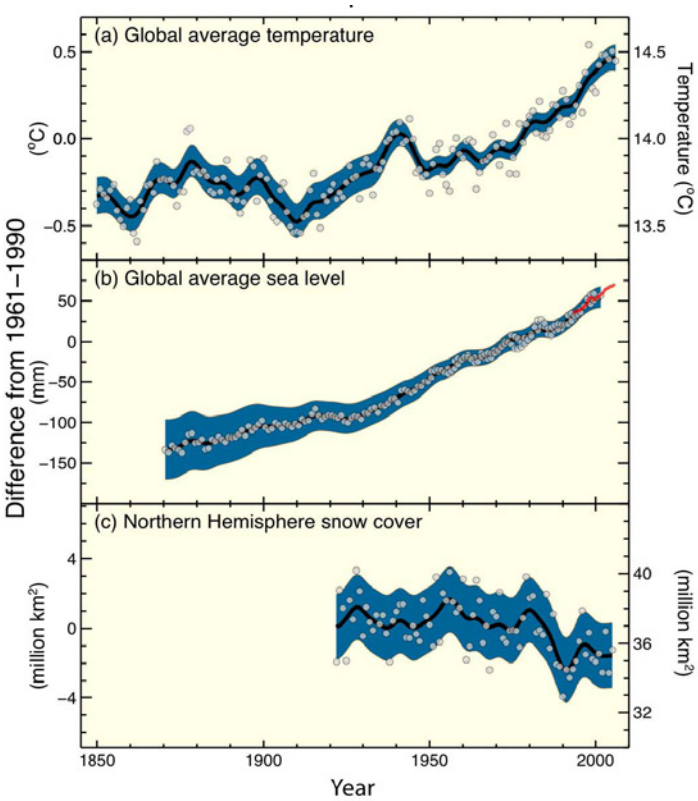

Figure 2-2. Global warming trends and associated sea level rise and snow cover decrease.[33]

3.5 Socioeconomic Impacts of Global Warming

Global temperature increases may have significant negative impacts on ecosystems, natural resources, and human health. Ecosystem structure and biodiversity will be compromised by temperature increases and associated climatic and hydrological disturbances.[34] The availability and quality of potable water resources may be compromised by increased salinisation of ground water due to sea-level rises, decreased supply in semi-arid and arid locations, and poorer water quality arising from increased water temperatures and more frequent floods and droughts.[35] These impacts on freshwater systems, in addition to the effects of increased drought and flood frequencies, can reduce crop productivity and food supply.

In addition to compromising food and water resources, there are other means through which climatic changes associated with global warming can affect human health and welfare. Warmer temperatures can cause more ground-level ozone, a pollutant that causes eye irritation and respiratory problems. Ranges of infectious diseases will likely increase, and some areas will face greater incidences of illness and mortality associated with increased flooding and drought events.

[33] Figure SPM-3 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."

[34] From the IPCC Working Group II Report.

[35] From the IPCC Technical Paper VI: "Climate Change and Water". Available online at: http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf

In its April 2007 Working Group II Report, the IPCC provided an assessment of the "current scientific understanding of impacts of climate change on natural, managed and human systems, the capacity of these systems to adapt and their vulnerability".[36] Here, the IPCC states that although some people will gain and some will lose because of global climate change, the overall change will be one of social and economic losses. California in particular is an area that could be negatively impacted by global warming. Global warming could alter the seasonal pattern of snow accumulation and snowmelt, which serve as primary sources for California's drinking water and irrigation water supplies. The scientific community projects extensions in the periods of high forest fire risk. Climatic changes would also affect agriculture, a major California industry, which could result in economic losses. For example, the heat wave in July 2006 is estimated to have cost the California dairy industry in excess of one billion dollars.[37]

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It is important to recognize that the climatic conditions experienced by the Project over its designed lifetime are likely to be substantially different from those observed over the past century. Consequently, it is useful to consider the implications of changing climatic conditions for Project performance. Scenarios[38] for 2100 modeled in the IPCC Fourth Assessment Report include:

Temperature Increase

- Low Emissions Scenario: 1.8°C (best estimate), with a range of 1.1°C to 2.9°C
- High Emissions Scenario: 4.0°C (best estimate), with a range of 2.4°C to 6.4°C

Sea Level Rise

- Low Emissions Scenario: 0.18 to 0.38 meters (range)
- High Emissions Scenario: 0.26 to 0.59 meters (range)

Potential implications for the Project include:

Sea level: Rising sea levels are unlikely to directly impact the proposed Project due to its distance from the coast and relative elevation.

Temperature: Rising temperatures could have a variety of impacts, including stress on sensitive populations (e.g., sick and elderly), additional burden on building systems (e.g., demand for

[36] Available online at: http://www.ipcc-wg2.org/index.html

[37] Office of the Governor.

[38] Future GHG emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change. Their future evolution is highly uncertain. Scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including climate modeling and the assessment of impacts, adaptation, and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain. More information on the IPCC's selection of scenarios is available at http://www.ipcc.ch/ipccreports/sres/emission/index.htm.

conditioning), and, indirectly, increasing emissions of greenhouse gases and criteria pollutants associated with energy generation. It is not possible to reliably quantify these risks at this time.

Precipitation: Climate change is expected to alter seasonal and inter-annual patterns of precipitation. These changes continue to be one of the most uncertain aspects of future scenarios. For this Project, the most relevant direct impacts are likely to be changes in the timing and volume of storm water runoff and changes in demand for irrigation. It is not possible to reliably quantify the implications of these changes at this time.

Wildfire: Changes in temperature and precipitation may combine to alter risks of wildfire. Changes in wildfire hazard have the potential to impact the Project; however, it is not possible to reliably quantify the implications of these changes at this time.

Water supply reliability: Changes in temperature and precipitation may also influence seasonal and inter-annual availability of water supplies. Consequently, it is reasonable to consider that climate change may affect water supply reliability. It is not possible to reliably quantify these risks for the Project at this time. For more information on the Project's water supply, please refer to Section 5.18, Water Resources, and the Water Supply Assessment in the EIR.

3.6 Impacts from Climate Change

The CNRA[39] recently prepared a document that discusses the impacts of climate change upon California, as well as California's climate adaptation strategy. The categories below are topics emphasized in the November 2008 Executive Order (S-13-08) which called on state agencies to develop California's first strategy to identify and prepare for these expected climate impacts. Adaptation strategies are addressed in the next section of this technical report.

3.6.1 Rising Temperatures

CRNA described new projections by MIT modelers predict a median probability of surface warming of 5.2 C by 2100, which is much higher than previous modeling completed in 2003.[40] Researchers modeled temperature changes specifically related to California.[41] The model predicted greater temperature increases in summer than winter, and larger increases inland compared to the coast.

3.6.2 Tipping Elements

The CNRA emphasized "tipping elements", which bring about "abrupt changes that could push natural systems past thresholds beyond which they could not recover". According to the CNRA, there are four main events that could bring about abrupt environmental changes. Each of these four has a particular tipping temperature at which the event is likely to occur. The consequence

[39] 2009 California Climate Adaptation Strategy. Discussion Draft. California Natural Resources Agency.

[40] Chandler, D. 2009. Climate change odds much worse than thought: New analysis shows warming could be double previous estimates. MIT News Office. May 19, 2009. Website: http://web.mit.edu/newsoffice/2009/roulette-0519.html

[41] Incorporated by reference. Moser, Susanne, Guido Franco, Sarah Pittiglio, Wendy Chou and Dan Cayan (2008). The Future is Now: An Update on Climate Change Science Impacts and Response Options for California. 2008 Climate Change Impacts Assessment Project - Second Biennial Science Report to the California Climate Action Team, CEC-500-2008-071, Sacramento, CA.

of crossing each threshold could cause a 7-12 m rise in sea level over the course of several centuries as shown in the table below.

Tipping elements that could trigger abrupt environmental changes.

Additional Warming (ºF)	Environmental Change	Length of Time
1-3	Rapid Arctic sea ice melt	10 years
2-4	Irreversible melting of the Greenland Ice Sheet	300 years or more
5-9	Irreversible melting of the West Antarctic Ice Sheet	300 years or more
5-7	Amazon forest die-back	None given
6-11	Intensification of El Niño-Southern Oscillation cycles	None given

3.6.3 Extreme Natural Events

In addition, CRNA listed extreme natural events are likely to occur, including higher nighttime temperatures and longer, more frequent heat waves overall; 12-35% decrease in precipitation levels by mid- to late-21st century; increased evaporation and faster incidences of snowmelt that will increase drought conditions, and more precipitation in the form of rain as compared to snow that will decrease water storage in California during the dry season and increase flood events during the wet season.[42]

3.6.4 Precipitation Changes and Rivers

CNRA also stated that climate change will intensify California's "Mediterranean climate pattern", with the majority of annual precipitation occurring between November and March and drier conditions during the summer.[43] This will increase droughts and floods and will affect river systems. One of the ways to quantify potential impacts related to river system was through calculating a rise in water temperature and its effects on fisheries resources. [44]

3.6.5 Sea Level Rise

CNRA states that sea level rise can cause damage to coastal communities and loss of land, which could reach tens of billions of dollars per year in direct costs and trillions of dollars of assets in collateral risk. [45] Current calculations of sea level rise from 1900 to 2000 estimate

[42] Cayan, Dan, Mary Tyree, Mike Dettinger, Hugo Hidalgo, Tapash Das, Ed Maurer, Peter Bromirski, Nicholas Graham, and Reinhard Flick (2009). Climate Change Scenarios and Sea Level Rise Estimates for the California 2008 Climate Change Scenarios Assessment. PIER Research Report, CEC-500-2009-014, Sacramento, CA: California Energy Commission.

[43] Cayan et al. 2009

[44] Crossin, G.T., S.G. Hinch, S.J. Cooke, D.W. Welch, D.A. Patterson, S.R.M. Jones, A.G. Lotto, R.A. Leggatt, M.T. Mathes, J.M. Shrimpton, G. Van Der Kraak and A.P. Farrell. 2008. Exposure to high temperature influences the behaviour, physiology, and survival of sockeye salmon during spawning migration. Canadian Journal of Zoology. 86(2): 127-140.

[45] Kahrl, F. and D. Roland-Holst (2008). California Climate Risk and Response. Berkeley, CA: University of California-Berkeley, Department of Agricultural and Resource Economics.

approximately 7 inches along the California coast.[46] Further, up to 55 inches of sea-level rise globally by the end of the 21st century is predicted under the business as usual scenario.

3.6.6 Low Sea Ice Levels

The CNRA states says that substantial sea ice melting from Greenland and the West Antarctic Ice Sheet has the potential to further raise sea levels. The sea ice extent in the Western Nordic Seas (i.e., Greenland, Norway, and Iceland Seas) is at the lowest level observed in the last 800 years. The implication being that a substantial reduction in sea ice in the Arctic sea promotes alterations in atmospheric circulation and precipitation patterns that extend to the mid-latitudes (e.g., the California coast). Additionally, it was reported that the variations in sea ice extent are correlated with changes in sea surface temperatures and atmospheric and ocean heat transport from the North Atlantic.[47]

The West Antarctic Ice Sheet is a marine-based ice sheet with edges that flow into floating ice shelves. Both the main sheet and the surrounding shelves have been showing signs of shrinking and collapsing due to global warming. Researchers have tracked the fate of at least nine shelves that have receded or collapsed around the Antarctic peninsula in the past 50 years.[48]

3.6.7 Ocean Chemistry

The CRNA also notes that an emerging effect from climate change may be acidification of the ocean. In turn, acidification will affect the ability of hard-shelled invertebrates to create their skeletal structures.[49] The implications of this change being major losses to shellfish industries, and shifts in food resources for ocean fisheries. The primary contributing factors were cited as increasing level of CO_2 and weather pattern shifts (Griffith et al. 2008). Increases in CO_2 result in increased uptake by the oceans, which result in decreased pH (acidification). Weather pattern shifts change the amount of calcium carbonate being delivered by rivers from sources stored in rocks, which further exacerbates the ability of invertebrates to form calcified shells.[50]

One of the main contributing factors to CO_2, outside of human influences, is melting permafrost. When permafrost thaws, it releases carbon into soil or beneath lakes and releases CO_2 and methane into the atmosphere. Scientists are now estimating that there is more than twice the total amount of carbon stored in permafrost as there is in atmospheric carbon dioxide, and "could amount to roughly half those resulting from global land-use change during this century".[51]

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[46] Cayan et al. 2009

[47] Fauria, M.M., A. Grinsted, S. Helama, J. Moore, M. Timonen, T. Martma, E. Isaksson, and E. Eronen. 2009. Unprecedented low twentieth century winter sea ice extent in the Western Nordic Seas since A.D. 1200. Climate Dynamics. Published online: 12 June 2009.

[48] Doyle, A. 2009. Antarctic ice shelf set to collapse due to warming. Roche, A. (ed) In Reuters UK. Thomas Reuters. January 19, 2009. Website: http://uk.reuters.com/articlePrint?articleId=UKTRE50I4G520090119

[49] Risien, J. (ed.). 2009. West Coast Regional Marine Research and Information Needs. Corvallis, Oregon: Oregon Sea Grant. ORESU-Q-09-001.

[50] Griffith, E.M., A. Paytan, K. Caldeira, T. D. Bullen and E. Thomas. 2008. A dynamic marine calcium cycle during the past 28 million years. Science. December 12, 2008.

[51] Schuur, E.A.G. et al. 2008. Vulnerability of Permafrost Carbon to Climate Change: Implications for the Global Carbon Cycle. BioScience. 58(8): 701-714.

3.7 California-specific Adaptation Strategies

The CNRA[52] discusses California's climate adaptation strategy. General themes from the report regarding adaptation strategies are summarized below although the report also includes many specific examples of how California may adapt to a changing climate.

Because climate change is already affecting California and current emissions will continue to drive climate change in the coming decades, regardless of any mitigation measured that may be adopted, the necessity of adaptation to the impacts of climate change is recognized by the state of California. The *2009 California Climate Adaption Strategy Discussion Draft* begins what will be on-going process of adaptation, as directed by Gov. Schwarzenegger's Executive Order S-13-08. The goals of the strategy are to analyze risks and vulnerabilities and identify strategies to reduce the risks. Once the strategies are identified and prioritized, government resources would be identified. Finally, the strategy includes identifying research needs and educating the public.

Climate change risks are evaluated using two distinct approaches: (1) projecting the amount of climate change that may occur using computer-based global climate models and (2) assessing the natural or human system's ability to cope with and adapt to change by examining past experience with climate variability and extrapolating this to understand how the systems may respond to the additional impact of climate change. The major anticipated climate changes expected in the State of California include increases in temperature, decreases in precipitation, particularly as snowfall, and increases in sea level, as discussed above. These gradual changes will also lead to an increasing number of extreme events, such as heat waves, wildfires, droughts, and floods. This would impact public health, ocean and coast resources, water supply, agriculture, biodiversity and the transportation and energy infrastructure.

Key preliminary adaptation recommendations included in the *Strategy* are as follows:

- Appointment of a Climate Adaption Advisory Panel;
- Improved water management in anticipation of reduced water supplies, including a 20% reduction in per capita water use by 2020;
- Consideration of project alternatives that avoid significant new development in areas that cannot be adequately protected from flooding due to climate change;
- Preparation of agency-specific adaptation plans, guidance or criteria by September 2010;
- Consideration of climate change impacts for all significant state projects;
- Assessment of climate change impacts on emergency preparedness;
- Identification of key habitats and development of plans to minimize adverse effects from climate change;
- Development of guidance by the California Department of Public Health by September 2010 for use by local health departments to assess adaptation strategies;
- Amendment of Plans to assess climate change impacts and develop local risk reduction strategies by communities with General Plans and Local Coastal Plans; and

[52] 2009 California Climate Adaptation Strategy. Discussion Draft. California natural Resources Board.

- Inclusion of climate change impact information into fire program planning by state fire fighting agencies.

3.8 Global, National, and California-wide GHG Emissions Inventories

Worldwide emissions of GHGs in 2004 were 26.8 billion tonnes of CO_2e.[53] In 2007, the US emitted about 7 billion tonnes of CO_2e or about 24 tonnes of CO_2e per year per person.[54] Over 80% of the GHG emissions in the US are comprised of CO_2 emissions from energy related fossil fuel combustion. In 2004, California emitted 0.492 billion tonnes of CO_2e, or about 7% of the US emissions.[55] If California were a country, it would be the 16th largest emitter of GHGs in the world.[56] This large number is due primarily to the sheer size of California. Compared to other states, California has one of the lowest per capita GHG emission rates in the country. This is due to California's higher energy efficiency standards, its temperate climate, and the fact that it relies on substantial out-of-state energy generation.

In 2004, 81% of greenhouse gas emissions (in CO_2e) from California were comprised of CO_2 emissions from fossil fuel combustion, with 4% comprised of CO_2 from process emissions. CH_4 and N_2O accounted for 5.7% and 6.8% of total CO_2e respectively, and high GWP gases[57] accounted for 2.9% of the CO_2e emissions. Transportation is by far the largest end-use category of GHG emissions. Transportation includes that used for industry (i.e., shipping) as well as residential use.

3.9 Potential for Reduction of GHG Emissions

In May 2007, the IPCC produced its Working Group III Report on the "scientific, technological, environmental, economic and social aspects" of reducing GHG emissions to alleviate climate change.[58] The report concluded that, even with current policies for sustainable development and mitigation of climate change, global GHG emissions will continue to grow over the next several decades.

[53] Sum of Annex I and Annex II countries without counting Land-Use, Land-Use Change and Forestry (LULUCF) http://unfccc.int/ghg_emissions_data/predefined_queries/items/3814.php For countries for which 2004 data was unavailable, the most recent year was used.

[54] 2006 Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007. Available online at: http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR6MBLP4/$File/06ES.pdfhttp://www.epa.gov/climatechange/emissions/usgginv_archive.html

[55] California Air Resources Board. Note that 2004 is typically the most recent inventory year presented by the ARB; as such, USA- and world-wide emissions from 2004 are presented here to keep the comparison years the same.

[56] Anywhere between the 12th and 16th depending upon methodology. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. California Energy Commission.

[57] Such as HFCs and PFCs.

[58] Available online at: http://www.ipcc.ch/ipccreports/ar4-wg3.htm

4 Greenhouse Gas Inventory

This section describes the methods that ENVIRON International Corporation (ENVIRON) used to estimate GHG emissions from Mission Village after development and full buildout, and presents the results of that analysis. ENVIRON evaluated GHG emissions from some aspects that are fully within the control of the Newhall Land and Farming Company, such as grading and the placement of utilities; some aspects that are in control of the builders, such as construction emissions; and some aspects for which control over emissions is shared by the developers, builders, and the residents, such as energy use in the built environment and traffic emissions from the development's future residents and employees. In addition, an estimate of "life-cycle" GHG emissions (i.e., GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure) is presented. This life-cycle estimate is to be used for comparison purposes only and is not included in the final inventory, as these emissions would be attributable to other industry sectors under AB 32. Each aspect of the GHG inventory is described in this section. The inventory does not consider GHG emissions from most sources outside of Mission Village that may indirectly service the residents (e.g., a landfill).

4.1 Evaluation of "New" Emissions

Whereas criteria pollutants have impacts on a local or regional basis, GHG emissions' impacts are on a global basis. Accordingly, the methods used to analyze GHG emissions vary somewhat from those used to analyze criteria pollutants. This section discusses the traditional analyses used in environmental documents for criteria pollutants, and goes on to discuss how the inventory of GHG emissions should be characterized.

4.1.1 Traditional Analyses for Criteria Pollutants

The calculation of "project" criteria pollutants (oxides of nitrogen, sulfur oxides, carbon monoxide, volatile organic compounds, lead, and particulate matter) in air quality emissions inventories for use in EIRs has a long history. The SCAQMD first published a comprehensive manual on the analysis of air quality impacts in 1993, and the Bay Area Air Quality Management District (BAAQMD) followed in 1999. Other smaller districts have prepared detailed guidance documents that describe the methods that should be used to calculate emissions inventories for EIRs from projects, including residential and commercial projects.

The goal of estimating emissions of criteria pollutants from projects is to understand whether there are significant new emissions in California's air basins, which have a limited ability to absorb additional criteria pollutant emissions without adverse air quality impacts.

When evaluating the air quality impacts for a new project, such as a residential development, the vehicular emissions associated with the residents as they work and shop within the basin are counted as new emissions in traditional air quality analyses, even if those new residents would have moved from another house in the same air basin. The typical rationale for this approach is that the new residential development represents growth in the basin. As a result, all emissions associated with its residents' vehicle travel should be counted as new emissions, even if this might lead to some over-counting of criteria pollutant emissions from the project.

A review of how air quality analyses deal with the issue of whether emissions are "new" might be instructive as to how to deal with the emissions of GHGs. However, while a similar approach for criteria pollutants and GHGs may be warranted, the impacts of GHG emissions are a function of their global concentrations, rather than local concentrations.

4.1.2 Regional Impacts of Criteria Pollutants Compared to Global Impacts of GHG Emissions

If construction results in new emissions of criteria pollutants in the air basin, even if there is a corresponding reduction in criteria emissions elsewhere, these emissions are new to the basin and therefore are counted. For GHGs, if the emissions simply moved from one basin to another, the emissions would not be new on a global scale. However, it is not clear how one can determine whether emissions are relocated, or whether they are the result of new growth.

Standard methodologies for evaluating the airborne criteria pollutant impacts of new projects have already, in a sense, addressed the issue of what is "new." However, the impacts of GHG emissions differ from those of criteria pollutants in that GHG emission impacts are a function of global concentrations rather than local concentrations. Thus, the question of whether or not a project's GHG impacts are significant, both on a project basis and on a cumulative basis, must be addressed based on global, rather than basin-wide, increases in emissions.

4.1.3 Determining Which Emissions are Associated with New Residences

GHG increases are directly tied to population growth and increased standards of living. New housing in California is a response to both population increase, and increasing standard of living for new California residents that moved from areas that were less economically developed. Therefore, operational emissions (including vehicular emissions) from new residences should be considered as growth, or new emissions, as residences are rarely removed from the housing supply once constructed.[59]

In addition, activities associated with new residences, such as the building energy-related emissions from commercial and retail establishments that are built to support new residences, are also included. Traffic between new residences and new retail is also accounted for, as these trips are directly associated with the new residences. However, traffic associated with trips between new commercial or retail and existing residences is not considered new,[60] and is not accounted for in this report. That traffic already exists from the existing residences, and the construction of new commercial or retail does not increase traffic, unless the average trip distance to that commercial or retail establishment increases as a result of the new construction.

In this report, emissions associated with construction and vegetation change are counted. Emissions associated with the electricity and natural gas use in all buildings are included. Emissions associated with delivering water to the site and from treating wastewater are

[59] There are exceptions, such as when one housing development replaces another, and, in those cases, the replacement residential development need not be considered growth.

[60] If, however, the new commercial area results in longer trips for its workers and residents than they would have previously made, then it adds GHGs emissions. Commercial development that could potentially increase VMT would be facilities that draw trips from far away that otherwise would not be made. A theme park, for example, may be viewed as such a development.

counted. All home-based car travel made by Mission Village residents are counted as Mission Village emissions, even if the vehicles leave the site. A small number of pass-by trips made by Mission Village residents may not be considered using this method. However, the additional vehicle miles traveled (VMT) (and therefore emissions) associated with these pass-by trips is estimated to be small. Emissions from non-Mission Village vehicles that enter the project site are not included because those emissions would have occurred absent Mission Village. For instance, workers that live in Bakersfield but would now work in Mission Village, and thus would commute to work in Mission Village. These workers commuted before the existence of Mission Village – perhaps within Bakersfield or to Los Angeles. Therefore, in this analysis, it is assumed that these workers commute the same distances, on average, as before the existence of Mission Village and therefore they do not contribute to any net new GHG emissions.

4.2 Units of measurement: Tonnes of CO_2 and CO_2e

The term "GHGs" includes gases that contribute to the natural greenhouse effect, such as CO_2, CH_4, N_2O, and water, as well as gases that are only man-made and that are emitted through the use of modern industrial products, such as HFCs and CFCs. The most important greenhouse gas in human-induced global warming is CO_2. While many gases have much higher GWPs than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for 85% of the GWP of all GHGs emitted by the United States.[61]

The effect each of these gases has on global warming is a combination of the mass of their emissions and their GWP. GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent than CO_2, with GWPs of 21 and 310, respectively. GHG emissions are typically measured in terms of mass of CO_2e. CO_2e emissions are calculated as the product of the mass of a given GHG and its specific GWP.

In many sections of this report, including the final summary sections, emissions are presented in units of CO_2e because the GWPs of CH_4 and N_2O were accounted for explicitly, or the CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from that particular emissions category.

In this report, 'tonnes' will be used to refer to metric tonnes (1,000 kilograms). The term 'tons' will be used to refer to short tons (2,000 lbs). Additionally, the totals presented in all tables and report sections may not equal the sum of components due to independent rounding of numbers.

4.3 Resources

To estimate GHG emissions from Mission Village, ENVIRON directly or indirectly relied primarily on five different types of resources:

1) emissions estimation guidance from government-sponsored organizations,

2) government-commissioned studies of energy use patterns,

[61] Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007, US Environmental Protection Agency. Available online at: http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf

3) energy surveys by other consulting firms, and

4) emissions estimation software.

These sources are described in more detail below.

4.3.1 Emissions Estimation Guidance

This inventory was developed using guidance from two government-sponsored organizations to assist in the estimation of GHG emissions. The first is the CCAR, which was established by the California Legislature to assist willing parties in estimating and recording their GHG emissions to use as a baseline for meeting future emissions reduction requirements. Publications by the CCAR include not only recommendations on how to compile a GHG emissions inventory, but also relevant data on energy use and emissions that are utilized in this protocol. The second organization is the IPCC, which was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The IPCC's main role is to assess information on climate change which is detailed in IPCC reports, including methodology reports. These reports also include relevant emission factors and specific scientific data that can be used to estimate GHG activities from various activities.

4.3.2 Emissions and Energy Use Studies

For estimating emissions based on electrical and natural gas energy use, literature information on patterns of energy use must often be employed. Studies commissioned by the California Energy Commission (CEC) provide data on energy use patterns associated with municipal activities and other activities that will take place in Mission Village. These data were used to estimate energy use patterns which were applied to the specific characteristics of Mission Village to estimate GHG emissions. In addition to CEC studies, studies performed by individual municipalities or scientific organizations are also used in this report.

4.3.3 Emissions Estimation Software

CARB, the SCAQMD, and other public and private organizations have developed several software programs to facilitate the calculation of emissions from construction, motor vehicles, and urban developments by streamlining emissions estimation from these sources. This inventory was developed using several models to estimate GHG emissions from the Mission Village development. These are the OFFROAD2007 model, the EMFAC model, and the URBEMIS model. The features of each of these models are described below.

OFFROAD – OFFROAD2007 is the most recent version of a model developed by CARB to estimate the activity and emissions of off-road mobile emissions sources, such as construction equipment. OFFROAD contains a database of default values for horsepower, load factor, and hours per day of operation and can calculate emission factors based on the type of equipment and year of use.

EMFAC – EMFAC, also developed by CARB, compiles real fleet data on the county-level for the state of California, including vehicle model year distributions, vehicle class (e.g., light-duty auto (LDA), medium-duty truck, heavy-heavy-duty truck) distributions, and emission rate information to generate fleet-average emission factors for most criteria

pollutants and CO_2. EMFAC2007 is the newest version of the program. Emission factors from EMFAC depend on the vehicle class, vehicle technology, speed, year of operation, average ambient air temperature, and relative humidity.

URBEMIS – The URBEMIS software was created by SCAQMD, although it is used by other air districts as well. It estimates emissions associated with different aspects of urban development. The Operational Data module in URBEMIS calculates emissions from mobile sources operating during the use of a development based on emission factors from EMFAC and traffic use information specific to a development. Mobile source emissions during the construction phase are calculated separately in the construction module of URBEMIS. URBEMIS provides county, air district / air basin, or state wide averages for number of daily trips per housing unit and per student at an elementary school in the absence of more specific information from traffic engineers. URBEMIS also provides air district-specific default values for vehicle fleet characteristics (vehicle class distribution and technology categories) and travel conditions (average trip length, trip speed, and relative frequency of each type of trip). URBEMIS (Versions 9.2.2 and 9.2.4),[62] uses EMFAC2007 emission factors and calculates CO_2 emissions using District-specific default parameters for various inputs including vehicle fleet characteristics and travel conditions.

In addition to mobile source emissions, URBEMIS can also calculate emissions associated with the construction phase of a development, as well as emissions from area sources, such as fireplaces, once the development is operational. The URBEMIS construction module enables separate emission calculations from each of the three typical stages of any construction project: demolition, site grading, and building construction. Based on the timing of construction and size of the development, URBEMIS defaults can be used to estimate emissions. Alternatively, the user can override these defaults by entering specific information about the construction project, such as what types and numbers of equipment are going to be used. In terms of area sources, URBEMIS is equipped to estimate GHG emissions from three types of GHG-emitting area sources based either on program defaults or more specific project information inputted by the user. These uses are natural gas fuel combustion, hearth fuel combustion, and landscaping equipment.

4.4 Impact of Regulatory Developments on Mission Village's GHG Inventory

Promulgated regulations that will affect Mission Village's emissions are accounted for in this inventory. In particular, the Pavley Standards and the RPS will be in effect at the time of buildout of Mission Village, and therefore are accounted for in the Mission Village emission calculations. This section provides an overview on the impact of these two rules (RPS and Pavley) on Mission Village's GHG inventory.

The RPS and the Pavley standards and associated emission reductions are quantitatively accounted for in the Mission Village inventory and further discussed later in this report.

[62] All versions of URBEMIS 9.2.x follow the same methodologies and do not contain any relevant differences.

4.4.1 Renewable Power Requirements

A major component of California's Renewable Energy Program is the RPS established under SBs 1078 (Sher) and 107 (Simitian). Under the RPS, certain retail sellers of electricity are required to increase the amount of renewable energy each year by at least 1% in order to reach at least 20% by December 31, 2010. California is now considering an even higher goal of 33% by 2020; however, this has not yet been promulgated. Renewable sources of electricity include wind, small hydropower, solar, geothermal, biomass, and biogas. The increase in renewable sources for electricity production will decrease indirect GHG emissions from Mission Village because electricity production from renewable sources is generally considered "carbon neutral."[63] For purposes of this analysis, ENVIRON assumes that the production of electricity from these renewable sources does not produce any net emissions of CO_2.

As noted above, indirect GHG emissions are associated with electricity use. The electricity used in a building is typically generated offsite at the power plant; because of this, electricity use in a building generally causes emissions in an indirect manner. The Mission Village development is supplied power by Southern California Edison (SCE). The 2007 SCE carbon-intensity factor is 631 lbs of CO_2e per megawatt hour (MWh)[64] and the 2006 SCE carbon-intensity factor is 641 lbs of CO_2e per MWh. These emission factors take into account the mix of energy sources used to generate electricity for SCE[65] during 2007 and 2006, respectively, and the relative carbon intensities of these sources.[66] SCE's 2007 mix of energy sources contains 13% of renewable sources. The RPS requires that utilities increase this mix to 20% by 2020.[67] Thus, at full buildout, it is anticipated that the carbon intensity factor will be 583 lb/MW-hr. The details of the calculation of the carbon intensity factor are presented later in this section. All calculations in this section accounting for the indirect GHG emissions from electricity use will use the carbon-intensity anticipated with implementation of the 20% renewable portfolio.

If the proposed 33% renewables target for 2020 were achieved, the CO_2 emission factor would decrease even further to 488 lbs CO_2/MWh. This 33% renewables goal was conservatively not accounted for in this analysis because it has not yet become law.

4.4.2 Vehicle Emissions Standards/Improved Fuel Economy

The two regulatory measures considered in this section are the vehicle GHG emission standards enacted under AB 1493 (Pavley) and the increased fuel economy standards under

[63] There is some debate on the carbon neutrality of using biomass and biogas for electricity production. While some may argue that the carbon released as CO_2 from biomass or biogas combustion originated from the atmosphere and thus does not contribute any net additional carbon to the atmosphere, others argue that the combustion still releases CO_2 into the atmosphere and thus cannot be ignored. For sake of the analysis presented here, we assume that electricity production from renewable sources is carbon neutral.

[64] California Climate Action Registry (CCAR) Database. Southern California Edison PUP Report. 2007.

[65] Natural gas, nuclear, coal, wind, solar, biogas, biomass, hydropower, and geothermal.

[66] When calculating indirect emissions due to electricity usage, it is important to consider that indirect emissions from using a given amount of electricity will vary with the fuel-mix used to produce electricity. For example, CO_2 emissions per kWh from a coal-fired power plant are significantly higher than CO_2 emissions per kWh from a natural gas-fired power plant. Therefore, to most accurately estimate GHG emissions from the Mission Village development, the carbon intensity of the specific mix of energy sources SCE uses to generate electricity was used to calculate emissions since SCE is the most likely source of electricity for Mission Village.

[67] The RPS requires 33%, but currently, only the commitment to 20% is law. 2002 Senate Bill 1078 and 2006 Senate Bill 107.

the EISA. The Pavley standards require GHG emission reductions from vehicles equivalent to approximately 30% by 2016.[68] This accounts for an approximately 20% reduction in 2020 GHG emissions across the passenger car and light duty truck fleet in California. The EISA requires that manufacturers achieve a CAFE of 35 mpg by 2020. USEPA is preparing a joint rulemaking with the Department of Transportation to establish vehicle GHG emissions and new CAFE standards that are similar to Pavley through 2016.[69]

4.5 Vegetation Change

This section presents the calculation of the positive and negative GHG emissions associated with vegetation removal and re-vegetation at the Mission Village development. The removal of existing vegetation can contribute to net GHG increases by reducing existing carbon sequestration capacity.[70] Following buildout of the Mission Village project, many privately owned areas will become re-vegetated with trees, shrubs and other vegetation. These re-vegetated areas could potentially sequester more CO_2 from the atmosphere than they did pre-development. The difference between the total before-development sequestered CO_2 and the after-development sequestered CO_2 is the one-time CO_2 released from clearing the vegetation less the CO_2 sequestered by new plantings.[71] The overall CO_2 emissions due to vegetation change will result from two processes: 1) the change in the amount of CO_2 sequestered by vegetation removed from the site, which would lead to a one-time GHG release, and 2) the amount that can be expected to be sequestered by new plantings. Both issues are discussed in this section.

In this section of this report, the units CO_2 and CO_2e are used interchangeably. CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from vegetation change.

4.5.1 Quantifying the One-Time Release by Changes in Carbon Sequestration Capacity

The one-time release of GHGs due to changes in carbon sequestration capacity was calculated using the following four steps:[72]

1. Identify and quantify the change in area of various land types due to the development (i.e. alluvial scrub, non-native grassland, agricultural, etc.): These area

[68] The standards start in model year 2009, and ramp up to a 30 percent reduction in greenhouse gas emissions for vehicles sold in model year 2016 and beyond. Source: Comparison of Greenhouse Gas Reductions for the United States and Canada Under US CAFE Standards and California Air Resources Board Greenhouse Gas Regulations, California Air Resources Board an Enhanced Technical Assessment February 25, 2008. http://www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf

[69] Source: "EPA and NHTSA Propose Historic National Program to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks", EPA-420-F-09-047a, September 2009. Available online at: http://www.epa.gov/oms/climate/regulations/420f09047a.htm

[70] In this section, it is assumed that all mature land-types (at least 20 years old) are at steady-state. See The World Resource Institute (WRI) "Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting" protocol available online at: http://www.wri.org/publication/land-use-land-use-change-and-forestry-guidance-greenhouse-gas-project-accounting

[71] In this section we assume that mature ecosystems do not have a net flux of carbon into or out of them.

[72] This section follows the IPCC guidelines, but has been adapted for ease of use for the Mission Village development.

changes include not only the area of land that will be converted to houses or commercial space, but also areas disrupted by the construction of associated borrow and grading areas. Areas temporarily disturbed that will eventually[73] recover to become vegetated will not be counted as vegetation removed as there is no net change in vegetation or land use.[74]

2. Estimate the biomass associated with each land type: For the purposes of this protocol, ENVIRON has listed the land types that are present at the Mission Village development site and characterized them using the available general vegetation types found in the IPCC publication Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines).[75] This characterization is shown in Table 4-A-1. The general IPCC vegetation types are as follows:

   Forest Land;

   Grass Land;

   Wetland;

   Cropland; and

   Settlements.

   California vegetation is heavily dominated by scrub and chaparral vegetation, which may not be accurately characterized by default forest or grass land properties. Consequently, ecological zones and biomass-based subdivisions identified in the IPCC Guidelines were used to sub-categorize the vegetation. The biomass values for each vegetation type are based on these categories, which relate the Mission Village vegetation to the IPCC vegetation types. Forest land, grass land and crop land categories and subcategories were used to determine the CO_2 emissions resulting from land use impacts at Mission Village. The total impacted area occupied by wetlands and settlements was negligible, hence GHG emissions from these areas were also assumed to be negligible.

3. Calculate CO_2 emissions from the net change of vegetation: When vegetation is removed, it may undergo biodegradation,[76] or it may be combusted. Either pathway results in the carbon (C) present in the plants being combined with oxygen (O_2) to form CO_2. To estimate the mass of carbon present in the biomass, biomass weight

[73] In this section, it is assumed that all mature land-types (at least 20 years old) are at steady-state. See The World Resource Institute (WRI) "Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting" protocol available online at: http://www.wri.org/publication/land-use-land-use-change-and-forestry-guidance-greenhouse-gas-project-accounting

[74] This assumption facilitates the calculation as a yearly growth rate and CO_2 removal rate does not have to be calculated. As long as the disturbed land will indeed return to its original state, this assumption is valid for time periods over 20 years.

[75] Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

[76] Cleared vegetation may also be deposited in a landfill or compost area, where some anaerobic degradation which will generate CH_4 may take place. However, for the purposes of this section, we are assuming that only aerobic biodegradation will take place which will result in CO_2 emissions, only.

is multiplied by the carbon fraction, 0.47.[77] The mass of carbon is multiplied by 3.67[78] to calculate the final mass of CO_2, assuming all of this carbon is converted into CO_2. The results of this calculation are shown in Table 4-A-1 for each type of vegetation.

4. Calculate the overall change in sequestered CO_2: For all types of land that change from one type of land to another,[79] the differences between initial and final values of sequestered CO_2 are calculated using the equation below.

Overall Change in Sequestered CO_2 [tonne CO_2]

$$= \sum_i (SeqCO_2)_i \times (area)_i - \sum_j (SeqCO_2)_j \times (area)_j$$

Where:

$SeqCO_2$	=	mass of sequestered CO_2 per unit area [tonne CO_2/acre]
area	=	area of land for specific land use type [acre]
i	=	index for final land use type
j	=	index for initial land use type

Table 4-A-1 shows the effective change in the amount of sequestered CO_2 due to the change in land use of the developed area for each land type. The total equivalent CO_2 emissions attributable to the net change of vegetation are approximately 30,082 tonnes.

4.5.2 Calculating CO_2 Sequestration by Trees

Planting individual trees on residential property will sequester CO_2. Changing vegetation as described above results in a one-time carbon-stock change. Planting trees is also considered to result in a one-time carbon-stock change. Table 4-A-2 presents default annual CO_2 sequestration rates on a per tree basis, based on values provided by the IPCC. The numbers given are for 10 likely species classes in urban areas and range from a high of 0.052 tonne CO_2 per year in hardwood maple to a low of 0.012 tonne CO_2 per year in juniper trees. Alternatively, an average of 0.035 tonne CO_2 per year per tree can be assumed for trees planted, if the tree type is not known.

Urban trees are only net carbon sinks when they are actively growing. The IPCC assumes an active growing period of 20 years. Thereafter, the accumulation of carbon in biomass slows with age, and will be completely offset by losses from clipping, pruning, and occasional death. Of course, actual active growing periods are subject to, among other things, species, climate regime, and planting density. In this report, the IPCC default value of 20 years will be assumed. Note that trees may also be replaced at the end of the 20-year cycle, which will result in additional years of carbon sequestration. However, this will be offset by the potential net release of carbon from the removal of the replaced tree.

[77] The fraction of the biomass weight that is carbon. From Table 4.3 of IPCC (2006), default forestland and agricultural land ratio. Here, a carbon fraction of 0.47 is used for all vegetation types. CCAR assumes a similar value of 0.5 in its Forest Sector Protocol.

[78] The ratio of the molecular mass of CO_2 to the molecular mass of carbon is 44/12 or 3.67.

[79] For example from forestland to grassland, or from cropland to permanently developed.

Approximately 4,985 new net trees will be planted in Mission Village.[80] Planting these trees will sequester approximately 3,531 tonnes of CO_2. This was calculated by using the average tree sequestration rate of 0.035 tonnes CO_2 per year per tree and assuming 20 years of growth. This sequestration brings the net CO_2 emissions from vegetation change to: 30,082 tonnes (vegetation removal) – 3,531 tonnes (4,985 net new trees) = 26,550 tonnes.

4.6 Construction Activities

This section describes the estimation of GHG emissions from construction activities at Mission Village. There are three major construction phases for an urban development: 1) demolition, 2) site grading, and 3) building construction. There will not be a demolition phase for this development since the construction will occur on previously undeveloped land. The building construction phase can be broken down into three subphases: 1) building construction, 2) architectural painting, and 3) asphalt paving. GHG emissions from these construction phases are largely attributable to fuel use from construction equipment and worker commuting. [81]

Three programs, the URBEMIS[82] model, the OFFROAD2007[83] model, and the EMFAC2007[84] model, have the capability to calculate construction CO_2 emissions. URBEMIS estimates emissions associated with different aspects of urban development. The Construction Data module in URBEMIS Version 9.2.4 calculates emissions from construction sources based on emission factor data from OFFROAD2007, EMFAC2007, and construction equipment use information specific to the development.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for diesel construction equipment because CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from construction equipment. For worker commuting, CH_4 and N_2O are explicitly calculated and therefore CO_2 and CO_2e for worker commuting are not equal.

4.6.1 Estimating GHG Emissions from Construction Phases

Impact Sciences provided ENVIRON with URBEMIS runs for Mission Village construction from 2008 – 2012 (see Appendix A for details). URBEMIS calculates CO_2 emissions from offroad construction equipment, worker commuting, and vendor trips based on the size and type of buildings specified by the user and URBEMIS defaults.[85]

[80] Personal communications with Newhall Land.

[81] GHG emissions from painting / coating is from worker commuting only. However, worker commuting during the painting phase is typically a very small, and is therefore not included in this analysis.

[82] Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.4 – 2008). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District. http://www.urbemis.com

[83] California Air Resources Board Mobile Source Emissions Inventory Program. December 2006. http://www.arb.ca.gov/msei/offroad/offroad.htm

[84] EMission FACtors (EMFAC2007) model (Version 2.3). November 2006. California Air Resources Board. http://www.arb.ca.gov/msei/onroad/latest_version.htm

[85] URBEMIS generated values for vendor trip length, vendor trips per building built, and number of pieces of equipment.

Table 4-B-1 presents the overall construction emissions for Mission Village. The total amount of GHG emissions from grading and building construction, including worker commuting during those phases is 82,781 tonnes CO_2e.

4.6.2 Uncertainties in Construction GHG Emissions Calculations

URBEMIS inputs for phase length and number of construction equipment during construction of buildings were supplied by Impact Sciences. These values represent URBEMIS default values and settings. As such, these values are first-order approximations only. Updating these parameters with actual construction estimator estimates will provide more refined emissions.

4.7 GHG Emissions Associated with Residential Buildings

Residential buildings include single-family homes, attached homes, apartments, and condominiums. This section describes the methods used to estimate the GHGs associated with activities in those buildings.[86] As discussed earlier in Section 4.4.1, the RPS will increase the renewable fraction of electricity deliveries to 20%, and that is incorporated into the estimation of GHGs from electricity in this section.

The amount of energy, and, therefore, the associated GHG emissions emitted per dwelling unit, varies with the type of residential building. Accordingly, some information on the type of residential buildings that are planned for Mission Village is needed to estimate GHG emissions. The Newhall Land and Farming Company provided data summarizing the main residential building categories for Mission Village. The major types of residential buildings are:

a. Single-family homes;
b. Attached townhouses or condominiums (i.e., duplexes, triplexes, etc.); and
c. Apartments.

GHGs are emitted as a result of activities in residential buildings when electricity and natural gas are used as energy sources. Combustion of any type of fuel emits CO_2 and other GHGs directly into the atmosphere; when this occurs in a residential building, it is a direct emission source[87] associated with that building. GHGs are also emitted during the generation of electricity from fossil fuels. When electricity is used in a residential building, the electricity generation typically takes place offsite at the power plant; hence, electricity use in a residential building generally causes emissions in an indirect manner.

While fuel combustion generates CH_4 and N_2O, the emissions of these GHGs typically comprise less than 1% of CO_2e emissions from electricity generation and natural gas consumption.[88] Fuel oil, kerosene, liquefied petroleum gas, and wood can also be used as fuels but will likely contribute only in small amounts as combustion sources within residential buildings. According to Newhall, there will be no wood-burning hearths in the dwelling units at Mission Village.

[86] The emissions per unit energy (electricity) used in this section incorporates the renewables energy requirement from the RPS as discussed in the previous sections of this report.

[87] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.1 (January). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf Chapter 8

[88] Ibid., Tables C1 and C2. The methane and nitrous oxide emission factors are negligible compared to the total CO_2 emission factor for electricity generation in California.

Energy use in residential buildings is divided into energy consumed by the built environment and energy consumed by uses that are independent of the construction of the building, such as plug-in appliances. In California, Title 24 governs energy consumed by the built environment. This includes the heating, ventilation, and air conditioning (HVAC) system, water heating, and some fixed lighting. Non-building energy use, or "plug-in" energy use can be further subdivided by specific end-use (refrigeration, cooking, lighting, etc.). Energy use for each was calculated separately, as described in the following sections. GHG emissions were calculated as the product of the resulting energy use and the appropriate emission factors, incorporating information on local electricity production and future renewable resource supplies, as discussed in Section 4.4.1 and shown in Tables 4-1 and 4-2.[89]

In this section of the report, the units CO_2 and CO_2e are used interchangeably for residential buildings because CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from residential buildings.

4.7.1 Estimate of Residential Energy Use Intensity

ENVIRON developed CO_2 intensity values (i.e., CO_2 emissions per dwelling unit per year) for the residential building types found in Mission Village using the California Energy Commission Consultant Report entitled "California Statewide Residential Appliance Saturation Study (RASS)". Three building types representative of the planned residences at Mission Village were evaluated: single-family detached houses, single-family town homes, and units in multi-family apartment buildings (with five or more units). Table 4-C-1 summarizes the number and sizes of the different dwelling types. All emissions estimates presented in this section assume that SCE electricity will meet the 20% renewable requirement in the RPS as outlined earlier in Section 4.4.1 and quantified later in this section. The methods that were used and the assumptions that were made in estimating energy use are described below.

4.7.1.1 Energy Use in the Built Environment

New Californian homes must be designed to meet building energy efficiency standards (Title 24). Compliance with Title 24 is determined from the total daily valuation (TDV) of energy use in the built-environment (on a per square foot per year basis). The regulated energy uses include space heating and cooling, domestic hot water heating, and hard-wired lighting. TDV energy use is a parameter that reflects the burden that a building imposes on an electricity supply system. In general, there is a larger electricity demand and, hence, higher stress on the supply system during the day (peak times) than at night (off peak). To account for this variation, the calculation of TDV assigns different weights for energy used at different times. For example, a building that uses a given amount of electricity during the peak mid-day period will have a higher TDV value than a building using an equivalent amount of electricity during off-peak hours. Title 24 determines compliance by comparing the energy use of a modeled (or 'proposed') home to a minimally Title 24 compliant 'standard home' of equal dimensions. Title 24 focuses on building energy efficiency per square foot; it places no limits upon the size of the house or the actual energy used per dwelling unit.

[89] The SCE PUP report for 2007 is available at: http://www.climateregistry.org/CarrotDocs/26/2007/SCEPUP07r3.xls

To estimate Title 24-compliant energy use for space heating, space cooling, lighting, and domestic hot water systems, data from RASS was used to calculate the total energy use per dwelling unit. The study estimates the unit energy consumption (UEC) values for individual households surveyed and also provides the saturation number for each type of end-use. The saturation number indicates the proportion of households that have a demand for each type of end-use category.

The most applicable data provided in RASS were used to estimate the UEC values for dwelling units at Mission Village. Where available, data for multifamily, 5+ unit apartment types in Forecast Climate Zone 9, which is the climate zone in which Mission Village is located, was used. If multifamily or Climate Zone 9 data was not available, then all household or statewide data was used, respectively. The RASS energy use estimate for heating, cooling and lighting was scaled up to reflect the larger size of the Mission Village dwelling units relative to those in the RASS study. Table 4-C-1 summarizes the percentages by which these particular energy use estimates were increased.

RASS does not report data specifically for hard-wired lighting or for plug-in lighting, but it does report data for outdoor lighting and for “miscellaneous” electricity end-uses. CEC estimates that 60% of total miscellaneous electricity use is for indoor lighting. For this analysis, energy associated with hard-wired lighting was estimated as the sum of outdoor lighting electricity and half of indoor lighting use (i.e. 30% of total miscellaneous electricity use). The other half of indoor lighting energy use was assumed to come from plug-in lighting.

The RASS dataset is comprised of older buildings, which are typically less energy efficient (on a per square foot basis) than newer buildings constructed to meet increasingly stricter efficiency standards. Although the homes used for RASS are likely less energy efficient than Title 24-compliant buildings, the energy use estimates were assumed to represent 2001 Title-24 compliant homes. The Title 24 standards have been updated twice (in 2005 and 2008) since RASS, and CEC has published reports estimating the percentage reductions in energy use resulting from these new standards. Because buildings at Mission Village would conform to the most updated (and most stringent) standards, ENVIRON accounted for the reduction in energy use resulting from the Title 24 updates by deducting the estimated percentage savings from the RASS energy use estimates, shown in Table 4-C-2.

RASS provides the annual electricity use per dwelling unit for various heating, cooling, and domestic hot water subcategories. ENVIRON calculated the total electricity demand for each category by multiplying the UEC and saturation values and summing the products for each end-use subcategory within each category. End-use subcategories used to calculate the electrical heating UEC value include conventional electric heating, electrical heat pump space heating, auxiliary heating, and furnace fan. Subcategories included in the cooling category include central air, room air, and evaporative cooling. RASS also provides the UEC values for natural gas usage used for heating and domestic hot water. The same method was used to calculate natural gas usage for each Title 24 category as described above. Natural gas subcategories used to estimate natural gas UEC heating values include primary heat and auxiliary heat; domestic hot water natural gas includes conventional gas water heat.

4.7.1.2 Energy Use from Major Appliances and Plug-ins

Typical major household appliances provided in new residential units include refrigerators, clothes washers and dryers, dishwashers, and cooking ranges. These are typical appliances provided with a new residential unit that the developer has some control over. Energy demand from using these major appliances is based on UEC and saturation values from RASS. Table 4-C-3 summarizes the estimated major appliance energy use for dwelling units at Mission Village.

In addition to major appliances, additional loads such as lighting, office equipment, plug-in cooking equipment and electronics other plug-in electricity loads, such as lighting in a miscellaneous category are also part of the anticipated energy use for a residential development. Similar to the major appliances above, energy use values for plug-in appliances are based on the UEC and saturation values for the miscellaneous category in RASS.

Table 4-C-4 summarizes the combined energy use including the Title 24 systems, major appliances, and plug-ins. All residential units at Mission Village will comply with the 2008 Title 24 standards, which will be in effect beginning January 1, 2010. In addition, Mission Village has committed to making all new homes 15% more energy efficient than 2008 Title 24 requirements, i.e., 15% more energy efficient on a TDV basis.[90] Although ENVIRON is aware that annual energy and TDV energy do not necessarily scale linearly with each other, ENVIRON assumed that all sources covered by Title 24 would uniformly use 15% less annual energy. For each type of home, the 2008 Title 24 compliant energy use was calculated as described above. These energy use numbers were then each multiplied by 0.85 to account for Mission Village's commitment to a 15% energy efficiency improvement over 2008 Title 24.

It should be noted that the estimates for residential plug-in energy-use presented here are likely overestimates. The estimates are based upon technologies that were available during the RASS survey, which was conducted in 2003. Future equipment models are likely to be more energy-efficient than current models. If future Mission Village residents install Energy Star appliances, use more energy efficient equipment, and replace incandescent lights with fluorescent lights, the actual electricity use for plug-ins will be lower than is estimated here. Conversely, future residents may have more small plug-ins (e.g. MP3 player, cell phone, miscellaneous equipment) that could somewhat offset the savings from more energy efficient equipment. However, because refrigerators, lighting, and large appliances contribute to the bulk of the electricity load, and these types of equipment will likely improve in energy efficiency in the future, the estimates presented here are still overestimates.

Table 4-C-4 shows the calculations for the improvement in energy use from Mission Village's commitment to a 15% improvement over 2008 Title 24.

4.7.1.3 Estimation of Annual Greenhouse Gas Emissions from Residential Buildings

Energy use data from Table 4-C-3 were multiplied by the emission factors presented in Tables 4-1 and 4-2 to generate CO_2 intensity values (i.e., CO_2 emissions per dwelling unit) for each

building type. As discussed earlier in Section 4.4.1, the RPS will increase the renewable fraction of electricity deliveries to 20%.

The Mission Village development will be supplied power by SCE. The 2007 SCE carbon-intensity factor is 631 lbs of CO_2e per MWh[91], as outlined in Table 4-1. This emission factor takes into account the mix of energy sources used to generate electricity for SCE[92] and the relative carbon intensities of these sources.[93] SCE's 2007 energy sources are comprised of 13% of renewables as outlined in Table 4-1. The RPS requires that utilities increase this fraction to 20% by 2010.[94] Thus, at full buildout, it is anticipated that the carbon-intensity factor will be 583 lb/MWh. The following equation illustrates these calculations:

$$\text{Buildout emission factor} = \frac{\text{SCE 2007 emission factor} \times (1 - \text{RPS}_{\text{renewable}}\ \text{fraction})}{(1 - \text{SCE 2007}_{\text{renewable fraction}})}$$

The above equation calculates the new emission factor if 20% of the electricity would be provided by renewable sources instead of the 2007 fraction of 13%. Note that if the proposed 33% renewables target for 2020 were achieved, the CO_2 emission factor would decrease even further to 488 lbs CO_2/MWh. This 33% renewables goal was conservatively not accounted for in this analysis because it has not yet been promulgated.

The builder has control over a portion of the estimated energy use for a residential building, namely the built environment and the initial major appliances. As shown in Table 4-C-5, the homes that are 15% more energy efficient than 2008 Title 24 have lower CO_2 emissions. When combined with appliances and all miscellaneous energy loads (MELs), as shown in Table 4-C-4, the single-family, attached, and apartment homes emit less CO_2 per year, respectively, than standard homes for the built environment and major appliances.

Table 4-C-6 shows the yearly CO_2 emissions from Mission Village by incorporating the aforementioned emission factors and the number of dwelling units for each building type for Title 24 systems and all plug-in energy. Total CO_2 emissions would be 15,563 tonnes per year for the CARB 2020 NAT scenario of minimally compliant 2005 Title 24 dwelling units. With a 15% improvement over 2008 Title 24 and the residential rooftop photovoltaic systems, the total emissions would be 12,609 tonnes per year, which represents a 19% reduction in GHG emissions over the CARB 2020 NAT scenario. As noted above, all emissions estimates presented here assume that the RPS goal of 20% renewables is achieved by SCE.

[91] California Climate Action Registry (CCAR) Database. Southern California Edison PUP Report. 2007.

[92] Natural gas, nuclear, coal, wind, solar, biomass, small hydropower, and geothermal.

[93] Indirect emissions due to electricity usage will vary with the fuel-mix used to produce electricity. For example, CO_2 emissions per kWh from a coal-fired power plant are significantly higher than CO_2 emissions per kWh from a natural gas-fired power plant. Therefore, to most accurately estimate GHG emissions from the Mission Village development, the carbon intensity of the specific mix of energy sources SCE uses to generate electricity was used to calculate emissions since SCE is the source of electricity for Mission Village.

[94] The RPS requires 33%, but currently, only the commitment to 20% is law. 2002 Senate Bill 1078 and 2006 Senate Bill 107.

Newhall has committed to using renewable electricity equivalent to putting photovoltaic systems (i.e., solar panels) on all of the single family detached residences.[95] Here, it is conservatively assumed that a 2-kilowatt (kWh) system would be installed, although larger systems (2.3 kWh) may be more common. An industry source[96] estimates that a 2-kWh system in Santa Clarita will generate 3,356 kWh per year.[97] The energy produced by the photovoltaic systems is renewable and is assumed, for the purposes of this estimate to result in zero GHG emissions. Accordingly, for the GHG emissions estimate the quantity of energy supplied by photovoltaic systems was subtracted from the single family residence electricity use. As seen in Table 4-C-6, with 15% improvements over 2008 Title 24 and with renewable energy, the 382 single-family homes emit a total of 1,254 tonnes CO_2 per year–726 tonnes less CO_2 then minimally 2005 Title 24 compliant single-family homes without renewable energy. Table 4-C-6 lists the CO_2 emissions reductions from the renewable energy and from the 15% improvement over 2008 Title 24. The total CO_2 emissions for all dwelling units, if minimally 2005 Title 24 compliant and without renewable energy, would be 15,563 tonnes per year. The total CO_2 emissions for all dwelling units, if 15% better than 2008 Title 24 and with renewable energy, would be 12,609 tonnes per year, representing a 19% reduction in GHG emissions over CARB 2020 NAT.

4.7.2 Additional Project Design Features to Reduce GHG Emissions

Newhall is committed to working with Southern California Edison and Southern California Gas Company to assess the feasibility of smart meter installation. According to the SCE website, SCE has started to implement the SmartConnect metering system[98] and the Itron “openway” meter has been selected for assessment.[99] No authoritative reference was found that outlined the overall energy savings from using smart meters.[100] There were numerous studies that suggest that smart meters can reduce peak demand by 10-20%[101] and energy costs from appliance use by approximately 10%.[102]

Overall energy savings from employing smart meters may differ from peak demand savings because some of the electricity use may simply be shifted to another time of day. Additionally, allowing the consumer to immediately see how their actions affect usage enables them to make more energy-conscious decisions and may decrease overall energy consumption.

[95] Newhall has also committed to renewable energy for non-residential buildings.

[96] Sunpower Solar Calculator, Sunpower Company. Available at: http://us.sunpowercorp.com/estimator/

[97] A kWh is one kilowatt of power for one hour.

[98] http://www.sce.com/NR/rdonlyres/62A69851-BFFB-48A7-9373-F231769B4E1B/0/EdisonSmartConnectFactSheet_1207.pdf

[99] www.itron.com

[100] The study from the Pacific Northwest National Laboratory states that the differences in mean energy consumption were small but measurable and that the variances in the measurements were large. Page 7.6 of http://gridwise.pnl.gov/docs/op_project_final_report_pnnl17167.pdf

[101] Pacific Northwest National Laboratory. Available online at: http://gridwise.pnl.gov/docs/pnnl_gridwiseoverview.pdf, http://gridwise.pnl.gov/ Institute of Electrical and Electronics Engineers online. Available at: http://www.spectrum.ieee.org/aug04/3824

[102] “Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design.” G. Wood, M. Newborough. *Energy and Buildings 35* (2003) 821–841 This report focuses mainly upon cooking appliances and finds approximately a 10% decrease in energy usage; the elasticity of other energy needs in the home (lighting, cooling) may be more or less elastic to changes in prices.

Based upon the limited available information, ENVIRON estimates that a 10% decrease in overall energy usage, and therefore greenhouse gas emissions, at Mission Village homes may be realized by the use of smart meters.

In addition, smart meters enable the meters to transmit usage directly to the utility provider eliminating the need for door-to-door meter reading. This could result in an additional reduction of greenhouse gases associated with vehicle emissions during door-to-door readings; these reductions were not quantified here.

Due to the preliminary nature of the estimate of the GHG savings from smart meters, this reduction in GHG emissions was not incorporated into the analysis. Also note that although Newhall has committed to working with Southern California Edison and Southern California Gas Company to assess the feasibility of smart meter installation, it is not certain at this point how many homes will install the smart meters.

4.7.3 Uncertainties in Residential Building GHG Calculations

Several factors lead to uncertainties in the above analysis, and are described in this section.

Although all buildings in the development will be Title 24 compliant, Title 24 does not specify building dimensions (e.g., size, height, or orientation). Title 24 also provides significant flexibility for window types, window amounts, insulation choice, and other parameters. This uncertainty is expected to neither over- nor underestimate emissions. Title 24 grants enough flexibility that if a designer puts in more windows than is “allowed” under the prescriptive measures, the energy efficiency losses can be offset by improving the window quality, or installing a more efficient HVAC system. Although it is unknown how exactly the buildings will be designed, each home will be Title 24 compliant, and thereby all design features of the home that make it less energy efficient will be offset by design features that make it more energy efficient.

Energy use will vary considerably depending upon the design of the home. The residential units to be built in Mission Village will vary considerably in size, layout, and overall design. The parameters used here are intended to represent the average home sizes in each category.

Built environment energy use will vary considerably depending upon the home owners’ habits regarding energy use. For instance, homeowners determine the set point of thermostats, the duration of showers, the usage of lights, if they are to have a second refrigerator, and the temperature of the refrigerator, among other things. Newhall Land will have little, if any, influence over homeowner behavior. Current median behavior attributes are presented here. To the extent that individuals are becoming more energy conscious, this will tend to overestimate energy use in the future.

Plug-in energy use will vary considerably depending upon the appliances, lights, and other plug-ins installed by the homeowner. Newhall Land will have little, if any, influence over these choices made by the homeowner. As above, the current median behavior attributes are presented here. To the extent that individuals are becoming more energy conscious, or appliances are becoming more energy efficient, this will tend to overestimate energy use in the future.

4.8 GHG Emissions Associated with Non-Residential Buildings

Non-residential buildings include all structures except residences that may exist in a development such as government, municipal, commercial, retail, and office space. This section describes the methods used to estimate the GHGs associated with activities in non-residential buildings. As discussed earlier in Section 4.4.1, the RPS will increase the renewable fraction of electricity deliveries to 20%.

The amount of energy used and the associated GHG emissions emitted per square foot of available space vary with the type of non-residential building. For example, food stores are far more energy-intensive than non-refrigerated warehouses, which have little climate-conditioned space. Newhall Land provided data summarizing the general non-residential building categories planned and the area of floor space planned for each building type. For new developments, the exact types of buildings are typically unknown. As such, not all building categories that may actually exist in Mission Village are represented below. However, all of the non-residential building area is accounted for, and the tables provided in this section present the differences in energy intensities from building type to building type. The types of non-residential buildings as provided to ENVIRON are:

1) Commercial
    a. Office (45%)
    b. Retail / Office (55%)
2) Library
3) School
4) Public Safety
    a. Fire Station (100%)

Similar to the case for residential buildings, GHGs are emitted as a result of activities in non-residential buildings for which electricity and natural gas are used as energy sources. Combustion of any type of fuel emits CO_2 and other GHGs directly into the atmosphere; when this occurs in a non-residential building this is a direct emission source[103] associated with that building. GHGs are also emitted during the generation of electricity from fossil fuels. When electricity is used in a non-residential building, the electricity generation typically takes place offsite at the power plant; electricity use in a non-residential building generally causes emissions in an indirect manner.

While fuel combustion generates CH_4 and N_2O, the emissions of these GHGs typically comprise less than 1% of CO_2e emissions from electricity generation and natural gas consumption.[104]

[103] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.1 (January). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf Chapter 8

[104] Ibid., Tables C1 and C2. The methane and nitrous oxide emission factors are negligible compared to the total CO_2 emission factor for electricity generation in California.

Fuel oil, kerosene, liquefied petroleum gas, and wood can also be used as fuels, but generally contribute only in small amounts as combustion sources within non-residential buildings. As such, these minor emissions are not accounted for here.

Similar to energy use in residential buildings, energy use in non-residential buildings is divided into energy consumed by the built environment and energy consumed by uses that are independent of the construction of the building such as plug-in appliances. In California, Title 24 governs energy consumed by the built environment, mechanical systems, and some fixed lighting. Non-building energy use, or "plug-in" energy use can be further subdivided by specific end-use (refrigeration, cooking, office equipment, etc.). The following two steps were performed to quantify the energy use due to non-residential buildings:

1. Calculate energy use from systems covered by Title 24[105] (HVAC system, water heating system, and the lighting system).
2. Calculate energy use from office equipment, plug-in lighting, and other sources not covered by Title 24.

The resulting energy use quantities were then converted to GHG emissions by multiplying by the appropriate emission factors obtained by incorporating information on local electricity production.[106] The total GHG emissions for non-residential buildings in Mission Village is estimated to be 5,927 tonnes CO_2 per year. The following sections describe the methodologies employed to estimate GHG emissions.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for non-residential buildings because CH_4 and N_2O are assumed to contribute a negligible[107] amount of GWP when compared to the CO_2 emissions from non-residential buildings.

4.8.1 Estimate of Non-residential Energy Use Intensity

ENVIRON developed CO_2 intensity values (CO_2 emissions per square feet per year) for building types found in Mission Village using data from the California CEUS.[108] The methods that were used to estimate these emissions for Mission Village are described below.

4.8.1.1 CEUS Database

The overall electricity use for the building types was calculated based on data provided by the CEC.[109] The building types and subcategories are shown in Table 4-D-1. Table 4-D-1 also provides the scheme used to relate Mission Village building types to CEUS building types.

[105] Title 24, Part 6, of the California Code of Regulations: California's Energy Efficiency Standards for Residential and Nonresidential Buildings. http://www.energy.ca.gov/title24/

[106] The Southern California Edison specific emission factor for electricity deliveries is 631 lbs CO_2/MWh. From the California Climate Action Registry Database. Southern California Edison PUP Report. 2007. This has been adjusted to account for the 20% Renewable Energy Portfolio Standard required for utilities to meet by 2010.

[107] The Southern California Edison specific emission factor for electricity deliveries is 631 lbs CO_2/MWh. From the California Climate Action Registry Database. Pacific Gas and Electric PUP Report. 2007. Although this emission factor accounts for only CO_2, the emissions associated with N_2O and CH_4 contribute to less than 1% of the electricity generation CO_2e emissions.

[108] California Energy Commission (CEC). California Commercial End-Use Survey Results. Data available from Itron Inc. at http://capabilities.itron.com/CeusWeb/Chart.aspx

The CEUS data is based on a survey conducted in 2002 of existing buildings. Each building type has a characteristic electricity and natural gas use per square foot of building space. Electricity use per square foot (electricity intensity) for each building sample was determined from the CEUS data. Similarly, the natural gas use per square foot (natural gas intensity) for each building sample was also determined.

For this analysis, energy use was based upon buildings in California Forecasting Climate Zone 9. Table 4-D-2 lists the breakdown of electricity use among several end uses for electricity in various non-residential building types. Table 4-D-3 lists the percentage breakdown of end uses for natural gas in various non-residential building types. The end use data provide an estimate of the percent of the total energy use comprised by Title 24 regulated (built environment) and plug-in electricity in each building type.

Baseline Title 24 usage rates from the CEUS database shown in this table have been adjusted to reflect improvements in Title 24 building codes since the survey was conducted. CEC discusses average savings for improvements from 2002 to 2005 ("Impact Analysis for 2005 Energy Efficiency Standards") as well as from 2005 to 2008 ("Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings"). ENVIRON used these CEC average savings percentages as presented in Table 4-D-4 to account for reductions in energy use due to the Title 24 updates.

The Title 24-regulated electricity use (cooling, space heating, water heating, lighting, ventilation) and the non-built electricity use (office equipment, refrigeration, cooking, etc.) are presented in Table 4-D-5. The Title 24-regulated natural gas use and the non-built natural gas use (primarily from cooking) are also presented in Table 4-D-5.

4.8.2 Estimation of Annual Greenhouse Gas Emissions from Energy Use in Non-Residential Buildings

Mission Village has committed to making all new non-residential buildings 15% more energy efficient than Title 24 2008 standards, or 15% more energy efficient on a TDV basis. Although ENVIRON is aware that annual energy use and TDV energy do not necessarily scale linearly with each other, as discussed in the residential section, ENVIRON assumed that all sources covered by Title 24 would uniformly use 15% less annual energy. These calculations are shown in Table 4-D-5. Non-Title 24 regulated energy use is assumed to still use the same amount of energy as a minimally Title 24 compliant building. There is no credit taken for any Energy Star appliances in the non-residential building category since it is difficult to determine which appliances may be present in the various non-residential building categories. In addition, these are generally not supplied with the building. Baseline Title 24 usage rates shown in this table have been adjusted to reflect improvements in Title 24 building codes presented in Table 4-D-4. This methodology results in a reduction of energy use for all building types. Because plug-ins are not covered under Title 24, the decrease in energy use is typically less than 15%, yet still substantial.

[109] Workbooks for "SCE – FCZ09" downloaded from http://capabilities.itron.com/CeusWeb/Chart.aspx for all building categories.

Energy use data from Table 4-D-5 was multiplied by the emission factors presented in Table 4-2 to generate CO_2 intensity values (CO_2 emissions per square foot of building area). The results are shown in Table 4-D-6. The CO_2 intensity values presented in Table 4-D-6 represent the non-residential building types in Mission Village described earlier.

Table 4-D-6 also shows the yearly CO_2 emissions from Mission Village by incorporating the CO_2 intensity developed as discussed above and the square footage of each of the main building categories. In addition, Newhall Land has committed to photovoltaic system equivalents for the non-residential buildings. As a result, overall CO_2 emissions associated with non-residential energy use after accounting for on-site renewable energy are 5,927 tonnes CO_2 per year.

4.8.3 Additional Project Design Features to Reduce GHG Emissions

Because of the LA County Green Building Ordinance, several buildings may be LEED Silver certified. LEED certification is a performance-oriented rating system where building projects earn points for satisfying criteria designed to address environmental impacts inherent in the design, construction, operations and management of buildings. As LEED Silver is for buildings that obtain approximately half of the overall possible LEED points, it may be appropriate to assume that the LEED Silver building would obtain half of the possible points in the 'optimize energy performance' category as well as half of the points from each of the other categories. To obtain half of the possible 'energy' points, the building would need to be approximately 30% better than 2005 Title 24.[110]

A 30% improvement over commercial 2005 Title 24 is more energy efficient than Newhall's commitment to a 15% improvement over 2008 Title 24, because 2008 Title 24 is approximately 5-10% more energy efficient than the commercial 2005 standards. Due to the preliminary nature of the GHG savings from LEED, these GHG emission reductions were not incorporated into this analysis. The percentage saving from LEED and Title 24 improvements varies between commercial and residential buildings because of different energy end-use patterns.

4.8.4 Uncertainties in Non-residential Building GHG Calculations

Several factors lead to uncertainties in the above analysis. These are described below.

- For new developments, the exact types of buildings are typically unknown. As such, not all building categories that may actually exist in Mission Village are represented in this analysis. However, all of the commercial building area is accounted for and the best available assessment of the building type composition of Mission Village was used. The tables provided in this section present the differences in energy intensities from building type to building type.
- Although it is unknown exactly how the buildings will be designed, each building will be Title 24 compliant. Therefore all design features of the building that make it less energy efficient will be offset by design features that make it more energy efficient.

[110] LEED 2009 for New Construction and Major Renovations. USGBC Member Approved November 2009.

4.9 Mobile Sources

This section estimates GHG emissions from mobile sources in Mission Village. The mobile source emissions considered for this project will be from the typical daily operation of motor vehicles by Mission Village residents. Mobile source emissions associated with the travel of residents living outside Mission Village are not counted in this inventory. This section first reviews the rationale for counting only the Mission Village residents' emissions as detailed in Section 4.1, and then explains the calculation methodologies in detail.

4.9.1 Evaluation of "New" Emissions For Mobile Sources

As noted earlier, GHG increases are directly tied to population growth and increased standards of living. New housing in California is a response to both population increase, and increasing standard of living for new California residents that moved from areas that were less economically developed. Therefore, operational emissions (including vehicular emissions) from new residences should be considered as growth, or new emissions, as residences are rarely removed from the housing supply once constructed.[111]

Traffic between new residences and new retail is accounted for, as these trips are directly associated with the new residences. However, traffic associated with new commercial or retail and existing residences is not new[112], and is not accounted for in this report. That traffic already exists from the existing residences, and the construction of new commercial or retail does not increase traffic, unless the average trip distance to that commercial or retail establishment increases as a result of the new construction.

All car travel made by Mission Village residents are counted as Mission Village emissions, even if the vehicles leave the site. Emissions from non-Mission Village vehicles that enter to project site are not counted because those emissions would have occurred absent Mission Village. For instance, workers that live in Bakersfield but will now work in Mission Village will commute to work in Mission Village. These workers commuted before the existence of Mission Village – perhaps within Bakersfield, to Santa Clarita, or to Los Angeles. Therefore, in this analysis, it is assumed that these workers commute the same distances, on average, as before the existence of Mission Village and therefore they do not contribute to any net new GHG emissions.

4.9.2 Estimating VMT from Mobile Sources

Fehr and Peers Traffic Consultants provided ENVIRON the Mission Village development VMT per dwelling unit (Appendix B). The Fehr and Peers estimate included all miles traveled by Mission Village residents that start or end at a Mission Village home regardless of internal or external destinations or trip purpose. Austin Foust's Traffic Report listed the number of trips per dwelling unit.[113] Table 4-E-1 outlines the number of dwelling units and the number of trips.

[111] There are exceptions, such as when one housing development replaces another, and, in those cases, the replacement residential development need not be considered growth.

[112] If, however, the new commercial area results in longer trips for its workers and residents than they would have previously made, then it adds GHGs emissions. Commercial development that could potentially increase VMT would be facilities that draw trips from far away that otherwise would not be made. A theme park, for example, may be viewed as such a development.

[113] NEWHALL RANCH RMDP AND SCP EIR/EIS TRAFFIC ANALYSIS DECEMBER 2008. Austin Foust also provided the percentage of these trips that were home-based productions – I.e. residents of the dwelling unit. Personal communications.

ENVIRON then estimated GHG emissions based upon all miles traveled by Mission Village residents that start or end from a Mission Village home regardless of internal or external destinations or purpose of trip. ENVIRON included emissions estimates based upon both VMT (running emissions) and startups (starting emissions). Table 4-E-2 outlines the trip lengths,

The analysis in this section uses parameters specific to the Proposed Project, as detailed in Appendix B. This approach provides an accurate representation of VMT at full buildout.

In an effort to include only trips made by Mission Village residents, as opposed to trips associated only with the commercial development, Fehr and Peers analyzed only trips originating or ending at Mission Village homes. This approach avoids counting trips made by residents of other cities that visit Mission Village. These trips are not counted because, as discussed above, these trips do not represent true growth; they would have been made in the absence of the population growth accommodated by Mission Village.

4.9.3 Estimating GHG Emissions from Mobile Sources

This section of the report describes the estimation of GHG emissions from the VMT estimates developed in the previous section. To develop the appropriate emission factor for the estimation of GHG emissions, ENVIRON incorporated promulgated regulatory actions that will affect GHG emissions factors.

The USEPA recently granted the waiver for California for its greenhouse gas emission standards for motor vehicles. Accordingly, the Pavley Standards, as discussed earlier in Section 4.4.2, will be in effect at buildout of Mission Village and therefore are accounted for in the automobile and light duty truck emission factors. The Pavley standards require GHG emission reductions from vehicles equivalent to approximately 30% by 2016.[114] Although new vehicle emissions factors will be reduced by 30% in 2016, the fleet average emissions reduction in 2020 will be less than that, due to vehicle phase-in. The Pavley Standards are expected to reduce total emissions for automobiles and light trucks by 20% relative to the scenario without Pavley or CAFE by the year 2020.[115] Table 4-E-2 outlines these calculations in detail.

The CO_2 emissions from mobile sources were calculated using the trip rates, trip lengths and emission factors for running and starting emissions from EMFAC2007 as follows:

$$CO_2 \text{ emissions} = VMT * EF_{running} + \text{Annual Trips} * EF_{start}$$

[114] The standards start in model year 2009, and ramp up to a 30 percent reduction in greenhouse gas emissions for vehicles sold in model year 2016 and beyond. Source: Comparison of Greenhouse Gas Reductions for the United States and Canada Under US CAFE Standards and California Air Resources Board Greenhouse Gas Regulations, California Air Resources Board an Enhanced Technical Assessment February 25, 2008. http://www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf

[115] By 2020, the combination of the adopted Pavley 1 and anticipated Pavley 2 rules are expected to reduce the 496,000 tons per day of CO2e emitted by light duty vehicles in California by 20 percent, or 100,500 tons per day. The baseline (496,000 tons per day) CO2e emissions are state-wide emissions (including running and startup emissions) at 2020 retrieved from EMFAC2007, assuming no Pavley Standards are implemented. Comparison of Greenhouse Gas Reductions for the United States and Canada Under US CAFE Standards and California Air Resources Board Greenhouse Gas Regulations, California Air Resources Board an Enhanced Technical Assessment February 25, 2008. http://www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf

Where: VMT = vehicle miles traveled
$EF_{running}$ = emission factor for running emissions

EF_{start} = emission factor for startup emissions

The CCAR GRP[116] recommends estimating GHG emissions from mobile sources at an individual vehicle level, assuming knowledge of the fuel consumption rate for each vehicle as well as the miles traveled per car. Since these parameters are not known for a future development, the CCAR guidance is too specific to use as recommended.

The CO_2 calculation involves the following assumptions:

- The emission factor depends upon the speed of the vehicle. ENVIRON assumed 35 miles per hour.
- EMFAC emission factors from the year 2020 were used for $EF_{running}$ based on Los Angeles County fleet mix of light duty vehicles.
- Startup emissions are CO_2 emitted from starting a vehicle. Startup emissions were calculated using the following assumptions:
    1. The number of starts is equal to the number of home-based trips made annually.
    2. The breakdown in vehicles was EMFAC fleet mix of light duty vehicles for LA County in 2020.
    3. The emission factor for startup was calculated based on an average wait between starts.

Fleet distribution types from EMFAC2007 from the year 2020 were used. Table 4-E-2 shows the CO_2 emissions from vehicles associated with residents of Mission Village as calculated according to the methodology described above. In order to account for the reductions in emissions due to the newly proposed Pavley Standards, the emissions calculated using the 2020 emission factor were decreased by 20% as shown in Table 4-E-2 and discussed earlier in this section.

N_2O, CH_4, and HFCs[117] are also emitted from mobile sources. The USEPA recommends assuming that CH_4, N_2O, and HFCs account for 5% of mobile source GHG emissions, taking into account their GWPs.[118] Therefore, CO_2 emissions in Table 4-E-2 were divided by 0.95 to account for non-CO_2 GHGs. Vehicles associated with the Mission Village development will emit approximately 39,355 tonnes CO_2e per year.

[116] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.1 (January). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

[117] HFCs can be emitted from air conditioning systems.

[118] USEPA. 2005. *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle.* Office of Transportation and Air Quality. February. (http://www.epa.gov/otaq/climate/420f05004.pdf)

4.10 Area Sources

This section estimates GHG emissions from area source emissions at the Mission Village development. The area emissions considered for this project are from hearths[119] and landscaping fuel combustion sources such as lawn mowers. GHG emissions due to natural gas combustion are excluded from this section since they are covered in residential emissions. URBEMIS 9.2.2[120] was used to calculate area source GHG emissions for the Mission Village development.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for area sources because methane and nitrous oxide are assumed to contribute a negligible amount of global warming potential when compared to the carbon dioxide emissions from area sources.

4.10.1 Estimating GHG Emissions from Area Sources

GHG emissions from area sources (Table 4-F-1) were calculated by Impact Sciences using URBEMIS 9.2.2[121] and the land use information specified in Sections 4.7 and 4.8. The location of the project as specified in URBEMIS determines the factors used to calculate the hearth fuel use. In Mission Village, it is estimated that hearths (natural gas fireplaces) will emit 15 tonnes CO_2 per year. Landscape maintenance emissions will emit approximately 15 tonnes CO_2 per year. In total, area sources from Mission Village account for approximately 30 tonnes CO_2 per year. Because area sources account for such a small percentage of the overall Mission CO_2 emissions, the contribution of methane and nitrous oxides to overall project GHG emissions was assumed to be small, and therefore was not calculated. The area source URBEMIS run is given in Appendix E.

4.11 Water/Sewage

The majority of estimated GHG emissions from water supply and sewage treatment are due to the energy used to convey, treat and distribute water. Thus, these emissions are generally indirect emissions from the production of electricity to power these systems. Additional emissions from wastewater treatment include CH_4 and N_2O, which are emitted directly from the wastewater. In general, the water /sewage category is the major source of municipal sector GHG emissions.

According to the Mission Village DEIR, the development would generate a total water demand of 2,917 acre-feet (AF) per year. Of these 2,917 AF, 1,676 AF will be potable groundwater pumped from an underlying aquifer and 1,241 AF will be non-potable reclaimed water produced by the Newhall Ranch Water Reclamation Plant.[122] To supply potable water to residential and commercial users, three processes are necessary: the supply and conveyance of the water from the source, the treatment of the water to make it acceptable for consumption, and the distribution of the water to individual users. After use, the wastewater is treated either for disposal or reuse as reclaimed water. Any reclaimed water is generally redistributed to users via

[119] "Hearths" can include wood stoves, fireplaces, and natural gas fired stoves.
[120] Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.2 – 2007). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District.
[121] Assumes full buildout.
[122] Approximate information provided by Newhall.

pumping. The emission factors and GHG emissions for all these processes are shown in Table 4-G-1. Note that the emissions factors here account for the 20% renewables expected from the RPS as described earlier in Section 4.4.1 and detailed in the residential section.

4.11.1 Potable Water Supply and Conveyance

Water is typically supplied to communities from several sources including the local underground aquifer, the State Water Supply, and recycled and reclaimed water.

To supply the annual demand for 1,676 AF of potable water, Mission Village will draw upon a local supply of water from an underground aquifer. [123] The energy needed to supply and convey Mission Village's water will be used to pump this water from the ground and distribute it throughout the development. Typical sources of water for Southern California are from Northern California and the Colorado River. Pumping water to Southern California from these typical sources emits more CO_2 per AF of water delivered as compared to local sourcing (see emission factors in Table 4-G-1).[124] For the supply of water of 1,676 AF from an underground aquifer, the Electric Power Research Institute has estimated that, nationwide, the amount of energy required to pump water from the ground ranges from 228 to 587 kWh per AF.[125] Pumping groundwater in Southern California is typically more energy-intensive than in other areas of the state and nation because its aquifers are relatively deep; in Southern California's Chino Basin, it has been estimated that 950 kWh of electricity are needed to supply one AF of groundwater.[126] To be conservative, it was assumed that it would require 950 kWh of electricity to extract one AF of water from the aquifer underlying Mission Village.[127] Using this emission factor, the expected potable water demand, and the 2007 SCE carbon-intensity factor adjusted for the RPS, GHG emissions from potable water supply and conveyance were calculated as shown in Table 4-G-1. A more refined estimate taking into account the actual aquifer depth and the physical properties of the aquifer would likely lower the estimate of CO_2 emissions from groundwater pumping slightly.

4.11.2 Potable Water Treatment and Distribution

For water intended for indoor use in Southern California, it is estimated that 36 kWh of electricity is necessary to treat one AF of water and an additional 414 kWh is necessary to distribute that

[123] Provided by Newhall staff.

[124] The CEC estimates that 50% of Southern California's water is supplied by importing water from Northern California and the Colorado River. California Energy Commission. (CEC) 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF. November. Page 112.

[125] Ibid. Page 26.

[126] Ibid. Page 26. The Chino Basin represents a worst-case scenario for energy needs for pumping water.

[127] Ibid. The amount of energy required to supply and convey water depends heavily both on how the water is extracted and on the distance between the water source and the end user. At least half of the potable water consumed in Southern California is drawn from surface water in Northern California or nearby states and supplied to the south via aqueducts. Pumping this water over great distances and sometimes high elevations to the end user can be very energy-intensive (CEC 2005). It has been estimated that the average amount of electricity necessary to supply and convey one AF of water suitable for indoor use to Southern California is 3,170 kWh, taking into consideration the large portion of water that is imported from hundreds of miles away (CEC 2006). However, since it is known that Mission Village will be using the less energy-intensive process of pumping groundwater to supply its potable water needs, it is appropriate to use a groundwater specific emission factor and not the generic average emission factor for Southern California.

water to the end users.[128] Based on the estimated potable water demand, these emission factors, and the SCE-carbon intensity factor, GHG emissions from potable water treatment and distribution were calculated as shown in Table 4-G-1. The estimate presented here may double-count some of the pumping energy requirements already accounted for in the groundwater pumping section. This is because the water may already be at the required pressure to distribute after being pumped from the aquifer. As such, the estimate provided here is likely conservative (i.e., high); a more refined analysis will likely yield lower emissions.

4.11.3 Wastewater Treatment

Emissions associated with wastewater treatment include indirect emissions necessary to power the treatment process and direct emissions from the organic material in the wastewater. ENVIRON based Mission Village's wastewater treatment on recycled water use and the Newhall Ranch Water Reclamation Plant recycled water to wastewater ratio. This wastewater volume is smaller than the total amount of water demanded by and supplied to Mission Village (2,917 AF per year), because not all of the water used by the community will be captured and treated as wastewater.

Indirect GHG emissions from the electricity necessary to power the wastewater treatment process were calculated for Mission Village. The electricity required to operate a wastewater treatment plant in Southern California is estimated to be 623 kWh per AF.[129] This is a conservative estimate because it assumes a level of treatment necessary for potable water. As not all wastewater treated at the reclamation plant will be treated to this level, the actual amount of electricity required will likely be lower. Based on the expected amount of wastewater requiring treatment (1,553 AF per year), this emission factor and the SCE carbon-intensity factor adjusted for 20% renewables in accordance with the RPS, indirect emissions due to wastewater treatment were calculated as shown in Table 4-G-1.

Direct emissions from wastewater treatment include emissions of CH_4 and N_2O. A per capita emission factor for these GHG emissions was developed based on a 2005 US GHG inventory for domestic wastewater treatment (25 teragrams CO_2e/year or 25 million tonnes CO_2e/year)[130] and the 2005 US population (approximately 296,410,404). Direct emissions from wastewater treatment were calculated using the emission factor developed from this data (0.084 tonnes CO_2e per capita per year) and the projected population at Mission Village (10,802 residents) as shown in Table 4-G-1.[131]

4.11.4 Non-Potable Recycled Water Distribution

The Mission Village DEIR estimates that non-potable water needs will be equal to 1,241 AF per year, which will be provided from reclaimed water. Once treated at the wastewater treatment plant, this water will need to be re-pumped through the development to supply it to end users. Estimates of the amount of energy needed to redistribute and, if necessary, additionally treat

[128] California Energy Commission. (CEC) 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December. Page 22.

[129] CEC 2006. Page 22.

[130] USEPA. 2007. Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf

[131] Population estimate provided by Newhall staff.

reclaimed water vary from 391 to 978 kWh per AF.[132] To be conservative, the high-end energy intensity estimate was used in this inventory. Based on the estimated demand for reclaimed water, the estimated electricity demand and the SCE carbon-intensity factor adjusted for 20% renewables per the RPS, non-potable reclaimed water redistribution emissions were calculated as shown in Table 4-G-1.

In total, all water and wastewater supply, treatment and distribution for Mission Village is expected to produce 2,108 metric tonnes of CO_2e annually.

4.11.5 Energy Savings from Pumping from Aquifer

Typical sources of water for Southern California are from Northern California and the Colorado River; based on CEC estimates for energy demand, pumping water to Southern California from these typical sources emits approximately 0.84 tonnes CO_2 per AF of water delivered.[133] If Mission Village were to acquire all of its water from these typical sources, the GHG emissions associated with pumping the water would be higher, as discussed in Section 5 of this report. However, since Mission Village will obtain most of its water from the local underground aquifer and from the reclamation plant, most of the water will not need to be pumped long distances to the project site. Therefore, the energy demand and its associated GHG emissions are lower than if the development were to obtain all of its water from the typical sources.

4.12 Public Lighting

GHG emissions from public lighting sources are due to indirect emissions associated with the production of the electricity that powers these lights. Lighting sources considered in this source category include streetlights, traffic signals, area lighting for parks and parking lots, and lighting in public buildings. The emissions and emission factor for public lighting is shown in Table 4-G-1. Data from a report by the City of Duluth[134] shows that the amount of electricity demanded for all types of public lighting is 149 kWh per capita per year.[135] Using this study, the SCE-specific carbon-intensity emission factor adjusted for 20% renewables per the RPS and the expected Mission Village population of 10,802, emissions from public lighting were estimated at 425 metric tonnes of CO_2e.[136]

4.13 Municipal Vehicles

GHG emissions from municipal vehicles are due to direct emissions from the burning of fossil fuels. Municipal vehicles considered in this source category include vehicles such as police cars, fire trucks, and garbage trucks. The emission factor for municipal vehicles is shown in Table 4-G-1. Data from reports by Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, California[137] show that the CO_2 emissions from municipal vehicles would be

[132] CEC 2006. Page 24.

[133] CEC 2006. Page 112.

[134] Duluth, while in a different environment, provides the best comparable data and represents conservative estimates.

[135] Skoog., C. 2001. This factor was calculated by summing the total electricity needs for municipal uses and dividing by the Duluth population. The Duluth population was calculated by dividing the city's reported GHG emissions by its reported per capita emissions.

[136] Population estimate provided by Newhall staff.

[137] City of Medford. 2001. Climate Action Plan. October. http://www.medford.org/Pages/MedfordMA_Energy/FINAL_LAP.pdf

approximately[138] 0.05 tonnes per capita per year. Data from a wide variety of municipalities, both based on size and location, indicate that CO_2 emissions from municipal vehicles are small. Using these studies and the expected Mission Village population of 10,802[139], emissions from municipal vehicles in Mission Village were estimated to be 540 metric tonnes of CO_2e, as shown in Table 4-G-1.

4.14 GHG Emissions Associated with Pools and Recreation Centers

It is assumed that three recreation centers will be built in Mission Village.[140] Recreation centers may include various pools, spas, and restroom buildings; ENVIRON assumed that pools are the main consumers of energy in recreation centers. This section describes the methods used to estimate the GHGs associated with pools in recreation centers.

The energy used to heat and maintain a swimming pool depends on several factors, including (but not limited to): whether the pool is indoors or outdoors, size of the pool (surface area and depth), water temperature, energy efficiency of pool pump and water heater, and whether solar heating is used. By making assumptions for these parameters and using known or predicted values for energy use, ENVIRON estimated the electricity and natural gas use of an outdoor pool.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for pools and recreation centers because methane and nitrous oxide are assumed to contribute a negligible amount of global warming potential when compared to the carbon dioxide emissions from pools and recreation centers.[141]

4.14.1 Recreation Center Characterization

ENVIRON assumed that the proposed pools will be outdoor pools with dimensions 50 meters by 25 yards (i.e., a typical competition-size pool size). ENVIRON based electricity calculations on a pool that ran its standard (not high-efficiency) water filter for 24 hours per day, 365 days per year. The large pool size and standard operating equipment allow for a conservative (high) energy use estimate that would decrease with a smaller pool or more efficient equipment.

As there is little data publicly available on the energy use of commercial swimming pools, ENVIRON extrapolated energy consumption from information obtained from two sources: 1)

City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf

City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://www.slocleanair.org/programs/pdf/Santa%20Rosa%20CA.pdf

Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.

[138] In an effort to be conservative, the largest per capita number from these four reports was used.

[139] Population estimate provided by Newhall staff

[140] Provided by Newhall staff.

[141] Only CO_2 emissions are estimated and are assumed to be equivalent to total GHG emissions since the contributions from methane (CH_4) and nitrous oxide (N_2O) are negligible compared to total GHG for emissions associated with electricity generation and natural gas combustion. The emission factors in the California Climate Action Registry General Reporting Protocol show that CH_4 and N_2O emissions (in CO_2e) are less than 1% of CO_2 emissions for these processes.

data on electricity and natural gas use for five pools in Oakland, California and 2) data from the US DOE.

4.14.2 Electricity Use of Recreation Centers

To estimate the baseline electricity usage factors for Mission Village pools, ENVIRON calculated the average annual electricity usage of five Oakland pools and scaled it to reflect the larger size of the Mission Village proposed pools, as shown in Tables 4-H-1 and 4-H-2. As the electricity use largely reflects pumps used to circulate the pool water, the climatic differences between Oakland and Mission Village are not expected to impact this estimate.

4.14.3 Natural Gas Use of Recreation Centers

The public pools in Mission Village will be heated by solar water heaters. Solar water heaters can provide up to 100% of the heating needs for the pool.[142] For comparison purposes, ENVIRON estimated natural gas usage for pool heating if solar heaters were not to be used. Tables 4-H-1 through 4-H-3 and the description below detail the natural gas calculations.

ENVIRON calculated the average annual natural gas usage for five pools from the City of Oakland Preliminary Facility Reports[143] and then scaled this usage to reflect the larger size of the Mission Village proposed pools. ENVIRON also adjusted the natural gas usage to account for savings from high-efficiency heaters and for the difference in average ambient temperature between Newhall and Oakland.

4.14.4 Conversion of Electricity and Natural Gas Use to Greenhouse Gas Emissions

Tables 4-H-2 and 4-H-3 show the results of these calculations for electricity and natural gas use. ENVIRON used emission factors from Table 4-2 to calculate the total CO_2 emissions for each pool. Based upon these assumptions, an outdoor competition-size pool emits approximately 632 tonnes of CO_2 per year (96 tonnes from electricity used to pump water and 535 tonnes from natural gas used to heat the pool). However, each Mission pool will have solar water heating, thereby reducing GHG emissions to only 97 tonnes per year per pool.

Assuming that there will be three solar heated competition-sized pools in Mission Village, the total yearly CO_2 emissions from recreation centers in Mission Village is 290 tonnes per year.

4.15 Summary of Emissions from Mission Village

Emissions from the various aspects of Mission Village are presented in Table 4-I-1. One-time vegetation emissions are estimated to be 26,550 tonnes CO_2. One-time construction emissions are estimated to be 82,781 tonnes CO_2e. Total annual emissions are estimated to be 61,284 tonnes CO_2e. Emissions from residential buildings are estimated to be 12,609 tonnes CO_2e per year. Emissions from non-residential buildings are estimated to be 5,927 tonnes CO_2e per year. Emissions from mobile sources are estimated to be 39,355 tonnes CO_2e per year. Emissions from municipal sources (water distribution, public lighting, and municipal vehicles) are estimated

[142] http://www.rlmartin.com/rspec/factsheets/indoor.htm

[143] Energy Efficient Commercial Pool Program; Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool. City of Oakland / Oakland Unified School District. October 2006.

to be 3,073 CO_2e per year. Emissions from area sources are estimated to be 31 tonnes CO_2e per year. Emissions from recreational centers are estimated to be 290 tonnes CO_2e per year.

Also noted in Table 4-I-1 is whether the emissions are attributable to a one-time action or are anticipated to occur on an annual basis, during each year after the full build-out of the development. The only one-time emissions are associated with construction and land use change emissions. There are 109,331 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to 61,284 tonnes of CO_2e. If the one-time emissions are annualized assuming a 40-year development life (which is likely low) then the one-time emissions account for approximately 2,733 tonnes of CO_2e per year.

As noted in Section 2.3.1 of this report, AB 32 requires that GHG emissions from California be reduced to 1990 levels by 2020. This represents a reduction of approximately 29% from CARB 2020 NAT. The goals of AB 32 are likely to be reached by increasing renewable or non-carbon producing electricity production, and improving the fuel efficiency of vehicles. As such, these measures were accounted for in calculating Mission's emissions for comparison to CARB 2020 NAT.

4.16 Life Cycle Emissions of Building Materials

An estimate of "life-cycle" GHG emissions (i.e., GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure) is presented in this section and attached as Appendix D. This estimate is to be used for comparison purposes only and is not included in the final inventory as these emissions would be attributable to other industry sectors under AB 32. For instance, the concrete industry is required by law to report emissions and undergo certain early action emission reduction measures under AB 32. Manufacturing of cement is specifically addressed in CARB's climate change proposed scoping plan.[144] Furthermore, for a life-cycle analysis for building materials, somewhat arbitrary boundaries must be drawn to define the processes considered in the life-cycle analysis.[145] In support of this approach, the California Air Pollution Control Officers Association (CAPCOA) white paper, discussed earlier, states: "The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of-life of construction materials would be speculative at the CEQA analysis level."

The calculations and results discussed here and presented more fully in Appendix D are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Technical Report. Life Cycle Assessment (LCA) emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, the analysis is highly uncertain.

[144] Climate Change Proposed Scoping Plan: a Framework for Change. 2008. CARB. December.

[145] For instance, in the case of building materials, the boundary could include the energy to make the materials, the energy used to make the machine that made the materials, and the energy used to make the machine that made the machine that made the materials.

Appendix D is an ENVIRON report that evaluates the life cycle GHG emissions associated with the building and infrastructure materials for this project. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. The report then compares the life cycle GHG emissions to the overall annual operational emissions. The materials analyzed in the report include materials for residential and non-residential buildings, and for site infrastructure. This report calculates the overall life cycle emissions from construction materials to be approximately 1.1% – 10% of the overall emissions.

The report estimates the life cycle GHG emissions for buildings by conducting an analysis of available literature on LCAs for buildings. According to these studies, approximately 75 - 97% of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 - 25% of the GHG emissions are due to material manufacture and transport. Using an approximate value for GHG emissions from the operation of buildings,[146] 3% to 25% of building emissions corresponds to approximately 0.9% - 10.1% of the project emissions.

The report presents the calculated life cycle GHG emissions for certain components of infrastructure (roads, storm drains, utilities, gas, electricity, and cable). This analysis considered the manufacture and transport of concrete and asphalt only, as ENVIRON assumed that other construction materials such as steel would be present in much smaller quantities. Because the manufacture of concrete has a higher CO_2 emission factor and Newhall estimates greater mass of concrete than asphalt, the majority of the emissions for infrastructure result from the manufacture of concrete. Because the asphalt and concrete are locally sourced,[147] the transportation emissions are relatively small. If a 40-year lifespan of the infrastructure is assumed, the total annualized emissions from embodied energy in infrastructure materials are approximately 0.2% of the project emissions.

The overall life cycle emissions, annualized by 40 years, are 1.1% to 10% of the annualized GHG emissions from the Mission Village project. The bulk of these emissions are from general life cycle analysis studies and do not reflect specific information from Mission Village.

Again, note that the calculations and results presented in this life cycle report are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Technical Report. LCA emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, and the fact that literature evaluations instead of site-specific studies were used to analyze the embodied energy, the analysis should be considered to yield highly uncertain results. Additionally, these estimates likely double count emissions from other industry sectors.

[146] The final value depends upon the emission factors assumed in the Mission Village study as well as in the LCA studies of the cited literature. Approximate values are presented here that are based upon an emission factor that, if changed from this value, will change the results somewhat, but the general range of the results is still applicable.

[147] ENVIRON assumed that half of the concrete and asphalt come from the Santa Clarita Valley source and the other half come from the San Fernando Valley source. The petroleum used in the asphalt comes from the Port of Los Angeles. Asphalt is roughly 92% by weight aggregate, so ENVIRON assumed that the remaining 8% is representative of the mass of petroleum transported from the Port of Los Angeles.

5 Inventory in Context

5.1 Overview of GHG Reduction Goals and Development of Significance Thresholds

There are currently no adopted GHG emission thresholds of significance for new residential or commercial developments in the SCAQMD or LA County. The following sections summarize possible GHG emission significance thresholds that are being considered, and GHG reduction goals that have been set by various regulatory agencies.

South Coast Air Quality Management District

In the spring of 2008, the SCAQMD convened a stakeholders working group in connection with its development of a CEQA significance threshold for GHG emissions. In December 2008, SCAQMD adopted a threshold for projects where it is the lead agency under CEQA (e.g., stationary source projects; air quality management plans and regulations). SCAQMD staff currently is developing a tiered threshold for residential and commercial projects. As of SCAQMD staff's November 2009 meeting, the draft tiered threshold provides the following guidance:

Tier 1: Is the project exempt from CEQA? If yes, the project is not significant and no further analysis is required.

Tier 2: Is the project consistent with an approved regional climate action plan? If yes, the project is not significant and no further analysis is required.

Tier 3: Would the project result in emissions below the screening level criteria? If yes, the project is not significant and no further analysis is required.

- Non-Land Use Type Specific Screening Level Criteria - 3,000 metric tons per year
- Land Use Type Specific Screening Level Criteria
    - Residential: 3,500 metric tons per year
    - Commercial: 1,400 metric tons per year
    - Mixed-Use: 3,000 metric tons per year

Tier 4: Would the project comply with certain performance-based standards? If yes, the project is not significant and no further analysis is required.

The performance-based standard asks whether a project would achieve either a 28 percent reduction below business-as-usual levels or a 4.6 metric ton per service population per year efficiency metric, and emit no more than 25,000 metric tons per year.

Tier 5: Would the project secure sufficient carbon offsets or credits to reduce emissions to a level at or below the screening level criteria presented in Tier 3, assuming a 30-year project life. If yes, the project is not significant and no further analysis is required.

Assembly Bill 32

As noted earlier, AB 32 requires that statewide GHG emissions by 2020 be reduced to 1990 levels (427 million tonnes[148]). To understand what percentage reduction in emissions would be required to achieve this goal, the CARB estimated the emissions that would be generated in 2020, assuming forecasted population growth, current trends, and no changes in energy efficiency or regulation in GHG emissions beyond that already legislated.[149] This forecast is termed CARB 2020 NAT. CARB's 2020 NAT prediction for 2020 emissions is 596 million tonnes. A decrease from 596 to 427 tonnes is equivalent to a 29% emissions reduction. Thus, the AB32 goal is a 29% reduction in emissions relative to the CARB's 2020 NAT scenario.

AB 32 will be reducing emissions in a variety of ways, including increasing energy efficiency and introducing more renewable energy sources. It is difficult to compare the Project emissions intensity to the AB 32 goals as it is not clear how the reductions will be distributed among the different sectors, what portion of reductions will be achieved from energy efficiency, and what fraction will be achieved by renewable resources. However, assuming that the emissions reductions are distributed evenly among the sectors, a reduction of 29% from a CARB 2020 NAT scenario would satisfy AB 32 goals.

5.2 California Air Resources Board Scoping Plan projections for 2020 if no actions are taken Scenario

As discussed in the introduction, because the SCAQMD has not yet established CEQA GHG significance thresholds, this section compares Project emissions with the requirements for emissions reductions for the State of California described in the CARB Scoping Plan.

In order to evaluate the emissions reductions that would be required within California to meet the goals of AB 32, the CARB prepared a Scoping Plan. This Scoping Plan contained an estimate of the GHG emissions that would result in 2020, considering population growth, if 'no actions were taken' to reduce GHG emissions (CARB 2020 NAT).[150] The Scoping Plan noted that emissions must be reduced by 29% from the CARB 2020 NAT if the state were to meet the GHG emissions goals of AB 32.

[148] http://www.arb.ca.gov/cc/inventory/data/forecast.htm#summary_forescast

[149] "The 2020 business-as-usual forecast does not take any credit for reductions from measures including the Pavley greenhouse gas emissions standards for vehicles, full implementation of the Renewables Portfolio Standard beyond current levels of renewable energy, or the solar measures." Climate Change Proposed Scoping Plan: a framework for change. California Air Resources Board, December 2008. Available at: http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm

[150] The term "CARB 2020 NAT" is used only in this report; the acronym did not exist when the February 2009 Technical Report was published. Many other reports refer to CARB 2020 NAT as the "business as usual scenario" or "BAU scenario". This report uses the new terminology to avoid confusion with the term BAU as it is used in other GHG regulatory context; e.g. the Kyoto Accords. The CARB 2020 NAT relies on specific CARB assumptions for projecting the projects year 2020 emissions.

The CARB 2020 NAT relies on specific assumptions such as electricity generation, vehicle fuel efficiency, and building energy efficiency codes. In particular, the CARB 2020 NAT assumes that all new electricity generation will be supplied by natural gas plants; building energy efficiency codes are held at 2005 Title 24; and vehicle fuel efficiency is not affected by any regulatory action.

This section provides an estimate of the emissions from the project if it was built to be consistent with the assumptions in the Proposed Project's CARB 2020 NAT scenario.

In this section, we compare the Mission Village emissions to a CARB 2020 NAT scenario that is derived from the CARB 2020 NAT scenario used by CARB in the Scoping Plan. For the CARB 2020 NAT scenario, we estimate emissions that would occur from a project similar in size and scope as Mission Village but built under CARB 2020 NAT conditions, and then compare Mission Village's emissions with these CARB 2020 NAT estimates.

We estimate the CARB 2020 NAT scenario in a manner similar to that used by CARB in its 2020 projection provided in the Scoping Plan.[151] Accordingly, the CARB 2020 NAT scenario assumes that energy usage rates (on a per person, per household or per square foot basis) remain at current[152] levels; no new emission reduction measures are enacted; and no project design features or commitments made by Newhall Land and Farming are included, beyond those required by regulation considered in constructing the CARB's 2020 NAT inventory. As described earlier, AB 32 goals can be expressed as a 29% reduction relative to the 2020 CARB 2020 NAT scenario. Therefore, our comparison can illustrate to what degree the project fulfills the AB 32 emissions reduction goal if it were applied on a project basis.

All categories of the annual GHG emission inventory--residential and non-residential buildings, mobile sources, water sources, municipal vehicles, public lighting, pools, and area sources--are considered separately, and then combined for an overall comparison.

The approach for the CARB 2020 NAT assessment varies from sector to sector and will be discussed in each section in turn.

5.2.1 Residential CARB 2020 NAT Results

The residential CARB 2020 NAT scenario presented in this report uses the SCE 2006 electricity emission factor, assumes no improvement over Title 24, and assumes no solar power installations on individual homes.

Project design features and cleaner electricity required by the RPS reduce residential emissions 19% below CARB 2020 NAT (Table 5-C-1).

[151] AB 32 Scoping Plan. http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm

[152] "Current" is defined by how CARB calculated their NAT scenario.

5.2.2 Non-Residential CARB 2020 NAT Results

The non-residential CARB 2020 NAT scenario presented in this report uses the SCE 2006 electricity emission factor,[153] assumes no improvement over Title 24, and assumes no solar power installations on buildings (Table 5-D-1).

Project design features and cleaner electricity required by the RPS reduce non-residential emissions 28% below CARB 2020 NAT (Table 4-D-6 and Table 5-D-2).

5.2.3 Mobile Source CARB 2020 NAT Results

ENVIRON calculated the mobile CARB 2020 NAT scenario as described below.

Fehr and Peers provided ENVIRON with CARB 2020 NAT VMT per dwelling for a typical development with LA county and Santa Clarita design characteristics (Appendix B). Fehr and Peers assumed that the CARB 2020 NAT scenario has the same dwelling unit mix as Mission Village. This CARB 2020 NAT scenario has 107 daily VMT per dwelling unit (Table 4-E-2) as compared to Mission Village that has 81 daily VMT.

ENVIRON compared the CARB 2020 NAT emissions to Mission Village's emissions. Mission Village generates fewer VMT and therefore fewer emissions because Mission village has many sustainable design features that LA County and Santa Clarita Valley generally do not.

In combination, Mission Village's denser development and the Pavley vehicle efficiency reduce mobile source emissions 39% below CARB 2020 NAT (Table 4-E-2).

5.2.4 Area Source CARB 2020 NAT Results

The area source CARB 2020 NAT scenario presented in this report is identical to the project scenario.

5.2.5 Municipal CARB 2020 NAT Results

The municipal CARB 2020 NAT scenario presented in this report uses the SCE 2006 electricity emission factor, assumes typical (i.e. non-local) Southern California water supply sources, and assumes no recycled water. Table 5-G-1 present the calculations, methodologies, and final results.

Water recycling, local sourcing of water, and the RPS collectively reduce municipal emissions by 40% below CARB 2020 NAT (Table 4-G-1 and Table 5-G-1).

5.2.6 Recreational (Pools) CARB 2020 NAT Results

The recreational (pools) CARB 2020 NAT scenario presented in this report uses the SCE 2006 electricity emission factor and assumes natural gas water heating instead of solar heating. Cleaner electricity also reduces emissions from the CARB 2020 NAT scenario.

[153] The 2006 SCE emission factor is deemed more consistent with the Scoping Plan assumptions for the CARB 2020 NAT scenario than the earlier emission factors, and is also based on more reliable data.

Solar heating and cleaner electricity required by the RPS reduce recreational (pool) emissions 85% below CARB 2020 NAT (refer to Table 4-H-3, Table 5-H-1 and Table 5-H-2).

5.3 Summary of CARB 2020 NAT Results

The sections above discuss the calculations and assumptions made in calculating the CARB 2020 NAT scenario. The CARB 2020 NAT analysis only includes annual emissions, and not the one-time vegetation and construction emissions. Table 4-I-1 adds the project emissions from all sources and compares to the sum of the CARB 2020 NAT emissions from these sources. Table 4-I-1 shows that, overall, the project is 36.0% better than the CARB 2020 NAT scenario and exceeds AB 32's 29% reduction for all design alternatives.

Even if the annualized project GHG emissions for vegetation and construction are included[154] in the overall project CARB 2020 NAT scenario, Mission Village is still 35.0% lower than the CARB 2020 NAT scenario.

[154] Annualized by 40 years. Note that this is highly conservative as Newhall is taking measures to reduce emissions from these sources. Also, because vegetation is not included in the ARB scoping plan, vegetation should likely not be included here.

6 Executive Order S-3-05 (Statewide GHG Targets)

Executive order S-03-05 mandates that California emit 80% less GHGs in 2050 than it emitted in 1990. As of 2004, California was emitting 12% more GHG emissions than in 1990. For California to reach the 2050 goal, the total 2050 emissions would be only 18% of the total 2004 emissions. Accounting for a population growth from 35,840,000 people in 2004 to approximately 55,000,000 people in 2050, the emissions per capita would have to be only 12% of what they were in 2004. This means an 88% reduction in per capita GHG emissions relative to 2004 must be realized in order to achieve California's 2050 GHG goals. Clearly, energy efficiency and reduced vehicle miles traveled will play important roles in achieving this aggressive goal, but the decarbonization of fuel will also be necessary.

The extent to which GHG emissions from traffic at Mission Village will change in the future depends on the quantity (e.g. number of vehicles, average daily mileage) and quality (i.e. carbon content) of fuel that will be available and required to meet both regulatory standards and residents' needs. As discussed above, renewable power requirements, the low carbon fuel standard, and vehicle emissions standards will all decrease GHG emissions per unit of energy delivered or per vehicle mile traveled. In this section we discuss the impact that future regulated fuel decarbonization may have on vehicular emissions at Mission Village.

The CEC published "State Alternative Fuels Plan"[155] in which it noted the existence of "challenging but plausible ways to meet 2050 [transportation] goals." The main finding from this analysis is that reducing today's average per capita driving miles by about 5 percent (or back to 1990 levels), in addition to the decarbonization strategies listed below, would achieve S-03-05 goals of 80% below 1990 levels. The approach described below is directly[156] from the CEC report.

An 80 percent reduction in GHG emissions associated with personal transportation can be achieved even if population grows to 55 million, an increase of 50 percent. The following set of measures could be combined to produce this result:

1. Lowering the energy needed for personal transportation by tripling the energy efficiency of on-road vehicles in 2050 with:
    a. Conventional gas, diesel, and flexible fuel vehicles (FFVs) averaging more than 40 mpg.
    b. Hybrid gas, diesel, and FFVs averaging almost 60 mpg.
    c. All electric and plug-in hybrid electric vehicles (PHEVs) averaging well over 100 mpg (on a greenhouse gas equivalents [GGE] basis) on the electricity cycle.
    d. Fuel cell vehicles (FCVs) averaging over 80 mpg (on a GGE basis).

[155] State Alternative Fuels Plan. December 2007 CEC-600-2007-011-CMF. Available online at: http://www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CMF.PDF
[156] Ibid. Page 67 and 68.

2. Moderating growth in per capita driving, reducing today's average per capita driving miles by about 5 percent or back to 1990 levels.
3. Changing the energy sources for transportation fuels from the current 96 percent petroleum-based to approximately:
   a. 30 percent from gasoline and diesel from traditional petroleum sources or lower GHG emission fossil fuels such as natural gas.
   b. 30 percent from transportation biofuels.
   c. 40 percent from a mix of electricity and hydrogen.
4. Producing transportation biofuels, electricity, and hydrogen from renewable or very low carbon-emitting technologies that result in, on average, at least 80 percent lower life cycle GHG emissions than conventional fuels.
5. Encouraging more efficient land uses and greater use of mass transit, public transportation, and other means of moving goods and people.

The measures described above are the types of measures that will yield required reductions. Although these types of measures are expected to occur and are consistent with the Mission development plan, Mission is not accounting for these measures in its GHG inventory.

Executive Order S-01-07[157] (January 18, 2007) initiated the LCFS as a Discrete Early Action under AB 32, which required implementation by January 2010. The LCFS requires a 10 percent or greater reduction by 2020 in the average fuel carbon intensity for transportation fuels in California regulated by the ARB.[158] The LCFS encompasses the life cycle emissions for fuels (i.e., "well-to-wheel"), thus, not only does it include the vehicle tailpipe emissions from the use of the fuel, it also includes all the energy used to produce, process, and transport the fuel. By design, the implementation of the LCFS would decrease the overall GHG emissions for California. However, its impact on vehicle tailpipe emissions is not obvious. As the Mission GHG inventory only considers the vehicle tailpipe emissions, and not the life cycle emissions for transportation, it is difficult to quantitatively assess the impacts of the LCFS on the inventory.

The Scoping Plan States "Reducing our greenhouse gas emissions by 80 percent will require California to develop new technologies that dramatically reduce dependence on fossil fuels, and shift into a landscape of new ideas, clean energy, and green technology."

[157] The text of Executive Order S-01-07 can be found here: http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf

[158] California's Low Carbon Fuel Standard Final Statement of Reasons (December 2009) is available here: http://www.arb.ca.gov/regact/2009/lcfs09/lcfsfsor.pdf

7 Conclusions

ENVIRON prepared a GHG emissions inventory for the Mission Village development. This emissions inventory was prepared consistent with the methodologies established by the CCAR where possible. The Mission Village emissions inventory considers eight categories of GHG emissions: vegetation/land use changes, construction activities, residential building energy, non-residential building energy, mobile sources, municipal sources, area sources, and recreation center energy. The emissions from construction and land use change would be one-time emissions events, while the other emissions would occur annually, throughout the life of the project. A quantitative assessment of the impact of a few key laws, rules and regulations to reduce GHG intensity in electricity production and vehicle use was also included.

A variety of methods were employed to develop the GHG emissions inventory. In addition to well established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several different estimation software programs were used. These included EMFAC, OFFROAD, and URBEMIS.

Emissions from the various aspects of the Mission Village development are presented in Table 4-I-1. This table highlights the one-time emissions that would be attributable to project entitlement, and the annual emissions expected to occur each year after the full buildout of the development. There are approximately 109,331 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to approximately 61,284 tonnes. Of this amount, 64% result from vehicular emissions associated with residential and commercial activities, and 30% result from the energy use associated with residential and non-residential buildings. If the one-time emissions are annualized assuming a 40-year development life (which is likely low), then the one-time emissions account for approximately 4.3% of the overall emissions.

This inventory was prepared assuming that all emissions from Mission Village are “new,” in the sense that, absent the development of Mission Village, these emissions would not occur. It is also important to note that these emissions are estimated assuming that the carbon intensity of the electricity supply system and transportation system change in the future due to state and federal laws in both areas – specifically the Pavley standards for vehicles and the RPS of 20% for electricity.

On average, Mission Village residential GHG emissions per dwelling unit are calculated to be 19% lower than the emissions from a minimally 2005 Title 24 compliant home of the same size. Mission Village non-residential GHG emissions per square foot are calculated to be 28% lower than emissions from a minimally Title 24 compliant building, assuming the same mix of building uses and square footages.

Mission Village mobile sources emit 39% less GHG emissions when compared to a CARB 2020 NAT scenario. The CARB 2020 NAT scenario includes the same housing mix as Mission Village, but project design features reflecting Los Angeles county and Santa Clarita Valley. After accounting for both the lower vehicle miles traveled as compared to current Los Angeles County and Santa Clarita Valley and the 20% decrease in GHG emissions per VMT of the

vehicle fleet in 2020, Mission Village would be 39% better than CARB 2020 NAT on a GHG basis when compared to Los Angeles County and Santa Clarita Valley.

Mission Village water use may be 40% better in GHG emissions than a comparative CARB 2020 NAT for a similar Southern California development. The GHG savings are mainly from recycling water and obtaining water from local sources.

Mission Village pool use will be 85% better in GHG emissions than a comparative CARB 2020 NAT for a similar Southern California development. The GHG savings are mainly from using solar heating.

It is yet unclear as to how to compare construction and vegetation change emissions to AB 32 mandated goals. Overall, the reductions in emissions from the residential, non-residential, transportation, municipal, area, and recreational sectors of Mission Village represent a 36.0% decrease from CARB 2020 NAT emissions; thus, Mission Village exceeds the AB 32 reduction standards of 29%. Even counting vegetation and construction, Mission Village is still 35.0% below the level of CARB 2020 NAT.

Anticipated state and federal regulatory developments will have various effects on Mission Village's GHG inventory. Both the Pavley vehicle emissions standards and the increased CAFE standards under the EISA of 2007 will result in a decrease in Mission Village's GHG inventory as tailpipe emissions would be lower. California's Renewables Portfolio Standard (RPS) 20% target for 2010 and anticipated 33% target for 2020 will also decrease Mission Village's indirect GHG emissions from electricity use. The Pavley Standards and the RPS 2010 20% target were both were quantitatively accounted for in this inventory.

The LCFS is unlikely to have a large effect on Mission Village's GHG inventory because the inventory only accounts for tailpipe emissions whereas the LCFS addresses the life cycle emissions for each fuel. Tailpipe emissions would decrease as a result of LCFS only if there is a significant shift from gasoline to alternative fuels with a combination of fuel efficiency and carbon content that would result in lower CO_2 emissions per mile driven. While the LCFS may not lead to a significant change in the vehicle tailpipe emissions, it will lead to a decrease in California GHG emissions because it also accounts for emissions from production, processing, and the transport of fuels. The LCFS was not quantitatively accounted for in this inventory.

The CEC published[159] a report that presents "challenging but plausible ways to meet 2050 [transportation] goals." The main finding from this analysis is that reducing today's average per capita driving miles by about 5 percent (or back to 1990 levels), in addition to decarbonization strategies, would achieve S-03-05 goals of 80% below 1990 levels. We would anticipate that similar decarbonization of the electricity supply would have a similar impact on the other sources major sources of GHGs from the development, such as the residential and commercial GHG emissions.

[159] STATE ALTERNATIVE FUELS PLAN. December 2007 CEC-600-2007-011-CMF. Available online at: http://www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CMF.PDF

vehicle fleet in 2020, Mission Village would be 39% better than CARB 2020 NAT on a GHG basis when compared to Los Angeles County and Santa Clarita Valley.

Mission Village water use may be 40% better in GHG emissions than a comparative CARB 2020 NAT for a similar Southern California development. The GHG savings are mainly from recycling water and obtaining water from local sources.

Mission Village pool use will be 85% better in GHG emissions than a comparative CARB 2020 NAT for a similar Southern California development. The GHG savings are mainly from using solar heating.

It is yet unclear as to how to compare construction and vegetation change emissions to AB 32 mandated goals. Overall, the reductions in emissions from the residential, non-residential, transportation, municipal, area, and recreational sectors of Mission Village represent a 36.0% decrease from CARB 2020 NAT emissions; thus, Mission Village exceeds the AB 32 reduction standards of 29%. Even counting vegetation and construction, Mission Village is still 35.0% below the level of CARB 2020 NAT.

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The LCFS is unlikely to have a large effect on Mission Village's GHG inventory because the inventory only accounts for tailpipe emissions whereas the LCFS addresses the life cycle emissions for each fuel. Tailpipe emissions would decrease as a result of LCFS only if there is a significant shift from gasoline to alternative fuels with a combination of fuel efficiency and carbon content that would result in lower CO_2 emissions per mile driven. While the LCFS may not lead to a significant change in the vehicle tailpipe emissions, it will lead to a decrease in California GHG emissions because it also accounts for emissions from production, processing, and the transport of fuels. The LCFS was not quantitatively accounted for in this inventory.

The CEC published[159] a report that presents "challenging but plausible ways to meet 2050 [transportation] goals." The main finding from this analysis is that reducing today's average per capita driving miles by about 5 percent (or back to 1990 levels), in addition to decarbonization strategies, would achieve S-03-05 goals of 80% below 1990 levels. We would anticipate that similar decarbonization of the electricity supply would have a similar impact on the other sources major sources of GHGs from the development, such as the residential and commercial GHG emissions.

[159] STATE ALTERNATIVE FUELS PLAN. December 2007 CEC-600-2007-011-CMF. Available online at: http://www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CMF.PDF

Table 4-1
GHG Emissions from Renewable Power Standards
Mission Village
Newhall Ranch, CA

Renewable Energy Source[1]	Energy Delivered[1] [million kWh]	Percentage of Renewable Energy Delivered [%]
Wind	2,359	21%
Small hydro	449	4%
Biogas	0	0%
Solar	0	6%
Biomass	786	7%
Geothermal	6,965	62%
Total[2]	**11,234**	**100%**
% of Total Energy From Renewables[1]	13%	
% of Total Energy From Non-Renewables	87%	
Total Energy Delivery[2]	83,958,770	MWh
from renewables	11,234,288	MWh
from non-renewables	72,724,482	MWh
CO_2 Emissions per Total Energy Delivered	630.89	lbs CO_2/MWh delivered
Total CO_2 Emissions[3]	24,026,108	metric tonnes CO_2
CO_2 Emissions per Total Non-Renewable Energy[4]	728.34	lbs CO_2/MWh delivered
Estimated Emission Factors for Total Energy Delivered[5]		
2010 RPS (20%)	582.7	lbs CO_2/MWh delivered
2020 RPS (33%)	488.0	lbs CO_2/MWh delivered

Notes:

1. The renewable energy portfolio for Southern California Edison, the power utility that is most likely to provide power to the Mission Village development. The renewable energy distribution is based on 2007 data available from the SCE PUP report.

2. Total energy value reported for 2007 by Southern California Edison in California Climate Action Registry PUP report.

3. The amount of CO_2 emissions is provided in Southern California Edison's Power/Utility Protocol (PUP) Report for 2007.

4. The emissions metric presented here is calculated based on the total CO_2 emissions divided by the energy delivered from non-renewable sources.

5. The emission factors for total energy delivered are estimated by multiplying the percentage of energy delivered from non-renewable energy by the CO_2 emissions per total non-renewable energy metric calculated above. Two emission factors are presented here for the current 20% RPS goal for 2010 and the presumed 33% RPS for 2020. The estimate provided here and the 2006 PUP report issued by Southern California Edison assume that renewable energy sources do not result in any CO_2 emissions. This is not necessarily true for biogas- and biomass-sourced energy, but some consider these sources to be "carbon neutral."

Abbreviations:
CO_2 = carbon dioxide
GHG - Greenhouse Gas
kWh = kilowatt-hour
lbs = pounds
MWh = Megawatt-hour
PUP = Power/Utility Protocol
RPS = Renewables Portfolio Standard
SCE = Southern California Edison

Table 4-2
Emission Factors by Energy Source
Mission Village
Newhall Ranch, CA

Energy Source	Scenario	Source Units	lb CO_2/source unit
Electricity	CARB 2020 NAT emission factor[1,3]	(kWh)	0.641
	2007 emission factor[2]		0.631
	2010 RPS (20%)[3]		0.583
Natural Gas[4]		(MMBTU)	117.0
		(ccf)	12.0

Notes:

1. Emission factor for electricity provided by Southern California Edison for 2006, obtained from the California Climate Action Registry Database.
2. Emission factor for electricity provided by Southern California Edison for 2007, obtained from the California Climate Action Registry Database.
3. The 2007 emission factor for electricity has been adjusted to account for the 20% Renewable Portfolio Standard required of electricity providers by 2010.
4. Emission factor for natural gas was obtained from California Climate Action Registry General Reporting Protocol, Table C7.

Abbreviations:

CARB 2020 NAT = California Air Resources Board 2020 No Action Taken
ccf = 100 cubic feet
kWh = kilowatt-hour
lb = pound
MMBTU = million british thermal units
RPS = Renewables Portfolio Standard

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

California Climate Action Registry Database: Southern California Edison Company 2006 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Table 4-A-1
Change in CO_2 Sequestration Due to Change in Land Use Type
Mission Village
Newhall Ranch, California

Mission Village Land Designation[1]	Mapped IPCC Land Designation[2]	Ratio of Above Ground / Below Ground Biomass[3]	Notes	Above Ground Biomass[4] [tonne d.m./acre]	Notes	Total Biomass[5] [tonne d.m./acre]	Notes	Tonnes Dry Matter Carbon/Acre[6] [tonne/acre]	Sequestered CO_2 / Acre[7] [tonne/acre]	Total Developed Area [acres]	Change in CO_2 Sequestered [tonne]
Agriculture	Cropland	--		--		4.0	12	2	7	224	1,565
Alluvial Scrub	Forest land	2.17	9	5.7	11	8		4	14	0	7
Arrow weed Scrub	Forest land	2.17	9	5.7	11	8		4	14	7.6	110
Big Sagebrush Scrub	Forest land	2.17	9	5.7	11	8		4	14	24.6	355
Chamise Chaparral	Forest land	2.17	9	5.7	11	8		4	14	2.6	37
Chamise - Hoaryleaf Ceanothus Chaparral	Forest land	2.17	9	5.7	11	8		4	14	1.9	27
California Annual Grassland	Grassland	--		--		2.5	13	1	4	82.4	351
Coast Live Oak Woodland	Forest land	4.35	8	53	10	65		30	112	28.5	3,179
California Sagebrush Scrub	Forest land	2.17	9	5.7	11	8		4	14	518.8	7,485
California Sagebrush Scrub - Artemisia	Forest land	2.17	9	5.7	11	8		4	14	16.1	233
California Sagebrush Scrub - Black Sage	Forest land	2.17	9	5.7	11	8		4	14	12.9	187
California Sagebrush Scrub - California Buckwheat	Forest land	2.17	9	5.7	11	8		4	14	84.7	1,222
California Sagebrush Scrub/Undifferentiated Chapparal	Forest land	2.17	9	5.7	11	8		4	14	15.5	223
California Sagebrush Scrub - Purple Sage	Forest land	2.17	9	5.7	11	8		4	14	132.9	1,918
Developed	--	--		--		0		0	0	8.1	0
Disturbed California Sagebruch Scrub	--	--		--		0		0	0	0.1	0
Disturbed Land	--	--		--		0		0	0	404.2	0
Disturbed Mulefat	Forest land	2.17	9	5.7	11	8		4	14	1.1	15
Eriodictyon Scrub	Forest land	2.17	9	5.7	11	8		4	14	0.6	9
Giant Reed Grassland	Grassland	--		--		2.5	13	1	4	5.6	24
Herbaceous Wetlands	--	--		--		0	14	0	0	4.0	0
Mexican Elderberry Scrub	Forest land	2.17	9	5.7	11	8		4	14	5.8	83
Mulefat Scrub	Forest land	2.17	9	5.7	11	8		4	14	1.8	25
Open Channel (developed)	--	--		--		0		0	0	0.0	0
River Wash	--	--		--		0	14	0	0	116.3	0
Southern Cottonwood/Willow Riparian Forest	Forest land	4.35	8	53	10	65		30	112	109.6	12,218
Southern Willow Scrub	Forest land	2.17	9	5.7	11	8		4	14	1.5	21
Shrub tamarisk	Forest land	2.17	9	5.7	11	8		4	14	1.1	15
Undifferentiated Chaparral	Forest land	2.17	9	5.7	11	8		4	14	36.1	520
Valley Oak/Grass	Grassland	--		--		2.5	13	1	4	3.3	14
Valley Oak Woodland	Forest land	4.35	8	53	10	64.7		30	112	2.1	238
Total										1,854	**30,082**

Notes:

1. Land types shown here represent vegetation that will be permanently removed upon development. Land designations provided by the Impact Science.
2. Mission Village land types are mapped to generalized IPCC Land Designations (IPCC 2006).
3. This value is used to calculate total biomass when data is only available for the above-ground biomass for a particular land type.
4. Numbers listed are used in conjunction with above ground/below ground ratios to calculate total biomass per acre. Values from source converted to tonne/acre.
5. Total biomass is either 1.) Listed directly in the IPCC protocol, or 2.) Calculated from above ground biomass and the Above Ground / Below Ground biomass ratios as follows: Total = Above + (Above / Ratio). Values from source converted to tonne/acre as necessary.
6. Total biomass multiplied by carbon fraction in plant material (0.47) to calculate carbon content. From IPCC (2006), default value for Forest Land (Table 4.3 of IPCC). 10.ere, it is assumed that agricultural vegetation has the same carbon fraction as other vegetation types.
7. It is conservatively assumed that all carbon is eventually converted into CO2. Multiply the mass of carbon by 3.67 to calculate the final mass of CO2 (the molecular mass of CO2 / the molecular mass of carbon is 44/12 or 3.67).
8. The value for the ratio of above ground/below ground biomass for forest land corresponds to the IPCC value for temperate mountain/continental systems (other broadleaf above-ground biomass 75-150 tonnes/hectare)(Table 4.4 of IPCC).
9. The value for the ratio of above ground/below ground biomass for various scrub types corresponds to the IPCC value for temperate mountain/continental systems (other broadleaf above-ground biomass <75 tonnes/hectare)(Table 4.4 of IPCC). This value is likely to be conservative since scrub is a type of shrub which is likely to have a smaller ratio than for trees.
10. The value for above ground biomass for forest land corresponds to the IPCC value for temperate mountain/continental systems (North and South America > 20 years)(Table 4.7 of IPCC).
11. The value for above ground biomass applied to various scrub types is based on a value of 1,417 g biomass/m 2 (or 5.7 tonne biomass/acre) for coastal sage scrub (Gray and Schlesinger). It is assumed that all scrub types will have similar values.
12. Total biomass for agricultural land corresponds to IPCC value for cropland (Table 8.4 of IPCC).
13. Total biomass for non-native grassland corresponds to IPCC value for grassland in warm temperate-dry climates (Table 6.4 of IPCC).
14. There is limited data on biomass content of river wash and freshwater marsh. For the purposes of this inventory, it will be assumed that these land types have negligible biomass associated with them. Any changes in G10.G emissions are expected to be de minimis because the amount of these land types is very low.

Abbreviations:

CO_2 - carbon dioxide
d.m. - dry matter
IPCC - Intergovernmental Panel on Climate Change
m^2 = square meter

Sources:

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 Agriculture, Forestry and Other Land Use. Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm
Gray, J.T. and W.H. Schlesinger. 1981. Biomass, Production, and Litterfall in the Coastal Sage Scrub of Southern California*Amer. J. Bot.* 68(1):24-33.

Table 4-A-2
Average Annual CO_2 Sequestration Per Tree
Mission Village
Newhall Ranch, California

Species Class	Annual CO_2 Sequestered Per Tree[1] [tonne CO_2/year]
Aspen	0.035
Soft Maple	0.043
Mixed Hardwood	0.037
Hardwood Maple	0.052
Juniper	0.012
Cedar/Larch	0.026
Douglas Fir	0.045
True Fir/Hemlock	0.038
Pine	0.032
Spruce	0.034
Average Default	0.035
Species Class	**Total CO_2 Sequestered by All Trees Planted at Mission Village[2] [tonne CO_2]**
Average Default (4,985 trees)[3]	3,531

Notes:

1. Annual mass of carbon accumulated is converted into mass of CO_2 sequestered based on the assumption that all carbon accumulated in the tree represents an equivalent amount of CO_2. Annual carbon accumulation rates provided in IPCC (2006) in Table 8.2 of the settlements section. When the Species Class is not provided, an average default value of 0.035 for annual CO_2 sequestered per tree is used.
2. Total mass of CO_2 sequestered = average default value of annual CO_2 sequestered per tree (0.035 tonne CO2/year) x number of trees planted at Mission Village (3,531 trees) x total CO_2 sequestration time (20 years - age at which tree matures and CO_2 sequestration reaches a saturation point).
3. Estimated by scaling the number of trees in Newhall Ranch by the total building square footage.

Abbreviations:

CO_2 - carbon dioxide

Source:

2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Volume 4 Agriculture, Forestry and Other Land Use. Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

ENVIRON International Corporation. 2009. Resource Management and Development Plan Spineflower Conservation Plan Climate Change Technical Report. February. Available at: http://www.dfg.ca.gov/regions/5/newhall/docs/app-8.html

Table 4-B-1
Mission Village Overall Construction GHG Emissions[1]
Mission Village
Newhall Ranch, California

Location	Grading, Trenching, and Street Paving	Building, Coating, and Paving	Total GHG Emissions
	(tonne CO_2e)		
Mission Village	18,852	63,928	82,781

Notes:
1. Impact Sciences provided ENVIRON with URBEMIS 9.2.4 runs for Mission Village construction from 2011 - 2018. URBEMIS calculates CO_2 emissions from off-road construction equipment, worker commuting, and vendor trips based on the size and type of buildings specified by the user and URBEMIS defaults.

Abbreviations:
CO_2e - carbon dioxide equivalent
GHG - Greenhouse Gas
tonne - metric tonne

Table 4-C-1
Specifications for Homes Modeled using Residential Appliance Saturation Survey
Mission Village
Newhall Ranch, CA

Specification	Units	Dwelling Type		
		Multi-family	Single family	Townhome
Forecast Climate Zone[1]		California Climate Zone 9		
Number of Dwelling Units	DU	3,140	382	890
Dwelling Unit Size[2]	SF	1,250	3,300	1,750
Average RASS Dwelling Unit Size[3]	SF	817	1,738	1,040
Difference in Size Relative to RASS Unit		53%	90%	68%

Notes:
1. Based on the Forecast Climate Zone map provided in the Executive Summary of the RASS report. Available at:http://energy.ca.gov/reports/400-04-009/2004-08-17_400-04-009ES.PDF
2. Based on information provided by Newhall.
3. Based on on-line searchable RASS database available at: http://websafe.kemainc.com/RASSWEB/DesktopDefault.aspx. The average square footage of all units of a particular dwelling type in Forecast Climate Zone 9 is shown here.

Abbreviations:
DU - Dwelling Unit
RASS - Residential Appliance Saturation Survey
SF - Square Feet

Sources:
Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.

Table 4-C-2
Energy Use per Residential Dwelling Unit: Title 24 Regulated Heating and Cooling
Mission Village
Newhall Ranch, California

	Electricity Delivered (kWh/DU/year)							Natural Gas Delivered (MMBTU/DU/yr)						
Type[1]	**Heating[2,3]**	**Cooling[2]**	**RASS Total**	**% Reduction due to 2005 standards relative to 2001[4,5]**	**2005 Estimated Total**	**% Reduction due to 2008 vs. 2005 standards[6]**	**2008 Estimated Total**	**Heating[2,3]**	**Domestic Hot Water[2,7]**	**RASS Total**	**% Reduction due to 2005 standards relative to 2001[4]**	**2005 Estimated Total**	**% Reduction due to 2008 vs. 2005 standards[6]**	**2008 Estimated Total**
Multi-family	0	357	357	24.3%	270	19.7%	217	24.9	15.3	40.2	15.7%	33.9	7%	31.5
Single family	0	1,814	1,814	19.8%	1,455	22.7%	1,125	30.9	22.3	53.2	6.7%	49.6	10%	44.7
Town home[8]	0	806	806	24.3%	610	19.7%	490	27.4	19.8	47.2	15.7%	39.8	7%	37.0

Notes:

1. Based on information provided by Newhall.
2. Based on the California Residential Appliance Saturation Survey (RASS), which collected data from over 21,100 households statewide. Only RASS data tabulated for the homes in the same forecast climate zone in which Mission Village would be located (Climate Zone 9) were considered in this analysis. The RASS estimates were increased by 90%, 68% and 53% to reflect the larger size of Mission Village's single family homes, attached homes and apartments, respectively relative to the corresponding types in the RASS study.
3. Homes were assumed to be heated using natural gas.
4. Reductions are taken with the assumption that the RASS estimate reflects heating/cooling/hot water electricity use for homes that are minimally compliant with 2001 Title 24 Standards (this version was the most current at the time of the RASS study).
More than 90% of the homes that participated in the survey were constructed before 1997. Because older homes tend to use more energy, the numbers shown here may overestimate actual energy use at a new development such as Mission Village.
5. Based on report by California Energy Commission on estimated first-year electricity savings due to 2005 standards for single-family, town homes and multi-family homes, relative to 2001 standards.
6. Based on California Energy Commission report on estimated first-year electricity savings due to 2008 standards for single-family, town homes and multi-family homes, relative to 2005 standards.
7. All domestic hot water systems are assumed to use natural gas.
8. Reductions in Title 24 energy use for multi-family homes were applied to townhomes.

Abbreviations:

DU - Dwelling
kWh - kilowatt-hour
MMBTU - million British thermal units
RASS - Residential Appliance Saturation Survey

Sources:

California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF
Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.

Table 4-C-3
Energy Use per Residential Dwelling Unit: Appliances and Plug-ins
Mission Village
Newhall Ranch, California

		Electricity Delivered (kWh/DU/year)2								Natural Gas Delivered (MMBTU/DU/yr)[2]		
Type	**Type[1]**	**Refrigerator**	**Clothes Washer**	**Clothes Dryer[3]**	**Dishwasher**	**Cooking Range (Electric)[4]**	**Total Major Appliances**	**MELs**	**Total**	**Clothes Dryer (Gas)[3]**	**Gas Cooking Range[4]**	**Total**
Standard Appliances	**Multi-family**	744	4	93	28	101	971	1,783	2,753	2.1	4.6	6.7
	Single family	1,135	121	242	59	123	1,681	2,825	4,505	2.1	4.6	6.7
	Town home	850	48	189	38	106	1,231	2,126	3,357	2.1	4.6	6.7

Notes:
1. Based on information provided by Newhall.
2. Energy use per residential dwelling unit is based on information in RASS report.
3. Dryers may be either electric or natural gas-fueled. Only electric dryers are included in this value.
4. Cooking ranges can be either gas or electric. This value represents the average of the electricity requirements for the two types.

Abbreviations:
DU - Dwelling Unit
kWh - kilowatt-hour
MMBTU - million british thermal units
MEL - Miscellaneous electric load
yr - year

Sources:
Environmental Protection Agency (USEPA). 2006 Annual Report. Energy Star and Other Climate Protection Partnerships. Available at: http://www.epa.gov/cpd/annualreports/annualreports.htm.
Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.

Table 4-C-4
Energy Use per Residential Dwelling Unit
Mission Village
Newhall Ranch, California

Title 24 Compliance	Dwelling Type[1]	Electricity Delivered						Natural Gas Delivered		
		Heating and Cooling	Hard Wired Lighting[6,7]	Major Appliances[2,4]	Plug-ins[3]	On-site Renewable Energy	Total	Heating and Domestic Hot Water	Gas Dryers and Oven Ranges[4,6]	Total
		[kWh / DU / year]						(MMBTU natural gas / DU / year)		
Minimally 2005 Title 24 Compliant (CARB 2020 NAT)	Multi-family	270	656	971	1,783	--	3,680	34	7	41
	Single family	1,455	1,584	1,681	2,825	--	7,545	50	7	56
	Town home	610	936	1,231	2,126	--	4,904	40	7	46
Minimally Title 24 Compliant (2008)	Multi-family	217	656	971	1,783	--	3,626	32	7	38
	Single family	1,125	1,584	1,681	2,825	--	7,215	45	7	51
	Town home	490	936	1,231	2,126	--	4,784	37	7	44
15% Better Than 2008 Title 24 and On-site Renewable Energy[5,8]	Multi-family	185	557	971	1,783	--	3,495	27	7	33
	Single family	956	1,347	1,681	2,825	-3,356	3,452	38	7	45
	Town home	416	796	1,231	2,126	--	4,570	31	7	38
Percentage Improvement over 2005 Title 24 (CARB 2020 NAT)	Multi-family	32%	15%	0%	0%	--	5%	21%	0%	18%
	Single family	34%	15%	0%	0%	--	54%	24%	0%	21%
	Town home	32%	15%	0%	0%	--	7%	21%	0%	18%
Percentage Improvement over 2008 Title 24	Multi-family	15%	15%	0%	0%	--	4%	15%	0%	12%
	Single family	15%	15%	0%	0%	--	52%	15%	0%	13%
	Town home	15%	15%	0%	0%	--	4%	15%	0%	13%

Notes:
1. Information provided by Newhall.
2. Cooking may be performed on an electric range or a natural gas stove. The values shown in these columns are 50% of the energy/heat used for each stove type.
3. "Plug-ins" refers to electricity use associated with plug-in lighting, plug-in appliances, and miscellaneous electric loads. This energy use is calculated based on the RASS report.
4. Dryers and ovens may be electric or gas. The values presented in this table represent 50% of the electricity and/or natural gas use for each equipment type.
5. Newhall has committed to a 15% improvement in energy use in the building envelope over 2008 Title 24 standards.
6. According to the CEC, standards for residential lighting did not change significantly in the 2008 version of Title 24.
7. Hard-wired lighting is assumed to include all outdoor lighting and hard-wired indoor lighting. Hard-wired indoor lighting energy use is estimated to be 30% of the energy listed under "miscellaneous" electricity load in the RASS report. According to the RASS study, 60% of total miscellaneous electricity use is for lighting; ENVIRON assumed that 50% of this energy is for hard-wired lighting and 50% is for plug-in lighting.
8. Newhall has committed to using renewable electricity equivalent to putting photovoltaic systems on all Single Family detached residences. For this calculation, Single Family dwelling units are assumed to be provided with a 2.0 kW solar system from Sunpower company. The yearly electricity savings are estimated to be 3356 kWh for a 2 kW solar system with a 30 degree roof slope and a south roof direction as provided for the City of Santa Clarita, CA.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
DU - Dwelling Unit
kWh - kilowatt-hour
MMBTU - million british thermal units
RASS - Residential Appliance Saturation Survey

Sources:
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF.

Table 4-C-5
CO_2e Emissions per Dwelling Unit
Mission Village
Newhall Ranch, California

Title 24[1] Compliance	Type[2]	Title 24 Systems1		Title 24 Systems and Major Appliances		Title 24 Systems and All MELs and On-site Renewable Energy		Title 24 Systems	Title 24 Systems and Major Appliances	Title 24 Systems and All MELs
		CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Total	CO_2 Total	CO_2 Total
		(lb / DU / year)						(tonne / DU / year)		
Minimally 2005 Title 24 Compliant	**Multi-family**	594	3,964	1,217	4,745	2,360	4,745	2.1	2.7	3.2
	Single family	1,949	5,808	3,027	6,589	4,838	6,589	3.5	4.4	5.2
	Town home	992	4,656	1,781	5,437	3,145	5,437	2.6	3.3	3.9
Minimally Title 24 Compliant (2008)	**Multi-family**	509	3,686	1,075	4,467	2,114	4,467	1.9	2.5	3.0
	Single family	1,579	5,227	2,559	6,008	4,206	6,008	3.1	3.9	4.6
	Town home	831	4,330	1,549	5,111	2,789	5,111	2.3	3.0	3.6
15% Better Than 2008 Title 24 and On-site Renewable Energy[5]	**Multi-family**	433	3,133	999	3,915	2,038	3,915	1.6	2.2	2.7
	Single family	1,342	4,443	2,322	5,224	2,013	5,224	2.6	3.4	3.3
	Town home	707	3,681	1,425	4,462	2,664	4,462	2.0	2.7	3.2
Percentage Improvement over 2008 Title 24	**Multi-family**	15%	15%	7%	12%	4%	12%	15%	11%	10%
	Single family	15%	15%	9%	13%	52%	13%	15%	12%	29%
	Town home	15%	15%	8%	13%	4%	13%	15%	12%	10%

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Newhall.
3. Converted from kWh to lb CO2 using emission factor from the California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008.
4. Converted from MBTU to lb CO_2 using emission factor from California Climate Action Registry General Reporting Protocol (CCAR GRP)
5. Newhall has committed to a 15% improvement in energy use in the building envelope over 2008 Title 24 standards.

Abbreviations:
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DU - Dwelling Unit
lb - pound
MEL - Miscellaneous electric load
tonne - metric tonnes

Sources:
2001 Residential Energy Consumption Survey conducted by the US Energy Information Administration: http://www.eia.doe.gov/emeu/recs/contents.html
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf
California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Table 4-C-6
GHG Emissions from Electricity and Natural Gas Usage in Residential Dwelling Units
Mission Village
Newhall Ranch, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title 24 Systems			Title 24 Systems and Major Appliances			Title 24 Systems and All MELs		
			CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant	**Multi-family**	3,140	2.1	6,491	**10,115**	2.7	8,491	**13,071**	3.2	10,119	**15,563**
	Single family	382	3.5	1,344		4.4	1,666		5.2	1,980	
	Town Home	890	2.6	2,280		3.3	2,914		3.9	3,465	
Minimally Title 24 Compliant (2008)	**Multi-family**	3,140	1.9	5,975	**9,238**	2.5	7,894	**12,067**	3.0	9,374	**14,333**
	Single family	382	3.1	1,179		3.9	1,484		4.6	1,770	
	Town Home	890	2.3	2,084		3.0	2,689		3.6	3,189	
15% Better Than 2008 Title 24 and On-site Renewable Energy[3]	**Multi-family**	3,140	1.6	5,079	**7,852**	2.2	6,998	**10,682**	2.7	8,478	**12,609**
	Single family	382	2.6	1,002		3.4	1,308		3.3	1,254	
	Town Home	890	2.0	1,771		2.7	2,376		3.2	2,877	
Percentage Improvement over 2008 Title 24	**Multi-family**	3,140	15%	15%	**15%**	11%	11%	**11%**	10%	10%	**12%**
	Single family	382	15%	15%		12%	12%		29%	29%	
	Town Home	890	15%	15%		12%	12%		10%	10%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Newhall.
3. Emissions reduction due to on-site renewable energy generation is deducted from "Title 24 Systems and All MELs" column only.

Abbreviations:
CO_2 - carbon dioxide
DU - Dwelling Unit
GHG - Greenhouse Gas
MEL - Miscellaneous electric loads
tonne - metric tonne

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 4-D-1
Land Use Categories Present in Mission Village (Non-Residential)
Mission Village
Newhall Ranch, California

General Building Type[1]	Building Area (SF)	%[2]	Refined Building Type[3]	%[4]	Modeled CEUS Building Category[5]	Building Area (SF)
Commercial	1,555,100	45%	Office	100%	All Office	697,000
		55%	Retail / Office	50%	Retail	429,050
				50%	All Office	429,050
Library	35,000	100%	Library	100%	All Office	35,000
School	100,000	100%	School	100%	School	100,000
Fire Station	13,000	100%	Fire Station	100%	Miscellaneous	13,000

Notes:
1. Four main building types provided by Newhall.
2. The percentage of each Refined Building Type present in the General Building Type.
3. The subcategories of General Building Type provided by Newhall.
4. The percentage of each Modeled Building Category present in the Refined Building Type.
5. The CEUS building type used in modeling that represents each Refined Building Type.

Abbreviations:
CEUS - California Commercial End-Use Survey
SF - Square Feet

Table 4-D-2
Electricity End-Use Distribution for Non-Residential Building Types
Mission Village
Newhall Ranch, California

		CEUS Building Type			
End Use[1]	**Title 24 System[2]**	**All Office**	**Miscellaneous**	**Retail**	**School**
Air Compressor	No	1%	4%	0%	0%
Cooking	No	1%	2%	1%	2%
Cooling	Yes	21%	14%	17%	16%
Exterior Lighting	No	7%	11%	9%	9%
Heating	Yes	1%	1%	0%	2%
Interior Lighting	No	24%	21%	39%	36%
Miscellaneous	No	4%	12%	6%	4%
Motors	No	4%	14%	1%	1%
Office Equipment	No	15%	2%	2%	4%
Process	No	0%	0%	0%	0%
Refrigeration	No	4%	10%	8%	9%
Ventilation	Yes	17%	8%	15%	13%
Water Heating	Yes	0%	1%	1%	2%

Notes:
1. All end use percentages for each CEUS Building Type are taken directly from CEUS database.
2. Only end uses regulated by Title 24 are included in the Title 24 building envelope energy budget. Hard-wired lighting (exterior lighting and some interior lighting) are part of Title 24, but are not considered part of the building envelope energy

Abbreviations:
CEUS - California Commerical End-Use Survey

Source:

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: http://www.energy.ca.gov/ceus/

Table 4-D-3
Natural Gas End-Use Distribution for Non-Residential Building Types
Mission Village
Newhall Ranch, California

		CEUS Building Type			
End Use[1]	**Title 24 System[2]**	**All Office**	**Miscellaneous**	**Retail**	**School**
Gas Cooking	No	3%	4%	18%	8%
Gas Cooling	Yes	2%	12%	0%	0%
Gas Heating	Yes	76%	25%	43%	49%
Gas Water Heating	Yes	19%	41%	31%	42%
Gas Miscellaneous	No	0%	2%	4%	1%
Gas Process	No	0%	16%	5%	0%

Notes:
1. All end use percentages for each CEUS Building Type are taken directly from CEUS database.
2. Only end uses regulated by Title 24 are included in the Title 24 building envelope energy budget.

Abbreviations:
CEUS - California Commerical End-Use Survey

Source:
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at:
Available at: http://www.energy.ca.gov/ceus/

Table 4-D-4
Title 24 Improvements by End Use
Mission Village
Newhall Ranch, California

End Use	Reduction from 2001 to 2005[2]	Reduction from 2005 to 2008[2]
Air Compressors	0.0%	0.0%
Cooking	0.0%	0.0%
Cooling	6.7%	8.3%
Exterior Lighting[1]	9.8%	11.7%
Gas Cooking	0.0%	0.0%
Gas Cooling	10.4%	9.3%
Gas Heating	3.1%	15.9%
Gas Hot Water	0.0%	0.0%
Gas Miscellaneous	0.0%	0.0%
Gas Process	0.0%	0.0%
Heating	4.9%	37.2%
Interior Lighting[1]	4.9%	5.9%
Miscellaneous	0.0%	0.0%
Motors	0.0%	0.0%
Office Equipment	0.0%	0.0%
Process	0.0%	0.0%
Refrigeration	0.0%	0.0%
Ventilation	5.0%	1.5%
Water Heating	0.0%	0.0%

Notes:

1. Exterior lighting was assumed to be covered by Title 24 lighting and therefore has the reduction taken. Interior lighting was assumed to be 50% Title 24 and 50% non-Title 24 uses. Therefore only half of the reduction for lighting was applied.

2. The percentage reductions for each end use category are taken directly from the CEC's "Impact Analysis for 2005 Energy Efficiency Standards" (2002 to 2005) as well as from the "Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings" (2005 to 2008). This represents the percentage to adjust each end use to reflect improvements in Title 24 building codes since 2002. ENVIRON used the 2002 CEUS data to represent energy use for buildings that are minimally compliant with the 2001 Title 24 standards. CEUS did not publish information on the ages of the buildings surveyed. Because older buildings tend to be less energy efficient, and the majority of the buildings in the survey were likely constructed before 2001, the 2002 CEUS data likely overestimates energy use for a 2001 Title 24-compliant building.

Abbreviations:

CEC - California Energy Commission
CEUS - California Commercial End-Use Survey

Sources:

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/

California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF

California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Table 4-D-5
Non-Residential Energy Use
Mission Village
Newhall Ranch, California

Building Type	CEUS Building Type	Energy Type	Units	Title 24 Energy Use Base1,2	Title 24 Energy Use 20082,3	15% Better than 2008 Title 24, Title 24 Energy Use 2,4	Non-Title 24 Energy Use[1,5]	Project Energy Use[6]
				[Unit/SF/yr]				
Fire Station	Miscellaneous	Electricity	kWh	7.26	6.31	5.37	5.76	11.12
		Gas	kBTU	15.77	14.37	12.21	4.45	16.67
Office and Library	All Office	Electricity	kWh	11.29	9.93	8.44	4.63	13.07
		Gas	kBTU	12.38	10.54	8.96	0.39	9.35
Retail	Retail	Electricity	kWh	13.52	11.95	10.16	3.23	13.39
		Gas	kBTU	1.36	1.21	1.03	0.49	1.52
School	School	Electricity	kWh	5.84	5.12	4.35	1.60	5.95
		Gas	kBTU	10.90	9.82	8.34	1.08	9.43

Notes:

1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy use rates are based on 2002 consumption data. ENVIRON used data for Southern California Edison (SCE), Zone 9, which is the sector in which Mission Village would be located.
2. Includes Title 24-regulated building envelope uses of electricity (heating, cooling, ventilation, water heating) and gas (heating, water heating) and all lighting.
3. ENVIRON multiplied the Title 24 Energy Use Base for each Title 24 end use category by the reduction factors for 2001 to 2005 and 2005 to 2008 and summed all applicable end use categories.
4. Mission Village has committed to exceed the 2008 Title 24 building code by 15% for all building envelope uses. This includes heating, cooling, ventilation, lighting, and water heating.
5. Includes all other uses of electricity (cooking, refrigeration office equipment, miscellaneous, process, motors, air compressors) and gas (cooling, cooking, miscellaneous, process) not included in the Title 24-regulated building envelope or lighting.
6. Project Energy Use sums the previous two columns (15% Better than 2008 Title 24 Energy Use and Non-Title 24 Energy Use).

Abbreviations:

CEC - California Energy Commission
CEUS - California Commerical End-Use Survey
kBTU - kilo (1000) British thermal units
kWh - kilowatt hour
SCE - Southern California Edison
SF - square feet
yr - year

Sources:

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Table 4-D-6
GHG Emissions from Non-Residential Buildings
Mission Village
Newhall Ranch, California

Building Type	CEUS Building Type	Size	Energy Type	Unit	15% Better than 2008 Title 24, All Energy Use 1	CO_2e Emissions[2]	Total CO_2e Emissions[3]
		[SF]			[Unit/SF/yr]	[tonne CO_2e/SF/yr]	[tonne CO_2e/yr]
Fire Station	Miscellaneous	13,000	Electricity	kWh	11.12	2.94E-03	38
			Gas	kBTU	16.67	8.85E-04	11
Office and Library	All Office	1,161,050	Electricity	kWh	13.07	3.46E-03	4,012
			Gas	kBTU	9.35	4.96E-04	576
Retail	Retail	429,050	Electricity	kWh	13.39	3.54E-03	1,519
			Gas	kBTU	1.52	8.08E-05	35
School	School	100,000	Electricity	kWh	5.95	1.57E-03	157
			Gas	kBTU	9.43	5.00E-04	50
						Total Emissions	**6,399**
						Total Savings from Solar Panels[4]	**472**
						Final Emissions	**5,927**

Notes:
1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy usage rates are based on 2002 consumption data. ENVIRON used data for Southern California Edison (SCE), Zone 9, which is the sector in which the Mission Village would be located.
ENVIRON used the 2002 CEUS data to represent energy use for buildings that are minimally compliant with the 2001 Title 24 standards. Title 24 usage rates have been adjusted to reflect improvements in Title 24 building codes from 2002 to 2005 according to CEC's "Impact Analysis for 2005 Energy Efficiency Standards", as well as from 2005 to 2008 according to the "Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings".
Mission Village has committed to exceed the 2008 Title 24 building code by 15% for all building envelope uses. This includes heating, cooling, ventilation, and water heating and lighting.
2. GHG emission factors are calculated by multiplying the corresponding usage rates or usages by the conversion factors.
3. The total GHG emissions are calculated by multiplying the corresponding usage rates or usages by the conversion factors and the total square footage of the buildings.
4. For this calculation, it is assumed that a 2.0 kW photovoltaic unit from Sunpower company will be mounted on every 1,600 square feet of roof space (this would cover approximately 8% of the rooftop building space). Here, we assume that the rooftop space available is approximately half of the total square footage. The yearly electricity savings are estimated to be 3,356 kWh for a 2 kW solar system with a 30 degree roof slope and a south roof direction as provided for the City of Santa Clarita, CA in http://sunpower1.cleanpowerestimator.com/default.aspx. Number of systems = (commercial square footage) / (1,600 sqft per system) / 2 (sqft roof space per sqft building space).

Abbreviations:
CEC - California Energy Commission
CEUS - California Commerical End-Use Survey
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kBTU - kilo (1000) British thermal units
kWh - kilowatt hour
SCE - Southern California Edison
SF - square feet
tonne - metric tonne
yr - year

Sources:
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_I

Table 4-E-1
Unit Parameters for Calculating Mobile Source GHG Emissions
Mission Village
Newhall Ranch, California

Unit Category from DEIR[1]	Amount[1]		Daily Productions[2]				Number of Daily Trips[6]
			ADT Rate/Unit[3]	% Home-Based Productions[4]	Effective Resident Productions[5]	Units	
Single family housing	382	Dwelling Units	9.90	64%	**6.34**	trips/dwelling unit	**2,420**
Condo/townhouse general	2,315	Dwelling Units	8.00	71%	**5.68**	trips/dwelling unit	**13,149**
Apartments low rise	905	Dwelling Units	6.90	71%	**4.90**	trips/dwelling unit	**4,434**
Senior (Active)	459	Dwelling Units	3.71	68%	**2.52**	trips/dwelling unit	**1,158**
Continued Care Retirement Community	351	Dwelling Units	2.81	6%	**0.17**	trips/dwelling unit	**59**

Notes:
1. Land use types and amounts provided on December 2, 2009 by Austin Foust Associates. via email.
2. Productions for each unit type provided by Austin Foust Associates. The average daily trips (ADT) and home-based production percentages associated with a single dwelling unit for single family housing, apartment low rise, condo/townhouse general, and senior (activity) are from the Santa Clarita Valley Consolidated Traffic Model (SCVCTM) 2004 Validation Report table 2-3. For continued care retirement community, the ADT is from Institute of Traffic Engineers (ITE) and the home-based production percentage was estimated by Austin-Foust Associates.
3. Unadjusted daily trips associated with a single dwelling unit of the specified type.
4. Percentage of home-based trips that are attributed to the residents of that particular home. A trip made by a delivery truck or a friend visiting from out of town is not counted as a trip for that home.
5. Number of trips made by residents of the dwelling unit.
6. Amount of each dwelling unit type multiplied by the effective daily trip rate.

Abbreviations:
ADT - Average Daily Trip
DEIR - Draft Environmental Impact Report
GHG - Greenhouse Gas

Source:
Austin Foust Associates. 2006. Westside Santa Clarita Valley Roadway Phasing Analysis. November.
Austin Foust Associates. 2004. Santa Clarita Valley Consolidated Traffic Model (SCVCTM) 2004 Validation Report.

Table 4-E-2
Mobile Source Greenhouse Gas Emissions
Mission Village
Newhall Ranch, California

Development Scenario[1]	Vehicle Miles Traveled per Dwelling Unit per Day[2]	Daily Trips[3]	Annual VMT[4]	Emission Factor Running (g/mile)[5]	Emission Factor Starts (g/start)[6]	CO_2 Emissions Running (tonne)	CO_2 Emissions Starts (tonne)	Total CO_2 Emissions (tonne)	Total CO_2e Emissions (tonne)[7]	Pavley standard emissions reduction percentage[8]	Total Emissions
Mission Village	81	21,220	130,440,780	353	106	46,057	821	46,878	49,345	**20%**	**39,355**
CARB 2020 NAT	107	21,220	172,310,660	353	106	60,841	821	61,662	64,907	**0%**	**64,907**
								Reduction over CARB 2020 NAT			**39%**

Notes:
1. The Mission Village scenario is the project scenario. Section 5 of the Mission Village Climate Change Technical Report, and Appendix B, described the CARB 2020 NAT scenario.
2. Provided by Fehr and Peers. See Appendix B for more details.
3. From previous table.
4. Vehicle miles per dwelling unit per day x 365 days per year x number of dwelling units.
5. Emission factors for vehicles based on weighted average of EMFAC estimates for all LDA, LT1, LT2, MDV and MCY classes in 2020 for Los Angeles County, evaluated at 35 mph.
6. Starting emission factors based on the weighted average distribution of time between trip starts from URBEMIS defaults and EMFAC emission estimates for each time period (i.e., 5 min, 10 min, and so on).
7. $CO_2e = CO_2 / 0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from on-road vehicles, taking into account their global warming potentials.
8. Estimated 2020 emissions reduction resulting from California fuel efficiency regulation adopted by Air Resources Board in their final form on August 4, 2005 pursuant to AB1493 (Pavley) signed into law in 2002. The percentage reduction calculated by dividing 100.5 tons/day of reduction by 496.4 tons/day of baseline emissions, presented in Table 11 of ARB's 2008 report.

Abbreviations:
ARB - California Air Resources Board
CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
EMFAC - EMission FACtors model
GHG - Greenhouse Gas
HFC - Hydro fluorocarbon
LDA - Light Duty Automobile as defined in EMFAC
LDT1 - Light Duty Trucks Class I as defined in EMFAC
LDT2 - Light Duty Trucks Class II as defined in EMFAC
MDV - Medium Duty Trucks as defined in EMFAC
MCY - Motocycle
N_2O - Nitrous oxide
tonne - metric tonne
URBEMIS - URBan EMISsions model
VMT - Vehicle Miles Traveled

Source:
California Air Resources Board. 2008. Comparison of Greenhouse Gas Reductions for the United States and Canada under U.S. CAFÉ Standards and California Air Resources Board Greenhouse Gas Regulations. February. Available at: http://www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf

Table 4-F-1
GHG Emissions from Area Sources
Mission Village
Newhall Ranch, California

Location	Hearths	Landscaping
	(tonne CO2e)	
Mission Village	15	15

Notes:
1. Impact Sciences provided ENVIRON with URBEMIS 9.2.4 runs for Mission Village. URBEMIS calculates CO_2 emissions from area sources based on the size and type of buildings specified by the user and URBEMIS defaults.

Abbreviations:
CO_2e - carbon dioxide equivalent
GHG - Greenhouse Gas
tonne - metric tonne

Table 4-G-1
GHG Emissions for Municipal Sources
Mission Village
Newhall Ranch, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity[11]	Units	Total CO_2e Emission [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	148.7	kWh/capita/yr	0.039	tonne CO_2e/capita/year	10,802	residents (capita)	425
						Lighting Total:	**425**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	10,802	residents (capita)	540
						Municipal Vehicles Total:	**540**
Water and Wastewater							
Groundwater Supply and Conveyance (Potable)[4]	950	kWh/acre-foot	0.25	tonne CO_2e/acre-foot	1,676	acre-feet/yr	421
Average Southern California Supply And Conveyance[5]	3,170	kWh/acre-foot	0.84	tonne CO_2e/acre-foot	0	acre-feet/yr	0
Water Treatment (Potable)[6]	36	kWh/acre-foot	0.01	tonne CO_2e/acre-foot	1,676	acre-feet/yr	16
Water Distribution (Potable)[7]	414	kWh/acre-foot	0.11	tonne CO_2e/acre-foot	1,676	acre-feet/yr	184
Wastewater Treatment (Indirect Emissions)[8]	623	kWh/acre-foot	0.16	tonne CO_2e/acre-foot	1,553	acre-feet/yr	256
Wastewater Treament Plant (Direct Emissions)[9]	--	--	0.084	tonne CO_2e/capita/year	10,802	residents (capita)	911
Recycled Water Distribution (Non-Potable)[10]	978	kWh/acre-foot	0.26	tonne CO_2e/acre-foot	1,241	acre-feet/yr	321
						Water and Wastewater Total:	**2,108**
						Municipal Sources Total:	**3,073**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor with adjustment to reflect 20% of power provided by renewables (2010 RPS).

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN and the Southern California-specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emission for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. Emission factor for groundwater supply and conveyance is based on the estimated energy necessary to pump and convey 1 million gallons of groundwater in Southern California's Chino Basin and the Southern California-specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables. This factor is applied to potable water demand.

5. Emission factor accounts for the various ways water is supplied, the energy intensities of those methods and the amount each method is used. The CEC estimates that 50% of Southern California's water from the State Water Project is supplied by importing water from Northern California and the Colorado River. This factor is provided only for purposes of comparison and was not used in this inventory.

6. Emission factor for water treatment is based on a Navigant Consulting refinement of a CEC study on the energy necessary to initially treat 1 million gallons of water and the Southern California-specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables. This factor is applied to potable water demand.

7. Emission factor for water distribution is based on a Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables. This factor is applied to potable water demand.

8. Emission factor for wastewater treatment is based on a Navigant Consulting refinement of a CEC study on the energy necessary to treat 1 million gallons of wastewater for indoor (i.e., potable or other household) use and the Southern California-specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables.

9. Emission factor for the wastewater treatment plant accounts for direct methane and nitrous oxide emissions from wastewater. The value used here is based on the 2005 US inventory of GHG emissions for domestic wastewater treatment plants (USEPA) divided by the 2005 US population. (25 Tg CO_2e/year/296,410,404 people = 0.093 ton CO_2e/capita/year)

10. Emission factor for recycled water distribution is based on an estimate of the energy necessary to redistrubute 1 million gallons of reclaimed water (i.e., treated wastewater) and the Southern-California specific electricity generation emission factor from Southern California Edison with adjustment to reflect 20% of power provided by renewables. This factor is applied to non-potable water demand.

11. Source quantities for potable and non-potable water demand are provided by Newhall. The source quantity for wastewater treatment indirect emissions is scaled up from the recycled water quantity based on the ratio of the two quantities from Landmark Village (wastewater treatment quantities specific to Mission Village were unavailable).

Abbreviations:

CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kWh - kilowatt hour
RPS - Renewables Portfolio Standard
Tg - teragram
tonne - metric tonne
USEPA - United States Environmental Protection Agency

References:

California Climate Action Registry Database. Southern California Edison PUP. 2007. Available at: http://www.climateregistry.org/CarrotDocs/26/2007/SCEPUP07r3.xls. Accessed on July, 2, 2009.

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USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf

Table 4-H-1
Baseline Energy Use from Swimming Pools
Mission Village
Newhall Ranch, California

Facility Name[1]	Pool Volume[1]	Number of Heaters[1]	Heater Rating[1]	Operation Schedule[1]		Annual Natural Gas Usage[2]	Average Annual Natural Gas Usage[3]	Annual Electricity Usage[4]	Average Annual Electricity Usage[5]
	(gal)		(BTU/hr)	(hrs / day)	(days / yr)	(MMBTU / yr)	(MMBTU / gal / yr)	(kWh / yr)	(kWh / gal / yr)
Fremont Pool	215,000	4	350,000	12	243	4,088	0.023	106,872	0.496
DeFremery Pool	226,659	1	1,738,800	10	243	4,231		105,120	
Live Oak Pool	260,000	4	350,000	12	365	6,132		95,309	
Lyons Pool	240,000	4	350,000	12	365	6,132		110,376	
Temescal Pool	227,605	4	350,000	12	365	6,132		162,060	

Notes:

1. To estimate the baseline electricity and natural gas energy usage factors for Mission Village pools, ENVIRON calculated the energy consumption of filter pumps and water heaters of 5 pools in Oakland, California and scaled them to present energy consumption per year per volume of the pool. Oakland pools data including pool volume, number of heaters, heater rating, operation schedule, and annual electricity usage are provided in the City of Oakland Energy Efficient Commercial Pool Program Preliminary Facility Reports.

2. Annual Natural Gas Usage calculated by multiplying the following factors: (Number of hrs/day) x (Number of days/yr) x (Number of Heaters) x (Heater Rating). Each of these factors were taken from the City of Oakland Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool.

3. Average Annual Natural Gas Usage calculated from the Annual Natural Gas Usage of all 5 pools divided by the total Pool Volume of all 5 pools.

4. Annual Electricity Usage for each pool is shown as reported in the City of Oakland Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool.

5. Average Annual Electricity Usage calculated from the Annual Electricity Usage of all 5 pools divided by the total Pool Volume of all 5 pools.

Abbreviations:

BTU - British Thermal Units
gal - gallon
hr - hour
kWh - kilowatt-hour
MMBTU - Million British Thermal Units
yr - year

Source:

Energy Efficient Commercial Pool Program; Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool. City of Oakland / Oakland Unified School District. October 2006.

Table 4-H-2
Greenhouse Gas Emissions per Swimming Pool[1]
Mission Village
Newhall Ranch, California

Energy Use Factors (Oakland pools)[2]			Energy Use Factors (adjusted for Mission Village pools)[3,4]			Pool Volume[5]	Annual Energy Use		Emission Factors[6]		Total Emissions per Pool[7] Without Solar Heating	Total Emissions per Pool Assuming Solar Heating[8]
						(gal)			(lb CO_2 / source unit)	Source Units	(tonne CO_2 / yr)	(tonne CO_2 / yr)
Electricity	0.496	(kWh / gal / yr)	Electricity	0.496	(kWh / gal / yr)	736,263	365,049	(kWh / yr)	0.583	(kWh)	632	97
Natural Gas	0.023	(MMBTU / gal / yr)	Natural Gas	0.014	(MMBTU / gal / yr)		10,090	(MMBTU / yr)	117	(MMBTU)		

Notes:

1. ENVIRON assumed an outdoor competition-size swimming pool as the main source of GHGs in an aquatic/recreation center. Only CO_2 emissions are estimated and are assumed to be equivalent to total GHG emissions since the contributions from methane (CH_4) and nitrous oxide (N_2O) are negligible compared to total GHG for emissions associated with electricity generation and natural gas combustion. The emission factors in the California Climate Action Registry General Reporting Protocol show that CH_4 and N_2O emissions (in CO_2e) are less than 1% of CO_2 emissions for these processes.

2. The weighted energy consumption of 5 Oakland pools is used to calculate the baseline energy use of an average sized pool within the project site.

3. ENVIRON adjusted the natural gas usage to account for savings from high-efficiency heaters. ENVIRON conservatively assumed that the Oakland pools used 78% efficient heaters, which is the minimum efficiency legally required (see 10 CFR Part 431). According to the U.S. Department of Energy, newer pools are likely to use heaters with 89-95% efficiency. ENVIRON conservatively assumed 90% efficiency for Mission Village pool heaters, resulting in a 12% savings over the Oakland pools.

4. ENVIRON adjusted the natural gas usage to account for the difference in average ambient temperature in Newhall and Oakland. The natural gas usage was multiplied by the following adjustment factor: (typical pool temperature - Newhall average ambient temperature) / (typical pool temperature - San Francisco-Richmond average ambient temperature) = (80 deg F - 63.3 deg F) / (80 deg F - 55.5 deg F). Typical pool temperature based on information from the Department of Energy, available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13300. Average ambient temperatures for Newhall and San Francisco-Richmond were obtained from the Western Regional Climate Center: http://www.wrcc.dri.edu/.

5. ENVIRON assumed an outdoor competition-size (50 m x 25 yd x 8 ft) swimming pool.

6. Emission factor for electricity is provided by Southern California Edison, obtained from the California Climate Action Registry Database. The electricity generation emission factor was adjusted to reflect 20% of power provided by renewables (2010 RPS). Emission factor for natural gas is obtained from California Climate Action Registry Reporting Protocol, Table C7.

7. Emissions for a single competition-size pool, assuming no solar heating.

8. Emissions for a single competition-size pool, assuming solar heating replaces all natural gas heating. This value now includes electricity from pumping only.

Abbreviations:

RPS - Renewables Portfolio Standard
CFR - Code of Federal Regulations
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
CH_4 - methane
ft - foot
gal - gallon
GHG - Greenhouse Gas
kWh - kilowatt-hour
lb - pound
MMBTU - Million British Thermal Units
N_2O - nitrous oxide
tonne - metric tonne
yr - year

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Energy Efficient Commercial Pool Program; Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool. City of Oakland / Oakland Unified School District. October 2006.

Managing Swimming Pool Water Temperature for Energy Efficiency (September 2009). U.S. Department of Energy. Available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13300

Determining Gas Swimming Pool Heater Energy Efficiency (September 2009). U.S. Department of Energy. Available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13170

Energy Efficiency Program for Certain Commercial and Industrial Equipment: Efficiency Standards for Commercial Heating, Air-Conditioning, and Water-Heating Equipment. U.S. Department of Energy, 10 CFR Part 431. Available at: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/ashrae_final_rule_030707.pdf

Table 4-H-3

Greenhouse Gas Emissions from All Recreation Centers (Swimming Pools)[1]

Mission Village

Newhall Ranch, California

Number of Pools	Total Emissions Without Solar Heating[2]	Total Emissions Assuming Solar Heating[3]
	(Tonne CO_2 / year)	(Tonne CO_2 / year)
3	1,896	290

Notes:

1. ENVIRON assumed an outdoor competition-size (50 m x 25 yd x 8 ft) swimming pool as the main source of GHGs in an aquatic/recreation center.
2. Emissions for three recreation centers in Mission Village, assuming no solar heating.
3. Emissions for three recreation centers in Mission Village assuming solar heating replaces all natural gas heating. This value now includes electricity from pumping only.

Abbreviations:

CO_2 - carbon dioxide
ft - foot
GHG - Greenhouse Gas
m - meter
tonne - metric tonne
yd - yard

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Energy Efficient Commercial Pool Program; Preliminary Facility Reports. Available at: http://www.oaklandpw.com/AssetFactory.aspx?did=2612

Table 4-I-1
Summary of Greenhouse Gas Emissions for Mission Village
Mission Village
Newhall, California

Source	GHG Emissions			Improvement over CARB 2020 NAT
	Unit	Project	CARB 2020 NAT	(%)
Vegetation	tonne CO_2e / year	26,550	26,550	N/A
Construction		82,781	82,781	N/A
Total (one-time emissions)		**109,331**	**109,331**	**N/A**
Residential	tonne CO_2e / year	12,609	15,563	19%
Non-Residential		5,927	8,283	28%
Mobile		39,355	64,907	39%
Municipal		3,073	5,109	40%
Recreational (Pools)		290	1,925	85%
Area		31	31	0%
Total (annual emissions)		**61,284**	**95,818**	**36.0%**
Annualized Total	**tonne CO_2e / year**	**64,017**	**98,551**	**N/A**

Abbreviations:
CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken
CO_2e - carbon dioxide equivalent
GHG - Greenhouse Gas

Table 5-C-1
CARB 2020 NAT GHG Emissions from Residential Building Energy Use
Mission Village
Newhall Ranch, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title 24 Systems			Title 24 Systems and Major Appliances			Title 24 Systems and All MELs		
			CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant (CARB 2020 NAT)	**Multi-family**	3,140	2.1	6,491	**10,115**	2.7	8,491	**13,071**	3.2	10,119	**15,563**
	Single family	382	3.5	1,344		4.4	1,666		5.2	1,980	
	Town Home	890	2.6	2,280		3.3	2,914		3.9	3,465	
15% Better Than 2008 Title 24 and On-site Renewable Energy[3]	**Multi-family**	3,140	1.6	5,079	**7,852**	2.2	6,998	**10,682**	2.7	8,478	**12,609**
	Single family	382	2.6	1,002		3.4	1,308		3.3	1,254	
	Town Home	890	2.0	1,771		2.7	2,376		3.2	2,877	
Percentage Improvement over 2005 Title 24 (CARB 2020 NAT)	**Multi-family**	3,140	22%	22%	**22%**	18%	18%	**18%**	16%	16%	**19%**
	Single family	382	25%	25%		22%	22%		37%	37%	
	Town Home	890	22%	22%		18%	18%		17%	17%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Newhall.
3. Emission reduction due to on-site renewable energy generation is deducted from "Title 24 Systems and All MELs" column only.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2 - carbon dioxide
DU - Dwelling Unit
GHG - Greenhouse Gas
MEL - Miscellaneous electric loads
tonne - metric tonne

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 5-D-1
CARB 2020 NAT Non-Residential Energy Use
Mission Village
Newhall Ranch, California

Building Type	CEUS Building Type	Energy Type	Units	Title 24 Energy Use Base1,3	Title 24 Energy Use 20052,3	Non-Title 24 Energy Use[1,4]	Total CARB 2020 NAT Energy Use[5]
				[Unit/SF/yr]			
Fire Station	Miscellaneous	Electricity	kWh	7.26	6.81	5.76	12.57
		Gas	kBTU	15.77	15.36	4.45	19.81
Office and Library	All Office	Electricity	kWh	11.29	10.62	4.63	15.25
		Gas	kBTU	12.38	12.06	0.39	12.45
Retail	Retail	Electricity	kWh	13.52	12.74	3.23	15.97
		Gas	kBTU	1.36	1.33	0.49	1.83
School	School	Electricity	kWh	5.84	5.50	1.60	7.09
		Gas	kBTU	10.90	10.72	1.08	11.80

Notes:
1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy use rates are based on 2002 consumption data. ENVIRON used data for Southern California Edison (SCE), Zone 9, which is the sector in which the Mission Village would be located.
2. ENVIRON multiplied the Title 24 Energy Use Base for each Title 24 end use category by the reduction factors for 2001 to 2005 and summed all applicable end use categories.
3. Includes Title 24-regulated building envelope uses of electricity (heating, cooling, ventilation, water heating) and gas (heating, water heating) and all lighting.
4. Includes all other uses of electricity (cooking, refrigeration office equipment, miscellaneous, process, motors, air compressors) and gas (cooling, cooking, miscellaneous, process) not included in the Title 24-regulated building envelope or lighting.
5. Total CARB 2020 NAT Energy Use sums the previous two columns (Title 24 Energy Use 2005 and Non-Title 24 Energy Use).

Abbreviations:
CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken.
CEC - California Energy Commission
CEUS - California Commercial End-Use Survey
kBTU - kilo (1,000) British thermal units
kWh - kilowatt hour
SCE - Southern California Edison
SF - square feet
yr - year

Sources:
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Table 5-D-2
CARB 2020 NAT GHG Emissions from Non-Residential Buildings
Mission Village
Newhall Ranch, California

Building Type	CEUS Building Type	Size	Energy Type	Unit	CARB 2020 NAT Energy Use[1]	CO_2e Emissions[2]	Total CARB 2020 NAT CO_2e Emissions[3]
		[SF]			[Unit/SF/yr]	[tonne CO_2e/SF/yr]	[tonne CO_2e/yr]
Fire Station	Miscellaneous	13,000	Electricity	kWh	12.57	3.66E-03	48
			Gas	kBTU	19.81	1.05E-03	14
Office and Library	All Office	1,161,050	Electricity	kWh	15.25	4.44E-03	5,151
			Gas	kBTU	12.45	6.61E-04	767
Retail	Retail	429,050	Electricity	kWh	15.97	4.65E-03	1,993
			Gas	kBTU	1.83	9.69E-05	42
School	School	100,000	Electricity	kWh	7.09	2.06E-03	206
			Gas	kBTU	11.80	6.26E-04	63
						Total	**8,283**

Notes:

1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy use rates are based on 2002 consumption data. ENVIRON used data for Southern California Edison (SCE), Zone 9, which is the sector in which the Mission Village would be located.

The CARB 2020 NAT scenario uses 2005 Title 24 building standards as this is what ARB used in their Scoping Plan. ENVIRON used the 2002 CEUS data to represent energy use for buildings that are minimally compliant with the 2001 Title 24 standards. Title 24 usage rates have been adjusted to reflect improvements in Title 24 building codes from 2002 to 2005 according to CEC's "Impact Analysis for 2005 Energy Efficiency Standards" .

2. GHG emission factors are calculated by multiplying the corresponding usage rates or usages by the conversion factors.

3. The total GHG emissions are calculated by multiplying the corresponding usage rates or usages by the conversion factors and the total square footage of the buildings.

Abbreviations:

CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken.
CEC - California Energy Commission
CEUS - California Commerical End-Use Survey
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kBTU - kilo (1000) British thermal units
kWh- kilowatt hour
SCE - Southern California Edison
SF - square feet
tonne - metric tonne
yr - year

Sources:

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Table 5-E-1
CARB 2020 NAT Mobile Source Housing Density Adjustment
Mission Village
Newhall Ranch, California

Trip Rates			Mission Village			CARB 2020 NAT[1]		
Land UseType	Unit Type	ADT Rate/Unit[2]	Units[2]	Trips[2]	% of dwelling units of particular type	Units[3]	Trips[3]	% of dwelling units of particular type
SF Residential	DU	9.9	382	3,782	9%	79,117	775,575	52%
MF Residential	DU	7.9	3,252	25,673	74%	46,276	356,606	30%
Senior/Retirement	DU	3.3	778	2,570	18%	26,845	88,696	18%
Total			4,412	32,025	100%	152,238	1,220,876	100%
Trip per DU				7.3			8.0	
Trip Reductions			**9.5%**					

Notes:
1. ENVIRON first made the CARB 2020 NAT scenario have the same number of multifamily and single family units as Santa Clarita Valley full build-out. Mission Village is part of the Santa Clarita Valley; therefore Santa Clarita full buildout represents how that area would be developed absent the Newhall development. ENVIRON then assumed that the CARB 2020 NAT scenario would have the same senior housing percentage as Mission Village: 18%.
2. Number of DU and trip rate for each land use type for Missioin Village presented in previous tables.

3. Number of DU and total trips for single and multifamily houses for Santa Clarita Valley obtained from the Austin Faust traffic study (2006) at full build-out, subtracting the contributions from Newhall Ranch development. Number of DU and total trips for single and multifamily houses for Newhall Ranch and Entrada from Climate Change Technical Report prepared by ENVIRON (2009).
ENVIRON estimated the number of the senior and retirement houses for Santa Clarita Valley based on the percentage of senior houses in Mission Village. This approach is conservative because the number of DU for multifamily house provided by Austin Faust has already included the senior houses although of which the actual number is not provided. As presented in this table, the average daily trip rate of a senior and retiremnet house is much lower that those of single and multifamily houses. This assumption further lowers the GHG emissions for the CARB 2020 NAT scenario and therefore requires even lower emissions from the project to meet the emission redution target.

Abreviations:
ADT - Average Daily Trip
CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken.
DU - Dwelling Unit
MF - MultiFamily
SF - Single Family

Source:
Newhall Ranch RMDP and SCP EIR/EIS, Traffic Analysis, November 2006, Austin Foust Associates.
Climate Change Technical Report, Resource Management and Development Plan, Spineflower Conservation Plan, January 2009, ENVIRON.

Table 5-E-2
CARB 2020 NAT Mobile Source Greenhouse Gas Emissions
Mission Village
Newhall Ranch, California

Trips	Daily Trips[1]	Annual VMT[2]	Emission Factor Running (g/mile)[3]	Emission Factor Starts (g/start)[4]	CO_2 Emissions Running (tonne)	CO_2 Emissions Starts (tonne)	Total CO_2 Emissions (tonne)	Total CO_2e Emissions (tonne)[3]	Pavley Reduction (-)[5]	Final CO_2e Emissions (tonne)
Mission Trips	21,784	60,752,582	353	106	21,451	843	22,294	23,467	20%	18,716
CARB 2020 NAT Trips	24,068	67,120,916	353	106	23,700	931	24,631	25,927	-	25,927
							Reduction over CARB 2020 NAT			**28%**

Notes:
1. Daily trips calculated by dividing Mission trips presented in table 4-E-2 by (1- reduction% presented in table 5-E-1).
2. Annual VMT calculated by dividing Mission VMT presented in table 4-E-2 by (1-reduction% presented in table 5-E-1).
3. Emission factors for vehicles based on weighted average of EMFAC estimates for all LDA, LT1, LT2, MDV and MCY classes in 2020 for Los Angeles County, evaluated at 35 mph.
4. Starting emission factors based on the weighted average distribution of time between trip starts from URBEMIS defaults and EMFAC emission estimates for each time period (i.e., 5 min, 10 min, and so on).
5. Estimated 2020 emissions reduction resulting from California fuel efficiency regulation adopted by Air Resources Board in their final form on August 4, 2005 pursuant to AB1493 (Pavley) signed into law in 2002. The percentage reduction calculated by dividing 100.5 tons/day of reduction by 496.4 tons/day of baseline emissions presented in ARB (2008).

Abbreviations:
ADT - Average Daily Trip
ARB - California Air Resources Board
CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken.
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
EMFAC - EMission FACtors model
GHG - Greenhouse Gas
HFC - Hydro fluorocarbon
LDA - Light Duty Automobile as defined in EMFAC
LDT1 - Light Duty Trucks Class I as defined in EMFAC
LDT2 - Light Duty Trucks Class II as defined in EMFAC
MDV - Medium Duty Trucks as defined in EMFAC
MCY - Motocycle
N_2O - Nitrous oxide
URBEMIS - URBan EMISsions model
VMT - Vehicle Miles Traveled

Source:
Comparison of Greenhouse Gas Reductions for the United States and Canada under U.S. CAFÉ Standards and California Air Resources Board Greenhouse Gas Regulations, February 2008. California Air Resources Board.

Table 5-G-1
CARB 2020 NAT GHG Emissions from Municipal Sources
Mission Village
Newhall Ranch, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity[11]	Units	Total CO_2e Emission [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	148.7	kWh/capita/yr	0.043	tonne CO_2e/capita/year	10,802	residents (capita)	467
						Lighting Total:	**467**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	10,802	residents (capita)	540
							540
Water and Wastewater							
Groundwater Supply and Conveyance (Potable)[4]	950	kWh/acre-foot	0.28	tonne CO_2e/acre-foot	0	acre-feet/yr	0
Average Southern California Supply And Conveyance[5]	3,170	kWh/acre-foot	0.92	tonne CO_2e/acre-foot	2,917	acre-feet/yr	2,689
Water Treatment (Potable)[6]	36	kWh/acre-foot	0.01	tonne CO_2e/acre-foot	1,676	acre-feet/yr	18
Water Distribution (Potable)[7]	414	kWh/acre-foot	0.12	tonne CO_2e/acre-foot	1,676	acre-feet/yr	202
Wastewater Treatment (Indirect Emissions)[8]	623	kWh/acre-foot	0.18	tonne CO_2e/acre-foot	1,553	acre-feet/yr	281
Wastewater Treatment Plant (Direct Emissions)[9]	--	--	0.084	tonne CO_2e/capita/year	10,802	residents (capita)	911
Recycled Water Distribution (Non-Potable)[10]	978	kWh/acre-foot	0.28	tonne CO_2e/acre-foot	0	acre-feet/yr	0
						Water and Wastewater Total:	**4,101**
						Municipal Sources Total:	**5,109**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN and the Southern California-specific electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emission for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. Emission factor for groundwater supply and conveyance is based on the estimated energy necessary to pump and convey 1 million gallons of groundwater in Southern California's Chino Basin and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is not applicable to the CARB 2020 NAT scenario but was used in the Mission Village inventory and is provided here for comparison.

5. Emission factor accounts for the various ways water is supplied, the energy intensities of those methods and the amount each method is used. The CEC estimates that 50% of Southern California's water from the State Water Project is supplied by importing water from Northern California and the Colorado River. For the CARB 2020 NAT scenario, ENVIRON assumed that all water is sourced from the State Water Project. This facto applied to total water demand.

6. Emission factor for water treatment is based on a Navigant Consulting refinement of a CEC study on the energy necessary to initially treat 1 million gallons of water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

7. Emission factor for water distribution is based on a Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for wastewater treatment is based on a Navigant Consulting refinement of a CEC study on the energy necessary to treat 1 million gallons of wastewater for indoor (i.e., potable or other household) use and the Southern California-specific electricity generation emission factor from Southern California Edison.

9. Emission factor for the wastewater treatment plant accounts for direct methane and nitrous oxide emissions from wastewater. The value used here is based on the 2005 US inventory of GHG emissions for domestic wastewater treatment plants (USEPA) divided by the 2005 US population. (25 Tg CO_2e/year/296,410,404 people = 0.093 ton CO_2e/capita/year)

10. Emission factor for recycled water distribution is based on an estimate of the energy necessary to redistribute 1 million gallons of reclaimed water (i.e., treated wastewater) and the Southern-California specific electricity generation emission factor from Southern California Edison. For the CARB 2020 NAT scenario, ENVIRON assumed that no water is recycled.

11. Source quantities for potable and non-potable water demand are provided by Newhall. The source quantity for wastewater treatment indirect emissions is scaled up from the non-potable water demand based on the ratio of the two quantities from Landmark Village (wastewater treatment quantities specific to Mission Village were unavailable).

Abbreviations:

CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken
CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - Greenhouse Gas
kWh - kilowatt hour
Tg - teragram
tonne - metric tonne
USEPA - United States Environmental Protection Agency

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City of Santa Rosa. Cities for Climate Protection: Santa Rosa. Available at: http://www.slocleanair.org/programs/pdf/Santa%20Rosa%20CA.pdf

M/J Industrial Solutions. 2003. Municipal Wastewater Treatment Plant Energy Baseline Study. June. www.cee1.org/ind/mot-sys/ww/pge1.pdf

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USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. Available at: http://www.epa.gov/climatechange/emissions/usgginv_archive.html

Table 5-H-1
CARB 2020 NAT Greenhouse Gas Emissions per Recreation Center[1]
Mission Village
Newhall Ranch, California

Energy Use Factors (Oakland pools)[2]			Energy Use Factors (adjusted for Mission Village pools)[3,4]			Pool Volume[5]	Annual Energy Use		Emission Factors[6]		Total Emissions per Pool[7]
						(gal)			(lb CO_2 / source unit)	Source Units	(tonne CO_2 / yr)
Electricity	0.496	(kWh / gal / yr)	Electricity	0.496	(kWh / gal / yr)	736,263	365,049	(kWh / yr)	0.641	(kWh)	642
Natural Gas	0.023	(MMBTU / gal / yr)	Natural Gas	0.014	(MMBTU / gal / yr)		10,090	(MMBTU / yr)	117	(MMBTU)	

Notes:

1. ENVIRON assumed an outdoor competition-size swimming pool as the main source of GHGs in an aquatic/recreation center. Only CO_2 emissions are estimated and are assumed to be equivalent to total GHG emissions since the contributions from methane (CH_4) and nitrous oxide (N_2O) are negligible compared to total GHG for emissions associated with electricity generation and natural gas combustion. The emission factors in the California Climate Action Registry General Reporting Protocol show that CH_4 and N_2O emissions (in CO_2e) are less than 1% of CO_2 emissions for these processes.

2. The weighted energy consumption of 5 Oakland pools is used to calculate the baseline energy use of an average sized pool within the project site.

3. ENVIRON adjusted the natural gas usage to account for savings from high-efficiency heaters. ENVIRON conservatively assumed that the Oakland pools used 78% efficient heaters, which is the minimum efficiency legally required (see 10 CFR Part 431). According to the U.S. Department of Energy, newer pools are likely to use heaters with 89-95% efficiency. ENVIRON conservatively assumed 90% efficiency for Mission Village pool heaters, resulting in a 12% savings over the Oakland pools.

4. ENVIRON adjusted the natural gas usage to account for the difference in average ambient temperature in Newhall and Oakland. The natural gas usage was multiplied by the following adjustment factor: (typical pool temperature - Newhall average ambient temperature) / (typical pool temperature - San Francisco-Richmond average ambient temperature) = (80 deg F - 63.3 deg F) / (80 deg F - 55.5 deg F). Typical pool temperature based on information from the Department of Energy, available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13300. Average ambient temperatures for Newhall and San Francisco-Richmond were obtained from the Western Regional Climate Center: http://www.wrcc.dri.edu/.

5. ENVIRON assumed an outdoor competition-size (50 m x 25 yd x 8 ft) swimming pool.

6. Emission factor for electricity is provided by Southern California Edison, obtained from the California Climate Action Registry Database. Emission factor for natural gas is obtained from California Climate Action Registry Reporting Protocol, Table C7.

7. Emissions for a single competition-size pool, assuming no solar heating.

Abbreviations:

CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken
CFR - Code of Federal Regulations
CO_2 - carbon dioxide
CH_4 - methane
ft - foot
gal - gallon
kWh - kilowatt-hour
lb - pound
MMBTU - Million British Thermal Units
N_2O - nitrous oxide
tonne - metric tonne
yr - year

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Energy Efficient Commercial Pool Program; Preliminary Facility Reports for DeFremery Pool, Fremont Pool, Live Oak Pool, Lyons Pool, and Temescal Pool. City of Oakland / Oakland Unified School District. October 2006.

Managing Swimming Pool Water Temperature for Energy Efficiency (September 2009). U.S. Department of Energy. Available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13300

Determining Gas Swimming Pool Heater Energy Efficiency (September 2009). U.S. Department of Energy. Available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13170

Energy Efficiency Program for Certain Commercial and Industrial Equipment: Efficiency Standards for Commercial Heating, Air-Conditioning, and Water-Heating Equipment. U.S. Department of Energy, 10 CFR Part 431. Available at: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/ashrae_final_rule_030707.pdf

Table 5-H-2
CARB 2020 NAT Greenhouse Gas Emissions from All Recreation Centers[1]
Mission Village
Newhall Ranch, California

Number of Pools	Total Emissions[2] (Tonne CO_2 / year)
3	1,925

Notes:

1. ENVIRON assumed an outdoor competition-size (50 m x 25 yd x 8 ft) swimming pool as the main source of GHGs in an aquatic/recreation center.

2. Emissions for three recreation centers in Mission Village, assuming no solar heating.

Abbreviations:

CARB 2020 NAT - California Air Resources Board Scoping Plan projections for 2020 if no actions are taken
CO_2 - carbon dioxide
ft - foot
GHG - Greenhouse Gas
m - meter
tonne - metric tonne
yd - yard

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Energy Efficient Commercial Pool Program; Preliminary Facility Reports. Available at: http://www.oaklandpw.com/AssetFactory.aspx?did=2612

APPENDIX A
Building Construction URBEMIS Runs Received from Impact Sciences

Appendix A
Building Construction URBEMIS Reports

Urbemis 2007 Version 9.2.4

Combined Annual Emissions Reports (Tons/Year)

File Name: Z:\Alan Sako\032.223 Mission Village\Emissions\02 Building, Coating, Paving\Mission Village Building Construction.urb924
Project Name: Mission Village - Building Construction
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2013 TOTALS (tons/year unmitigated)	0.87	4.62	19.00	0.03	0.14	0.23	0.37	0.05	0.21	0.26	3,223.35
2014 TOTALS (tons/year unmitigated)	11.22	17.95	71.24	0.13	0.55	0.99	1.54	0.20	0.89	1.09	12,947.83
2015 TOTALS (tons/year unmitigated)	11.01	16.53	66.72	0.13	0.55	0.96	1.51	0.20	0.86	1.05	13,003.75
2016 TOTALS (tons/year unmitigated)	10.75	14.90	62.43	0.13	0.55	0.88	1.43	0.20	0.79	0.98	13,002.72
2017 TOTALS (tons/year unmitigated)	10.47	13.43	58.14	0.13	0.55	0.81	1.36	0.20	0.72	0.92	12,952.24
2018 TOTALS (tons/year unmitigated)	5.13	6.10	27.19	0.06	0.28	0.38	0.65	0.10	0.34	0.44	6,475.91

Construction Unmitigated Detail Report:
CONSTRUCTION EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2013	0.87	4.62	19.00	0.03	0.14	0.23	0.37	0.05	0.21	0.26	3,223.35
Building 10/01/2013-06/30/2018	0.87	4.62	19.00	0.03	0.14	0.23	0.37	0.05	0.21	0.26	3,223.35
Building Off Road Diesel	0.11	0.63	0.44	0.00	0.00	0.04	0.04	0.00	0.04	0.04	74.56
Building Vendor Trips	0.29	3.10	2.68	0.01	0.03	0.13	0.15	0.01	0.12	0.12	808.73
Building Worker Trips	0.47	0.89	15.88	0.02	0.11	0.06	0.17	0.04	0.05	0.09	2,340.06
2014	11.22	17.95	71.24	0.13	0.55	0.99	1.54	0.20	0.89	1.09	12,947.83
Building 10/01/2013-06/30/2018	3.12	16.31	69.94	0.13	0.55	0.86	1.40	0.20	0.76	0.96	12,746.05
Building Off Road Diesel	0.38	2.30	1.70	0.00	0.00	0.14	0.14	0.00	0.13	0.13	294.84
Building Vendor Trips	1.04	10.77	9.75	0.03	0.11	0.44	0.55	0.04	0.40	0.44	3,198.24
Building Worker Trips	1.69	3.24	58.48	0.10	0.44	0.28	0.71	0.16	0.23	0.39	9,252.98
Coating 01/01/2014-06/30/2018	7.81	0.01	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.62
Architectural Coating	7.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coating Worker Trips	0.01	0.01	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.62

Asphalt 04/01/2014-06/30/2018	0.29	1.63	1.12	0.00	0.00	0.14	0.14	0.00	0.13	0.13	174.17
Paving Off-Gas	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.25	1.54	0.99	0.00	0.00	0.13	0.13	0.00	0.12	0.12	139.75
Paving On Road Diesel	0.01	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.11
Paving Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.31
2015	11.01	16.53	66.72	0.13	0.55	0.96	1.51	0.20	0.86	1.05	13,003.75
Asphalt 04/01/2014-06/30/2018	0.37	2.02	1.46	0.00	0.00	0.17	0.17	0.00	0.15	0.15	230.75
Paving Off-Gas	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.31	1.91	1.30	0.00	0.00	0.16	0.16	0.00	0.15	0.15	185.16
Paving On Road Diesel	0.01	0.10	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.32
Paving Worker Trips	0.00	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
Building 10/01/2013-06/30/2018	2.84	14.50	65.10	0.13	0.55	0.79	1.34	0.20	0.70	0.90	12,745.39
Building Off Road Diesel	0.35	2.11	1.67	0.00	0.00	0.13	0.13	0.00	0.12	0.12	294.84
Building Vendor Trips	0.94	9.42	8.98	0.03	0.11	0.38	0.49	0.04	0.35	0.39	3,198.36
Building Worker Trips	1.55	2.97	54.45	0.10	0.44	0.28	0.71	0.16	0.23	0.39	9,252.19
Coating 01/01/2014-06/30/2018	7.81	0.01	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.62
Architectural Coating	7.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coating Worker Trips	0.00	0.01	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.62
2016	10.75	14.90	62.43	0.13	0.55	0.88	1.43	0.20	0.79	0.98	13,002.72
Asphalt 04/01/2014-06/30/2018	0.34	1.88	1.44	0.00	0.00	0.15	0.15	0.00	0.14	0.14	230.75
Paving Off-Gas	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.29	1.79	1.29	0.00	0.00	0.15	0.15	0.00	0.14	0.14	185.16
Paving On Road Diesel	0.01	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.32
Paving Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
Building 10/01/2013-06/30/2018	2.60	13.00	60.84	0.13	0.55	0.73	1.28	0.20	0.64	0.84	12,744.36
Building Off Road Diesel	0.32	1.94	1.65	0.00	0.00	0.11	0.11	0.00	0.11	0.11	294.84
Building Vendor Trips	0.86	8.32	8.33	0.03	0.11	0.34	0.45	0.04	0.31	0.34	3,198.44
Building Worker Trips	1.42	2.74	50.87	0.10	0.44	0.28	0.71	0.16	0.23	0.39	9,251.09
Coating 01/01/2014-06/30/2018	7.81	0.01	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.61
Architectural Coating	7.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coating Worker Trips	0.00	0.01	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.61
2017	10.47	13.43	58.14	0.13	0.55	0.81	1.36	0.20	0.72	0.92	12,952.24
Asphalt 04/01/2014-06/30/2018	0.32	1.76	1.41	0.00	0.00	0.14	0.14	0.00	0.13	0.13	229.86
Paving Off-Gas	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.27	1.67	1.28	0.00	0.00	0.14	0.14	0.00	0.13	0.13	184.45
Paving On Road Diesel	0.01	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.22
Paving Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.20
Building 10/01/2013-06/30/2018	2.37	11.67	56.58	0.13	0.55	0.67	1.22	0.20	0.59	0.79	12,694.88

Building Off Road Diesel	0.29	1.77	1.62	0.00	0.00	0.10	0.10	0.00	0.09	0.09	293.71
Building Vendor Trips	0.78	7.38	7.72	0.03	0.11	0.30	0.41	0.04	0.27	0.31	3,186.29
Building Worker Trips	1.30	2.52	47.24	0.10	0.44	0.27	0.71	0.16	0.23	0.39	9,214.88
Coating 01/01/2014-06/30/2018	7.78	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.50
Architectural Coating	7.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coating Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.50
2018	5.13	6.10	27.19	0.06	0.28	0.38	0.65	0.10	0.34	0.44	6,475.91
Asphalt 04/01/2014-06/30/2018	0.15	0.82	0.70	0.00	0.00	0.06	0.07	0.00	0.06	0.06	114.93
Paving Off-Gas	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.13	0.78	0.64	0.00	0.00	0.06	0.06	0.00	0.06	0.06	92.22
Paving On Road Diesel	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.61
Paving Worker Trips	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.10
Building 10/01/2013-06/30/2018	1.09	5.28	26.43	0.06	0.27	0.32	0.59	0.10	0.28	0.38	6,347.23
Building Off Road Diesel	0.13	0.81	0.80	0.00	0.00	0.04	0.04	0.00	0.04	0.04	146.85
Building Vendor Trips	0.36	3.31	3.61	0.02	0.06	0.13	0.19	0.02	0.12	0.14	1,593.20
Building Worker Trips	0.60	1.16	22.02	0.05	0.22	0.14	0.36	0.08	0.12	0.19	4,607.17
Coating 01/01/2014-06/30/2018	3.89	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.75
Architectural Coating	3.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coating Worker Trips	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.75

Phase Assumptions

Phase: Paving 4/1/2014 - 6/30/2018 - Type Your Description Here
Acres to be Paved: 141.41
Off-Road Equipment:
1 Pavers (100 hp) operating at a 0.62 load factor for 8 hours per day
2 Paving Equipment (104 hp) operating at a 0.53 load factor for 8 hours per day
2 Rollers (95 hp) operating at a 0.56 load factor for 6 hours per day

Phase: Building Construction 10/1/2013 - 6/30/2018 - Default Building Construction Description
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 7 hours per day
3 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day
1 Generator Sets (49 hp) operating at a 0.74 load factor for 8 hours per day
3 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day
1 Welders (45 hp) operating at a 0.45 load factor for 8 hours per day

Phase: Architectural Coating 1/1/2014 - 6/30/2018 - Default Architectural Coating Description
Rule: Residential Interior Coatings begins 1/1/2005 ends 6/30/2008 specifies a VOC of 100

Appendix A
Building Construction URBEMIS Reports

Rule: Residential Interior Coatings begins 7/1/2008 ends 12/31/2040 specifies a VOC of 50
Rule: Residential Exterior Coatings begins 1/1/2005 ends 6/30/2008 specifies a VOC of 250
Rule: Residential Exterior Coatings begins 7/1/2008 ends 12/31/2040 specifies a VOC of 100
Rule: Nonresidential Interior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250
Rule: Nonresidential Exterior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250

Appendix A
Building Construction URBEMIS Reports

Urbemis 2007 Version 9.2.4

Combined Annual Emissions Reports (Tons/Year)

File Name: Z:\Alan Sako\032.223 Mission Village\Emissions\01 Grading, Trenching, Street Paving\Mission Village Grading Trenching
Project Name: Mission Village - Construction - Grading, Trenching, and Paving
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2011 TOTALS (tons/year unmitigated)	2.80	24.41	11.55	0.00	406.02	1.07	407.09	84.79	0.98	85.78	2,557.50
2011 TOTALS (tons/year mitigated)	2.80	24.41	11.55	0.00	57.40	1.07	58.47	11.99	0.98	12.97	2,557.50
Percent Reduction	0.00	0.00	0.00	0.00	85.86	0.00	85.64	85.86	0.00	84.88	0.00
2012 TOTALS (tons/year unmitigated)	5.65	48.43	23.20	0.00	774.09	2.09	776.19	161.66	1.92	163.59	5,450.33
2012 TOTALS (tons/year mitigated)	5.65	48.43	23.20	0.00	109.44	2.09	111.53	22.86	1.92	24.78	5,450.33
Percent Reduction	0.00	0.00	0.00	0.00	85.86	0.00	85.63	85.86	0.00	84.85	0.00
2013 TOTALS (tons/year unmitigated)	5.53	46.42	22.63	0.00	739.51	1.99	741.49	154.44	1.83	156.27	5,600.60
2013 TOTALS (tons/year mitigated)	5.53	46.42	22.63	0.00	104.55	1.99	106.54	21.84	1.83	23.66	5,600.60
Percent Reduction	0.00	0.00	0.00	0.00	85.86	0.00	85.63	85.86	0.00	84.86	0.00
2014 TOTALS (tons/year unmitigated)	5.18	39.98	20.35	0.00	661.34	1.72	663.07	138.12	1.58	139.70	5,215.83
2014 TOTALS (tons/year mitigated)	5.18	39.98	20.35	0.00	93.51	1.72	95.23	19.53	1.58	21.11	5,215.83
Percent Reduction	0.00	0.00	0.00	0.00	85.86	0.00	85.64	85.86	0.00	84.89	0.00

Construction Unmitigated Detail Report:
CONSTRUCTION EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2011	2.80	24.41	11.55	0.00	406.02	1.07	407.09	84.79	0.98	85.78	2,557.50
Mass Grading 07/01/2011-06/30/2012	0.31	2.55	1.31	0.00	34.85	0.12	34.98	7.28	0.11	7.39	292.35
Mass Grading Dust	0.00	0.00	0.00	0.00	34.85	0.00	34.85	7.28	0.00	7.28	0.00
Mass Grading Off Road Diesel	0.31	2.55	1.21	0.00	0.00	0.12	0.12	0.00	0.11	0.11	280.13
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.22
Mass Grading 07/01/2011-11/20/2014	2.49	21.85	10.24	0.00	371.17	0.94	372.11	77.52	0.87	78.38	2,265.15
Mass Grading Dust	0.00	0.00	0.00	0.00	371.17	0.00	371.17	77.51	0.00	77.51	0.00
Mass Grading Off Road Diesel	2.48	21.83	9.81	0.00	0.00	0.94	0.94	0.00	0.87	0.87	2,210.16
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Mass Grading Worker Trips	0.01	0.02	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.99
2012	5.65	48.43	23.20	0.00	774.09	2.09	776.19	161.66	1.92	163.59	5,450.33
Mass Grading 07/01/2011-06/30/2012	0.30	2.35	1.27	0.00	34.59	0.11	34.70	7.22	0.10	7.33	290.11
Mass Grading Dust	0.00	0.00	0.00	0.00	34.59	0.00	34.59	7.22	0.00	7.22	0.00
Mass Grading Off Road Diesel	0.29	2.35	1.18	0.00	0.00	0.11	0.11	0.00	0.10	0.10	277.99
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.12
Mass Grading 07/01/2011-11/20/2014	4.73	40.67	19.35	0.00	739.51	1.73	741.24	154.44	1.59	156.03	4,512.99
Mass Grading Dust	0.00	0.00	0.00	0.00	739.50	0.00	739.50	154.44	0.00	154.44	0.00
Mass Grading Off Road Diesel	4.71	40.63	18.56	0.00	0.00	1.73	1.73	0.00	1.59	1.59	4,403.46
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.05	0.80	0.00	0.01	0.00	0.01	0.00	0.00	0.00	109.53
Trenching 03/01/2012-10/09/2014	0.31	2.71	1.29	0.00	0.00	0.12	0.12	0.00	0.11	0.11	324.36
Trenching Off Road Diesel	0.31	2.70	1.17	0.00	0.00	0.12	0.12	0.00	0.11	0.11	307.41
Trenching Worker Trips	0.00	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.94
Trenching 07/01/2012-10/19/2013	0.19	1.63	0.78	0.00	0.00	0.07	0.07	0.00	0.07	0.07	194.91
Trenching Off Road Diesel	0.19	1.62	0.70	0.00	0.00	0.07	0.07	0.00	0.07	0.07	184.73
Trenching Worker Trips	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.18
Trenching 09/01/2012-02/06/2014	0.12	1.07	0.51	0.00	0.00	0.05	0.05	0.00	0.04	0.05	127.96
Trenching Off Road Diesel	0.12	1.06	0.46	0.00	0.00	0.05	0.05	0.00	0.04	0.04	121.27
Trenching Worker Trips	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.68
2013	5.53	46.42	22.63	0.00	739.51	1.99	741.49	154.44	1.83	156.27	5,600.60
Mass Grading 07/01/2011-11/20/2014	4.55	38.03	18.42	0.00	739.51	1.61	741.12	154.44	1.48	155.92	4,512.98
Mass Grading Dust	0.00	0.00	0.00	0.00	739.50	0.00	739.50	154.44	0.00	154.44	0.00
Mass Grading Off Road Diesel	4.52	37.99	17.68	0.00	0.00	1.61	1.61	0.00	1.48	1.48	4,403.46
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.04	0.74	0.00	0.01	0.00	0.01	0.00	0.00	0.00	109.52
Trenching 03/01/2012-10/09/2014	0.35	3.00	1.50	0.00	0.00	0.13	0.13	0.00	0.12	0.12	388.33
Trenching Off Road Diesel	0.35	2.99	1.37	0.00	0.00	0.13	0.13	0.00	0.12	0.12	368.05
Trenching Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
Trenching 07/01/2012-10/19/2013	0.28	2.40	1.20	0.00	0.00	0.11	0.11	0.00	0.10	0.10	310.96
Trenching Off Road Diesel	0.28	2.39	1.09	0.00	0.00	0.11	0.11	0.00	0.10	0.10	294.72
Trenching Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.24
Trenching 09/01/2012-02/06/2014	0.35	3.00	1.50	0.00	0.00	0.13	0.13	0.00	0.12	0.12	388.33
Trenching Off Road Diesel	0.35	2.99	1.37	0.00	0.00	0.13	0.13	0.00	0.12	0.12	368.05
Trenching Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
2014	5.18	39.98	20.35	0.00	661.34	1.72	663.07	138.12	1.58	139.70	5,215.83
Mass Grading 07/01/2011-11/20/2014	3.85	31.21	15.71	0.00	657.34	1.31	658.65	137.28	1.21	138.49	4,011.53

Mass Grading Dust	0.00	0.00	0.00	0.00	657.33	0.00	657.33	137.28	0.00	137.28	0.00
Mass Grading Off Road Diesel	3.83	31.17	15.09	0.00	0.00	1.31	1.31	0.00	1.21	1.21	3,914.18
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.03	0.62	0.00	0.00	0.00	0.01	0.00	0.00	0.00	97.34
Trenching 03/01/2012-10/09/2014	0.26	2.12	1.13	0.00	0.00	0.09	0.09	0.00	0.08	0.08	300.55
Trenching Off Road Diesel	0.26	2.11	1.03	0.00	0.00	0.09	0.09	0.00	0.08	0.08	284.85
Trenching Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.70
Trenching 09/01/2012-02/06/2014	0.03	0.28	0.15	0.00	0.00	0.01	0.01	0.00	0.01	0.01	40.17
Trenching Off Road Diesel	0.03	0.28	0.14	0.00	0.00	0.01	0.01	0.00	0.01	0.01	38.07
Trenching Worker Trips	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10
Asphalt 02/13/2014-12/31/2014	0.75	4.06	2.16	0.00	0.01	0.20	0.21	0.00	0.19	0.19	560.84
Paving Off-Gas	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.45	3.42	1.80	0.00	0.00	0.18	0.18	0.00	0.17	0.17	402.39
Paving On Road Diesel	0.05	0.64	0.25	0.00	0.00	0.02	0.03	0.00	0.02	0.02	140.58
Paving Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.87
Fine Grading 09/26/2014-11/20/2014	0.29	2.31	1.21	0.00	4.00	0.10	4.10	0.84	0.09	0.93	302.74
Fine Grading Dust	0.00	0.00	0.00	0.00	4.00	0.00	4.00	0.84	0.00	0.84	0.00
Fine Grading Off Road Diesel	0.29	2.31	1.15	0.00	0.00	0.10	0.10	0.00	0.09	0.09	294.04
Fine Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fine Grading Worker Trips	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.70

Phase Assumptions

Phase: Fine Grading 9/26/2014 - 11/20/2014 - Stabilization
Total Acres Disturbed: 1261.8
Maximum Daily Acreage Disturbed: 20
Fugitive Dust Level of Detail: Default
10 lbs per acre-day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Crawler Tractors (147 hp) operating at a 0.64 load factor for 8 hours per day
1 Crushing/Processing Equip (142 hp) operating at a 0.78 load factor for 8 hours per day
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Graders (174 hp) operating at a 0.61 load factor for 8 hours per day
2 Off Highway Trucks (479 hp) operating at a 0.57 load factor for 8 hours per day
1 Rollers (95 hp) operating at a 0.56 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 8 hours per day
4 Scrapers (313 hp) operating at a 0.72 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Appendix A
Building Construction URBEMIS Reports

Phase: Mass Grading 7/1/2011 - 6/30/2012 - Utility Corridor Grading
Total Acres Disturbed: 32
Maximum Daily Acreage Disturbed: 8
Fugitive Dust Level of Detail: Low
  Onsite Cut/Fill: 3831.42 cubic yards/day; Offsite Cut/Fill: 0 cubic yards/day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Crawler Tractors (147 hp) operating at a 0.64 load factor for 8 hours per day
2 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Off Highway Trucks (479 hp) operating at a 0.57 load factor for 8 hours per day
1 Rubber Tired Loaders (164 hp) operating at a 0.54 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Mass Grading 7/1/2011 - 11/20/2014 - Mission Village Grading
Total Acres Disturbed: 1261.8
Maximum Daily Acreage Disturbed: 20
Fugitive Dust Level of Detail: Low
  Onsite Cut/Fill: 46327.68 cubic yards/day; Offsite Cut/Fill: 0 cubic yards/day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
4 Crawler Tractors (147 hp) operating at a 0.64 load factor for 10 hours per day
2 Excavators (168 hp) operating at a 0.57 load factor for 10 hours per day
2 Graders (174 hp) operating at a 0.61 load factor for 10 hours per day
2 Off Highway Trucks (479 hp) operating at a 0.57 load factor for 10 hours per day
2 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 10 hours per day
8 Scrapers (313 hp) operating at a 0.72 load factor for 10 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 10 hours per day
6 Water Trucks (189 hp) operating at a 0.5 load factor for 10 hours per day

Phase: Trenching 3/1/2012 - 10/9/2014 - Sewer
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 8 hours per day
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Other Material Handling Equipment (191 hp) operating at a 0.59 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Trenching 7/1/2012 - 10/19/2013 - Storm Drain
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 8 hours per day

Appendix A
Building Construction URBEMIS Reports

1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Other Material Handling Equipment (191 hp) operating at a 0.59 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Trenching 9/1/2012 - 2/6/2014 - Water
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 8 hours per day
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Other Material Handling Equipment (191 hp) operating at a 0.59 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Paving 2/13/2014 - 12/31/2014 - Street Paving
Acres to be Paved: 184.8
Off-Road Equipment:
1 Graders (174 hp) operating at a 0.61 load factor for 8 hours per day
1 Pavers (100 hp) operating at a 0.62 load factor for 8 hours per day
1 Rollers (95 hp) operating at a 0.56 load factor for 8 hours per day
1 Scrapers (313 hp) operating at a 0.72 load factor for 8 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Construction Mitigated Detail Report:
CONSTRUCTION EMISSION ESTIMATES Annual Tons Per Year, Mitigated

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2011	2.80	24.41	11.55	0.00	57.40	1.07	58.47	11.99	0.98	12.97	2,557.50
Mass Grading 07/01/2011-06/30/2012	0.31	2.55	1.31	0.00	4.93	0.12	5.05	1.03	0.11	1.14	292.35
Mass Grading Dust	0.00	0.00	0.00	0.00	4.93	0.00	4.93	1.03	0.00	1.03	0.00
Mass Grading Off Road Diesel	0.31	2.55	1.21	0.00	0.00	0.12	0.12	0.00	0.11	0.11	280.13
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.22
Mass Grading 07/01/2011-11/20/2014	2.49	21.85	10.24	0.00	52.48	0.94	53.42	10.96	0.87	11.83	2,265.15
Mass Grading Dust	0.00	0.00	0.00	0.00	52.47	0.00	52.47	10.96	0.00	10.96	0.00
Mass Grading Off Road Diesel	2.48	21.83	9.81	0.00	0.00	0.94	0.94	0.00	0.87	0.87	2,210.16
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.01	0.02	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.99
2012	5.65	48.43	23.20	0.00	109.44	2.09	111.53	22.86	1.92	24.78	5,450.33
Mass Grading 07/01/2011-06/30/2012	0.30	2.35	1.27	0.00	4.89	0.11	5.00	1.02	0.10	1.12	290.11

Mass Grading Dust	0.00	0.00	0.00	0.00	4.89	0.00	4.89	1.02	0.00	1.02	0.00
Mass Grading Off Road Diesel	0.29	2.35	1.18	0.00	0.00	0.11	0.11	0.00	0.10	0.10	277.99
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.12
Mass Grading 07/01/2011-11/20/2014	4.73	40.67	19.35	0.00	104.55	1.73	106.28	21.84	1.59	23.43	4,512.99
Mass Grading Dust	0.00	0.00	0.00	0.00	104.55	0.00	104.55	21.83	0.00	21.83	0.00
Mass Grading Off Road Diesel	4.71	40.63	18.56	0.00	0.00	1.73	1.73	0.00	1.59	1.59	4,403.46
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.05	0.80	0.00	0.01	0.00	0.01	0.00	0.00	0.00	109.53
Trenching 03/01/2012-10/09/2014	0.31	2.71	1.29	0.00	0.00	0.12	0.12	0.00	0.11	0.11	324.36
Trenching Off Road Diesel	0.31	2.70	1.17	0.00	0.00	0.12	0.12	0.00	0.11	0.11	307.41
Trenching Worker Trips	0.00	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.94
Trenching 07/01/2012-10/19/2013	0.19	1.63	0.78	0.00	0.00	0.07	0.07	0.00	0.07	0.07	194.91
Trenching Off Road Diesel	0.19	1.62	0.70	0.00	0.00	0.07	0.07	0.00	0.07	0.07	184.73
Trenching Worker Trips	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.18
Trenching 09/01/2012-02/06/2014	0.12	1.07	0.51	0.00	0.00	0.05	0.05	0.00	0.04	0.05	127.96
Trenching Off Road Diesel	0.12	1.06	0.46	0.00	0.00	0.05	0.05	0.00	0.04	0.04	121.27
Trenching Worker Trips	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.68
2013	5.53	46.42	22.63	0.00	104.55	1.99	106.54	21.84	1.83	23.66	5,600.60
Mass Grading 07/01/2011-11/20/2014	4.55	38.03	18.42	0.00	104.55	1.61	106.16	21.84	1.48	23.32	4,512.98
Mass Grading Dust	0.00	0.00	0.00	0.00	104.55	0.00	104.55	21.83	0.00	21.83	0.00
Mass Grading Off Road Diesel	4.52	37.99	17.68	0.00	0.00	1.61	1.61	0.00	1.48	1.48	4,403.46
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.04	0.74	0.00	0.01	0.00	0.01	0.00	0.00	0.00	109.52
Trenching 03/01/2012-10/09/2014	0.35	3.00	1.50	0.00	0.00	0.13	0.13	0.00	0.12	0.12	388.33
Trenching Off Road Diesel	0.35	2.99	1.37	0.00	0.00	0.13	0.13	0.00	0.12	0.12	368.05
Trenching Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
Trenching 07/01/2012-10/19/2013	0.28	2.40	1.20	0.00	0.00	0.11	0.11	0.00	0.10	0.10	310.96
Trenching Off Road Diesel	0.28	2.39	1.09	0.00	0.00	0.11	0.11	0.00	0.10	0.10	294.72
Trenching Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.24
Trenching 09/01/2012-02/06/2014	0.35	3.00	1.50	0.00	0.00	0.13	0.13	0.00	0.12	0.12	388.33
Trenching Off Road Diesel	0.35	2.99	1.37	0.00	0.00	0.13	0.13	0.00	0.12	0.12	368.05
Trenching Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.28
2014	5.18	39.98	20.35	0.00	93.51	1.72	95.23	19.53	1.58	21.11	5,215.83
Mass Grading 07/01/2011-11/20/2014	3.85	31.21	15.71	0.00	92.94	1.31	94.25	19.41	1.21	20.62	4,011.53
Mass Grading Dust	0.00	0.00	0.00	0.00	92.93	0.00	92.93	19.41	0.00	19.41	0.00
Mass Grading Off Road Diesel	3.83	31.17	15.09	0.00	0.00	1.31	1.31	0.00	1.21	1.21	3,914.18
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.02	0.03	0.62	0.00	0.00	0.00	0.01	0.00	0.00	0.00	97.34

Trenching 03/01/2012-10/09/2014	0.26	2.12	1.13	0.00	0.00	0.09	0.09	0.00	0.08	0.08	300.55
Trenching Off Road Diesel	0.26	2.11	1.03	0.00	0.00	0.09	0.09	0.00	0.08	0.08	284.85
Trenching Worker Trips	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.70
Trenching 09/01/2012-02/06/2014	0.03	0.28	0.15	0.00	0.00	0.01	0.01	0.00	0.01	0.01	40.17
Trenching Off Road Diesel	0.03	0.28	0.14	0.00	0.00	0.01	0.01	0.00	0.01	0.01	38.07
Trenching Worker Trips	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10
Asphalt 02/13/2014-12/31/2014	0.75	4.06	2.16	0.00	0.01	0.20	0.21	0.00	0.19	0.19	560.84
Paving Off-Gas	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving Off Road Diesel	0.45	3.42	1.80	0.00	0.00	0.18	0.18	0.00	0.17	0.17	402.39
Paving On Road Diesel	0.05	0.64	0.25	0.00	0.00	0.02	0.03	0.00	0.02	0.02	140.58
Paving Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.87
Fine Grading 09/26/2014-11/20/2014	0.29	2.31	1.21	0.00	0.57	0.10	0.67	0.12	0.09	0.21	302.74
Fine Grading Dust	0.00	0.00	0.00	0.00	0.57	0.00	0.57	0.12	0.00	0.12	0.00
Fine Grading Off Road Diesel	0.29	2.31	1.15	0.00	0.00	0.10	0.10	0.00	0.09	0.09	294.04
Fine Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fine Grading Worker Trips	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.70

Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Fine Grading 9/26/2014 - 11/20/2014 - Stabilization

For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

For Unpaved Roads Measures, the Reduce speed on unpaved roads to less than 15 mph mitigation reduces emissions by:

PM10: 44% PM25: 44%

For Unpaved Roads Measures, the Manage haul road dust 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

The following mitigation measures apply to Phase: Mass Grading 7/1/2011 - 6/30/2012 - Utility Corridor Grading

For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

For Unpaved Roads Measures, the Reduce speed on unpaved roads to less than 15 mph mitigation reduces emissions by:

PM10: 44% PM25: 44%

For Unpaved Roads Measures, the Manage haul road dust 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

The following mitigation measures apply to Phase: Mass Grading 7/1/2011 - 11/20/2014 - Mission Village Grading

For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

Appendix A
Building Construction URBEMIS Reports

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

For Unpaved Roads Measures, the Reduce speed on unpaved roads to less than 15 mph mitigation reduces emissions by:

PM10: 44% PM25: 44%

For Unpaved Roads Measures, the Manage haul road dust 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

APPENDIX B
VMT Memo from Fehr and Peers

DRAFT

FEHR & PEERS
TRANSPORTATION CONSULTANTS

TECHNICAL MEMORANDUM

Date: April 15, 2010

To: Corey Harpole – Newhall Land
David Weaver - Environ

From: Ronald T. Milam - Fehr & Peers

Subject: ***Newhall Ranch Villages Mixed-Use VMT Estimate*** ***SM09-2373.02***

Fehr & Peers has completed an evaluation of vehicle miles of travel (VMT) for the Mission Village project in response to Environ's request for input data to their greenhouse gas (GHG) analysis for the project. Based on previous transportation analysis work already completed for the Mission Village project, two estimates of VMT were available. One estimate is a direct output of the Santa Clarita Valley Consolidated Travel Demand Model (SCVCTDM). This estimate was not selected because it only represents travel within the Santa Clarita Valley. Trips outside the valley need to be included for a full accounting of VMT. Further, the SCVCTDM estimate of VMT does not isolate the VMT generated exclusively by households, which is the desired variable for Environ's analysis. The second VMT estimate was generated using the mixed-use development (MXD) trip generation equation developed by Fehr & Peers and used to estimate trip internalization for Mission Village. This equation does produce the VMT generated per household estimate desired by Environ and relies of trip length inputs that capture trips occurring beyond the limits of Santa Clarita Valley.

The MXD equation was used to estimate trip internalization for Mission Village to capture the effects of built environment variables (i.e., land use density, land use diversity, etc.) that were not fully reflected in the SCVCTDM. The main outputs of the MXD equation are estimates of gross and net vehicle trips, but VMT can also be estimated if regional average trip lengths data is

available. VMT is basically an estimate of total vehicle travel distance that is calculated by multiplying the number of vehicle trips by average trip lengths measured in miles. For this study, two sets of average trip lengths were needed. The first set was for trips that stay internal to the project, which were estimated to be 1.0 mile for all trip purposes based on the physical size of the development. The second set of average trip lengths represent trips that are external to the project (this means that at least one trip end occurs outside the project). These trip lengths were used in the MXD equation as described below.

- **Home-based work (HBW) trip length**, which simply refers to trips between home and work, was estimated based on the 2000 Census average travel time for Los Angeles County of 29.7 minutes. This was converted to distance assuming an average network speed of 30 miles per hour (mph), which equates to approximately 14.7 miles. This distance was compared to the SCVCTDM trip length estimate of 10.7 to verify it was longer, thus capturing additional travel that occurs outside the Santa Clarita Valley.

- **Home-based other (HBO) trip length**, which captures trips between home and all other destinations other than work, was estimated based on information contained in Travel Estimation Techniques for Urban Planning, *NCHRP Report 365*, Transportation Research Board, 1998. This reference manual states that all non-work trips in areas with less than 500,000 people are typically 75 to 85 percent of the HBW trip length. This study used the higher end of this range, which resulted in an average trip length for HBO (and NHB as noted below) of 12.5 miles.

- **Non-home based (NHB) trip length**, which captures trips made by residents of Mission Village households that occur away from the home. For example, a resident making a trip between their job location and a restaurant would be a NHB trip. This trip purpose uses the same 12.5 miles noted above.

If desired, additional data sources could be evaluated to verify the trip lengths estimated above. These sources include the California Statewide Household Travel Survey, the National Household Travel Survey, and the Southern California Association of Governments (SCAG) Household Travel Survey, and the SCAG regional travel demand model.

To understand how VMT is calculated, a simple example is provided below using the vehicle trip rates from the SCVCTDM and the trip lengths described above for one single family household.

- One single family household generates 9.9 daily vehicle trips. This value is then split into the trip purposes listed above according to distributions from NCHRP Report 365 as shown below.
    - HBW = 21 percent (9.9 x 0.21 = 2.08 daily vehicle trips)
    - HBO = 56 percent (9.9 x 0.56 = 5.54 daily vehicle trips)
    - NHB = 23 percent (9.9 x 0.23 = 2.28 daily vehicle trips)

- The trips by purpose are multiplied by the average trip lengths for each purpose as follows.
    - HBW = 2.08 daily vehicle trips x 14.7 miles = 30.56 VMT
    - HBO = 5.54 daily vehicle trips x 12.5 miles = 69.30 VMT
    - NHB = 2.28 daily vehicle trips x 12.5 miles = 28.46 VMT

- The final step adds the trip purpose VMT values together, which equates to an estimate of approximately 128 VMT generated per single family household.

The example above is somewhat extreme because it makes no adjustments for the location of the single family household or the built environment around it, which can influence the number of vehicle trips that are made and their length. For Mission Village, the MXD equation adjusted the vehicle trip generation estimates to account for the following built environment variables.

- Development scale – the physical size of the development and the number of jobs in the development
- Density – population plus jobs per square mile
- Diversity – the mix of jobs and population and the mix of retail jobs and total jobs
- Destinations – jobs within one mile and within 30 minutes by transit
- Distance to Transit – jobs within 30 minutes by transit
- Design – intersections per square mile
- Demographics – vehicle ownership and average household size

Table 1 displays the estimates of household VMT generation for Mission Village after accounting for the built environment effects on vehicle trip generation.

Table 1 Household VMT Results for Mission Village			
Results	**Gross (without MXD adjustments)**	**Net (with MXD adjustments)**	**Percent Difference**
Total Daily VMT generated by Households (weekday)	474,204	357,724	25%
Daily VMT generated per household (weekday)	107	81	25%

The results in Table 1 show that the household generated VMT from Mission Village is about 25 percent lower than would occur without the built environment effects. Another way to interpret this result is that a similar amount of development occurring in the Santa Clarita Valley without Mission Village's smart growth characteristics would likely generate VMT per household closer to the 107 shown in Table 1. To understand how the specific MXD variables influenced these results, we conducted a detailed review of the MXD equation results as summarized below.

Factors Contributing to Vehicle Trip Reductions

- **Development Scale** – the site area and total employment level are both significantly higher than the average mixed use site studied in the development of the model.

- **Diversity** – the site's jobs / population balance and retail jobs / total jobs balance are closer to the optimal levels than the than the average mixed use site studied in the development of the model.

- **Destinations and Distance to Transit –** the site has more jobs within one mile and within 30 minutes by transit than the average mixed use site studied in the development of the model.

- **Demographics –** the site's projected average household size is slightly smaller than the average mixed use site studied in the development of the model.

Offsetting Factors

- **Density –** the site is slightly less dense than the average mixed use site studied in the development of the model in terms of (population + jobs) per square mile.

- **Design** – the site has slightly fewer intersections per square mile than the average mixed use site studied in the development of the model.

- **Demographics –** Vehicle ownership at the site is slightly higher than the average mixed use site studied in the development of the model.

Since the MXD variables only affected trip generation and not trip length, it is possible that the actual amount of VMT generated could be less. Further study would be required to verify this statement.

APPENDIX C
Area Source URBEMIS Run

Appendix C
Area Source URBEMIS Report

Urbemis 2007 Version 9.2.4

Combined Annual Emissions Reports (Tons/Year)

File Name: Z:\Alan Sako\032.223 Mission Village\Emissions\03 Operational\Mission Village Operational.urb924
Project Name: Mission Village - Operational
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (tons/year, unmitigated)	39.73	13.73	16.66	0.00	0.06	0.06	17,231.72
TOTALS (tons/year, mitigated)	39.73	13.73	16.66	0.00	0.06	0.06	17,231.72
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (tons/year, unmitigated)	44.59	49.19	449.66	0.88	149.02	29.00	87,270.26
TOTALS (tons/year, mitigated)	40.14	43.56	398.09	0.77	131.94	25.66	77,268.12
Percent Reduction	9.98	11.45	11.47	12.50	11.46	11.52	11.46

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (tons/year, unmitigated)	84.32	62.92	466.32	0.88	149.08	29.06	104,501.98
TOTALS (tons/year, mitigated)	79.87	57.29	414.75	0.77	132.00	25.72	94,499.84
Percent Reduction	5.28	8.95	11.06	12.50	11.46	11.49	9.57

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	1.04	13.60	6.70	0.00	0.03	0.03	17,198.02
Hearth	0.02	0.01	0.01	0.00	0.00	0.00	17.06
Landscape	1.49	0.12	9.95	0.00	0.03	0.03	16.64
Consumer Products	33.73						
Architectural Coatings	3.45						
TOTALS (tons/year, unmitigated)	39.73	13.73	16.66	0.00	0.06	0.06	17,231.72

Appendix C
Area Source URBEMIS Report

Area Source Mitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Annual Tons Per Year, Mitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	1.04	13.60	6.70	0.00	0.03	0.03	17,198.02
Hearth	0.02	0.01	0.01	0.00	0.00	0.00	17.06
Landscape	1.49	0.12	9.95	0.00	0.03	0.03	16.64
Consumer Products	33.73						
Architectural Coatings	3.45						
TOTALS (tons/year, mitigated)	39.73	13.73	16.66	0.00	0.06	0.06	17,231.72

Area Source Changes to Defaults

Percent residential using natural gas changed from 78% to 100%

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 100%

The number of persons per household for consumer product use changed from 3 persons to 2.45 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	2.98	3.45	31.89	0.06	10.55	2.05	6,183.25
Apartments low rise	5.13	5.70	52.65	0.10	17.41	3.39	10,209.76
Condo/townhouse general	14.95	16.91	156.15	0.30	51.64	10.05	30,280.22
Retirement community	1.56	1.55	14.36	0.03	4.75	0.92	2,784.23
Congregate care (Assisted Living)	0.97	0.90	8.32	0.02	2.75	0.54	1,612.62
Elementary school	1.45	0.89	8.04	0.02	2.63	0.51	1,540.60
Library	1.63	1.73	15.38	0.03	4.94	0.96	2,893.79
City park	0.09	0.08	0.69	0.00	0.23	0.05	135.23
Regnl shop. center	4.67	5.15	45.52	0.09	15.00	2.92	8,760.12
General office building	5.43	6.20	56.16	0.11	18.82	3.66	10,999.65
Office park	5.65	6.53	59.63	0.12	20.00	3.89	11,697.86
Firestation	0.08	0.10	0.87	0.00	0.30	0.06	172.93
TOTALS (tons/year, unmitigated)	44.59	49.19	449.66	0.88	149.02	29.00	87,270.26

Operational Mitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Annual Tons Per Year, Mitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2

Appendix C
Area Source URBEMIS Report

Single family housing	2.74	3.13	28.96	0.06	9.58	1.86	5,615.14
Apartments low rise	4.55	4.95	45.71	0.09	15.12	2.94	8,863.86
Condo/townhouse general	13.45	14.98	138.40	0.27	45.77	8.91	26,837.39
Retirement community	1.26	1.17	10.84	0.02	3.58	0.70	2,101.61
Congregate care (Assisted Living)	0.74	0.61	5.62	0.01	1.86	0.36	1,090.62
Elementary school	1.38	0.81	7.27	0.01	2.38	0.46	1,394.17
Library	1.48	1.57	13.92	0.03	4.47	0.87	2,618.75
City park	0.09	0.07	0.62	0.00	0.21	0.04	122.38
Regnl shop. center	4.25	4.66	41.19	0.08	13.57	2.64	7,927.50
General office building	4.96	5.61	50.82	0.10	17.03	3.31	9,954.18
Office park	5.16	5.91	53.96	0.10	18.10	3.52	10,586.03
Firestation	0.08	0.09	0.78	0.00	0.27	0.05	156.49
TOTALS (tons/year, mitigated)	40.14	43.56	398.09	0.77	131.94	25.66	77,268.12

Operational Settings:

Includes correction for passby trips
Does not include double counting adjustment for internal trips
Analysis Year: 2020 Season: Annual
Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	127.33	9.90	dwelling units	382.00	3,781.80	33,450.02
Apartments low rise	56.56	6.90	dwelling units	905.00	6,244.50	55,232.61
Condo/townhouse general	144.69	8.00	dwelling units	2,315.00	18,520.00	163,809.43
Retirement community	91.80	3.71	dwelling units	459.00	1,702.89	15,062.06
Congregate care (Assisted Living) Facility	13.60	2.81	dwelling units	351.00	986.31	8,723.91
Elementary school		1.45	students	900.00	1,305.00	8,344.59
Library		84.98	1000 sq ft	36.00	3,059.28	15,657.36
City park		2.60	acres	40.90	106.34	736.93
Regnl shop. center		37.06	1000 sq ft	224.10	8,305.15	47,582.35
General office building		11.56	1000 sq ft	634.00	7,329.04	59,710.34
Office park		10.20	1000 sq ft	697.00	7,109.40	63,461.18
Firestation		7.41	1000 sq ft	13.50	100.03	941.75
					58,549.74	472,712.53

Vehicle Fleet Mix

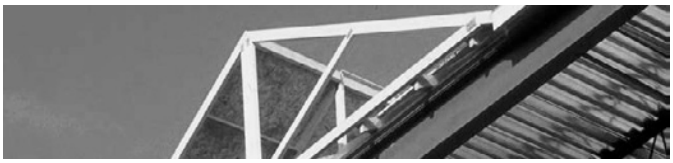
Appendix C
Area Source URBEMIS Report

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	50.6	0.0	100.0	0.0
Light Truck < 3750 lbs	7.2	0.0	98.6	1.4
Light Truck 3751-5750 lbs	23.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	11.0	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.7	0.0	82.4	17.6
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.6	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.9	41.4	58.6	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	12.7	7.0	9.5	13.3	7.4	8.9
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
Library				5.0	2.5	92.5
City park				5.0	2.5	92.5
Regnl shop. center				2.0	1.0	97.0
General office building				35.0	17.5	47.5
Office park				48.0	24.0	28.0
Firestation				35.0	17.5	47.5

APPENDIX D
Life Cycle Greenhouse Gas Emissions from Building Materials



Life Cycle Greenhouse Gas Emissions from Building Materials

Mission Village

Prepared for:

Newhall Land
Valencia, CA

Prepared by:

ENVIRON International Corporation
Emeryville, CA

April 2010

ENVIRON
www.environcorp.com

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Table 5 Summary of Life Cycle Greenhouse Gas (GHG) Emissions from Buildings and Infrastructure

Acronyms

AP-42	Compilation of Air Pollutant Emission Factors
$CaCO_3$	limestone
CaO	calcium oxide
CCAR	California Climate Action Registry
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
ENVIRON	ENVIRON International Corporation
ft^2	square feet
GHG	greenhouse gas
GRP	General Reporting Protocol
kWh/m^2	kilowatt hour per square meter
LCA	life cycle analyses
MMBTU	million British thermal units

1.0 EXECUTIVE SUMMARY

This report evaluates the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of Mission Village. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. This report then compares the life cycle GHG emissions to the overall annual operational emissions of Mission Village.[1] The materials analyzed in this report include materials for 1) residential and non-residential buildings and 2) site infrastructure. This report calculates the overall life cycle emissions from construction materials to be 686 to 6,291 tonnes per year, or 1.1 – 10% of the overall Mission Village project emissions.

ENVIRON estimated the life cycle GHG emissions for buildings by conducting an analysis of available literature on life cycle analyses (LCA) for buildings. According to these studies, approximately 75 - 97% of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 - 25% of the GHG emissions are due to material manufacture and transport. Using the GHG emissions from the operation of Mission Village buildings, 3% to 25% corresponds to 573 to 6,178 tonnes CO_2 per year or 0.9 – 10.1% of the Mission Village project emissions.

ENVIRON calculated the life cycle GHG emissions for infrastructure (roads, storm drains, utilities, gas, electricity, cable) to be equal to a one time emission of 4,497 tonnes CO_2. This analysis considered the manufacture and transport of concrete and asphalt. Based on this analysis, the transport of the materials leads to 291 tonnes of CO_2 emissions and the manufacture of the materials leads to 4,206 tonnes of emissions. Because the manufacture of concrete has a higher CO_2 emission factor, the majority of the emissions for infrastructure result from the manufacture of concrete even though the mass of asphalt is higher. Because the asphalt and concrete are locally sourced, the transportation emissions are relatively small. If a 40-year lifespan of the infrastructure is assumed, the total annualized emissions are 112 tonnes per year or 0.2% of the Mission Village project emissions.

The overall life cycle emissions from embodied energy in the Mission Village building materials, annualized by 40 years, are 686 to 6,291 tonnes CO_2 / year. This represents 1.1% – 10% of the annualized GHG emissions from Mission Village. The bulk of these emissions are from general life cycle analysis studies and do not reflect the details of Mission Village.

[1] ENVIRON estimated life cycle GHG emissions from materials in Mission Village. The percentages reflect the portion of life cycle GHG emissions compared to the total emissions for Mission Village area.

2.0 INTRODUCTION

This report evaluates the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of Mission Village. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. This report then compares the life cycle GHG emissions to the overall annual operational emissions of Mission Village. The materials analyzed in this report include materials for 1) residential and non-residential buildings and 2) site infrastructure.

2.1 Background on Life Cycle Analysis

LCA is a method developed to evaluate the mass balance of inputs and outputs of systems and to organize and convert those inputs and outputs into environmental themes or categories. In this case, the LCA is related to GHG emissions associated with the different stages of a life cycle. The LCA field is still relatively new, and while there are general standards for goals and general practices for LCAs[2] the specific methodologies and, in particular, the boundaries chosen for the LCA makes inter-comparison of various studies difficult. Simple choices such as the useful life of a building or road, for example, can change the LCA outcome substantially. Additionally, the geographic location, climatic zone and building type significantly influence patterns of energy consumption (and energy efficiency) and therefore determine life cycle GHG emissions, which makes comparisons among different studies difficult.

The calculations and results presented in this report are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Technical Report. LCA emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, the analysis is not exact and may be highly uncertain.

3.0 EMISSIONS ESTIMATES

3.1 Life Cycle GHG Emissions from Building Materials

ENVIRON estimated the life cycle GHG emissions for building materials by conducting an analysis of available literature on life cycle analyses (LCA) for buildings. According to these studies, approximately 75 - 97% of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 - 25% of the GHG emissions are due to building material manufacture and transport. Based on the GHG emissions from the operation of Mission Village buildings[3], 3% to 25% corresponds to 573 to 6,178 tonnes

[2] ISO 14044 and ISO 14040

[3] Climate Change Technical Report: Mission Village. ENVIRON. April 2010.

CO_2 per year, as shown in Table 1. The specific LCA studies used are discussed in the next section.

With the current energy generation mix in the US which relies heavily on fossil fuel based sources, focusing on energy efficiency measures (which ultimately reduces lifetime GHG emissions) is more effective in reducing the overall GHG footprint than focusing on materials with low embodied energy. As the energy generation measures reduce their GHG intensity (shift away from fossil fuel to renewable fuels), material selection will be a more critical factor in a building's GHG emissions over its life cycle.

3.1.1 LCA Studies for Buildings

The LCA literature studies tend to compare the energy used to make and transport building materials, or the embodied energy, with the operational energy use. In this manner, the relative importance of the embodied energy can be assessed. ENVIRON discusses several studies that compare the embodied energy and the operational energy.

A life cycle assessment of a 66,000 ft^2 sustainably-designed university building[4] in the US Mid-west[5] estimated that the GHG emissions associated with its energy use over a 100-year time horizon to be 135,000 metric tones of carbon dioxide equivalent (CO_2e), 96.5% of which result from operations phase activities, 3% from material production (of which ⅓ is cement production) and 0.5% from transportation and decommissioning combined. The study also notes that the GHG emissions closely matches the distribution of life cycle energy distributions, indicating that operational energy requirements are the key factor determining overall GHG emissions, especially when considering fossil fuel based energy generation. This building has a longer estimated life than the Mission Village buildings, which would lead to a lower comparison of embodied energy to operational energy.

A study of single-family homes in the US Mid-west,[6] one built using standard construction techniques and the second incorporating energy efficiency measures, reached similar conclusions. Over the life cycle of the homes (assumed to be 50 years), the conventional home uses 15,000 MMBTU and the energy efficient configuration uses 6,000 MMBTU of energy, representing a 60% reduction in overall energy. As GHG emissions closely match the distribution of life cycle energy distributions, the energy efficient variant resulted in 63% fewer emissions. Of the total energy use over the structure's life cycle, 91% of the conventional house total energy results from energy consumed in the use stage (e.g., operating energy). This value drops to 74% in the energy efficient home as the energy embodied in the building materials stays the same or is slightly higher than that in the conventional home and operating energy is reduced.

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[4] Includes 4 floors of classroom and open-plan offices and 3 floors of hotel rooms, in this evaluation used as a surrogate for a generic commercial structure.

[5] Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings*, **35**(10): p. 1049.

[6] Keoleian, G.A., S. Blanchard, and P. Reppe. (2000) Life-cycle energy, costs, and strategies for improving a single-family house. *Journal of Industrial Ecology*, **4**(2): p. 135.

Similarly, a review of 60 case studies of homes from nine European countries in a variety of climates[7] indicated that operating energy represents the largest part of energy demand by a building during its life cycle. In one evaluation the operating energy is reported as between 92 - 95% for conventional construction and 72 - 90% for low-energy buildings[8] (which are also consistent with other literature references[9]). Sartori and Hestnes[26] also note that buildings constructed with energy efficiency measures may have a higher energy (and concomitant GHG emissions) embodied by the materials used in construction (e.g., more insulation, higher thermal mass), but over the lifespan of the building the overall energy use (operating and embodied energy) is dramatically lower due to the large reductions in operating energy. As an example, the embodied energy was estimated to be 1171 kWh/m^2 for a conventional house and 1391 kWh/m^2 for a passive, energy efficient home, an increase of 220 kWh/m^2 or 19%. Over the lifetime of the building, however, the total energy (operating and embodied) of the conventional house was approximately 22,500 kWh/m^2, while the passive house was roughly 5,500 kWh/m^2, a four-fold decrease in the total energy over an assumed 80 year life cycle.

3.1.2 Energy Efficiency vs. Embodied Energy in Buildings

From our analysis of these assessments, we note the following major conclusions:

- To minimize GHG lifetime emissions, optimization of energy efficiency (both thermal and electrical) for the operational phase of a building should be the primary emphasis for design, especially when the energy supplied is generated from fossil fuel sources.

- Passive design measures such as the orientation of structure to maximize solar heating and daylighting as well as natural ventilation; heavy construction to increase the thermal mass of the structure with materials that have a high capacity for absorbing heat and change temperature slowly; and solar control like window shading[10] should be emphasized[11,12,13] as they have a negligible increase in embodied energy (GHG emissions from material production) and can reduce total energy substantially.[14]

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[7] Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings*, **39**(3): p. 249.

[8] Winther, B.N. and A.G. Hestnes. (1999) Solar versus green: The analysis of a Norwegian row house. *Solar Energy*, **66**(6): p. 387.

[9] Adalberth, K., A. Almgren, and E.H. Petersen. (2001) Life Cycle Assessment of Four Multi-Family Buildings. *International Journal of Low Energy and Sustainable Buildings*, **2**.

[10] United Nations Environment Program 2007 Buildings and Climate Change report whole-house system measures are recommended for the Mediterranean and desert climate zones

[11] Browning, W.D. and J.J. Romm. (1998) *Greening the Building and the Bottom Line*. Snowmass, Colorado: Rocky Mountain Institute.

[12] United Nations Environment Program. (2007) *Buildings and Climate Change: Status, Challenges and Opportunities.*

[13] US Department of Energy Building Technologies Program. (2007) www.eere.energy.gov/buildings/. October.

[14] Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings*, **39**(3): p. 249.

- Active energy efficiency measures (e.g., mechanical ventilation, artificial cooling, free cooling) may as much as double the embodied energy of the structure, but can halve overall energy usage.

- With the current energy generation mix in the US which relies heavily on fossil fuel based sources, focusing on energy efficiency measures (which ultimately reduces lifetime GHG emissions) is more effective in reducing the overall GHG footprint than focusing on materials with low embodied energy. As the energy generation measures reduce their GHG intensity (shift away from fossil fuel to renewable), material selection will be a more critical factor in a building's GHG emissions over its life cycle.

One can not evaluate the life cycle emissions of a building product independent of the impact that the building product has on energy use. For example, studies that evaluate the relative embodied energy and GHG emissions associated with the production of structural materials such as steel, concrete or wood generally indicate that the wood products have the lowest GHG emissions as it is produced from a renewable resource that may actually remove CO_2 during its production phase and sequester it during its use phase.[15,16] However, these studies do not account for the effect of the material on overall building energy efficiency, which is often heavily dependent on the climate in which the building is located. In desert climates, the thermal mass of the structure is important for energy savings, as the thermal mass cools at night and keep the house cool during the day during hot weather and conversely heats during the day keeps the house warm during the evening during cool weather. To increase thermal mass, concrete is much more effective than wood. In other types of climates (cooler with less solar heating), wood with insulation has a greater impact at improving overall building efficiency.

For some building products or systems, the net energy savings during the operational portion of the building's life cycle are comparable. If this is the case, then the alternative with the lowest embodied GHG emissions will result in the lowest life cycle GHG emissions.

Building materials with high replacement rates, like carpeting and wiring, can often have a high contribution to the overall GHG emissions as their impact is dependent on renovation schedules. For example, if two building materials have the same embodied energy but one is replaced every 5 years and the second is replaced every 25 years then the first will have five times the embodied energy over the lifetime of the building. As such Scheuer et al.[17] indicate that "[d]esign strategies that maximize the service life of building materials should be maximized." These strategies include designing the structure for minimal material use and choosing materials with low embodied energy, high recycled content, and long life spans.

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[15] Borjesson, P. and L. Gustavsson. (2000) Greenhouse gas balances in building construction: Wood versus concrete from life-cycle and forest land-use perspectives. *Energy Policy*, **28**(9): p. 575.

[16] Lenzen, M. and G. Treloar. (2002) Embodied energy in buildings: Wood versus concrete - Reply to Borjesson and Gustavsson. *Energy Policy*, **30**(3): p. 249.

[17] Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings*, **35**(10): p. 1049.

From our analysis of these product or system specific assessments, we note the following major conclusions:

- Products or systems which have the greatest impact in improving overall building energy efficiency over the building's life cycle should be selected to minimize life cycle GHG emissions. These alternatives may not necessarily have the lowest embodied GHG emissions.

- When evaluating products or systems that have similar impacts on overall building energy efficiency, alternatives with the lowest embodied GHG emissions should be selected to minimize GHG emissions.

- Materials with high replacement rates (e.g., carpeting, wiring) tend to have higher embodied energy due to their short life cycle, therefore minimizing embodied GHG emissions is most critical for these types of products or systems to minimize overall GHG emissions. Materials with low replacement rates (e.g., piping, air ducts) tend to have lower embodied energy over the life cycle of the building, therefore differences in overall GHG emissions between several alternative are likely to be small.

3.2 GHG Emissions from Manufacture of Infrastructure Materials

ENVIRON evaluated the embodied energies of materials likely to be found in the infrastructure (roads, storm drains, utilities, gas, electricity, cable) of Mission Village. The embodied energies of different materials vary based upon the transportation distance and manufacturing processes. A material that is locally-sourced may require a large amount of energy to be produced and, on the contrary, a material with a relatively low energy intensity may be sourced from farther away. ENVIRON assumed that concrete and asphalt will be among the dominant materials used in the infrastructure and estimated the embodied energies of these two materials. To estimate the quantity of materials required for buildings and infrastructure at Mission Village, ENVIRON used the quantities required for Newhall Ranch and scaled them based on the total building area of Mission Village as compared to Newhall Ranch. The manufacture of these materials results in overall CO_2 emissions of 4,206 tonnes. Eighty-nine percent of these emissions (3,735 tonnes) result from the manufacture of concrete because concrete has a higher CO_2 emission factor.

3.2.1 Embodied Energy in Concrete Production

Concrete is composed primarily of cement, water, and aggregate such as sand and gravel, with small amounts of chemical admixtures. A typical concrete mix contains approximately 15% cement by volume.[18] Because the remaining 85% of concrete is composed of water and aggregate, ENVIRON assumed that all of the manufacture-related embodied energy in concrete stems from the production of cement.

[18] Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp

There are two main sources of CO_2 emissions from the production of cement: "calcining" emissions and fossil fuel combustion emissions. Calcining emissions result from the chemical conversion of limestone ($CaCO_3$) to calcium oxide (CaO) and carbon dioxide (CO_2). CaO is a precursor to cement and CO_2 is released to the atmosphere. The emissions from fossil fuel combustion vary based on fuel type, but in general slightly more than half of the emissions associated with cement production are attributed to calcining emissions and the remainder result from fossil fuel combustion.[19]

ENVIRON used three sources to estimate CO_2 emission factors for the production of cement. The Energy Information Administration (EIA)[20] and AP-42[21] estimate that 0.5 tonnes of CO_2 are emitted from the calcining process for every 1 tonne of cement produced. AP-42 also provides a range (0.75 – 1.19 tonnes CO_2 / tonne cement) of total CO_2 emission factors (including calcining emissions and fossil fuel combustion emissions). The consulting group Battelle[22] estimates a total CO_2 emission factor for cement production in North America of 0.99 tonnes CO_2 / tonne cement. These emission factors are presented in Table 2.

3.2.2 Embodied Energy in Asphalt Production

The manufacture of asphalt is less energy intensive than the manufacture of cement. Asphalt is composed of asphalt cement and aggregate; the aggregate typically constitutes 92% by weight of the asphalt mixture.[23] AP-42 estimates CO_2 emission factors for batch mix (37 pounds CO_2 / short ton asphalt) and drum mix (33 pounds CO_2 / short ton asphalt) hot mix asphalt plants based on fuel usage within the plants.[24] ENVIRON used the average of these two values to represent the embodied energy of asphalt for the Mission Village infrastructure.

3.2.3 Embodied Energy in Infrastructure

ENVIRON used the CO_2 emission factors from cement and asphalt to estimate the embodied energy of the infrastructure materials in Mission Village. Predicted amounts of concrete and asphalt for the infrastructure were estimated by scaling the amount of material required for Newhall Ranch using the ratio of total building area in Mission Village to that in Newhall Ranch. The estimated emissions from the manufacture of the infrastructure materials are presented in

[19] USGS 2005 Minerals Yearbook: Cement. February 2007. pg 16.1-16.2. http://minerals.usgs.gov/minerals/pubs/commodity/cement/cemenmyb05.pdf

[20] EIA Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. August 2007. http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html

[21] EPA AP42 Section 11.6: Portland Cement Manufacturing. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s06.pdf

[22] Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.

[23] EPA AP42 section 11.1: Hot Mix Asphalt Plants. pg 11.1-1. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf

[24] EPA AP42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf

Table 3. Because concrete is 15% cement by volume,[25] the total volume of concrete is multiplied by 15% to yield the volume of cement presented in Table 3. The emissions from the cement manufacture are assumed to be equal to the emissions from concrete manufacture. One-time emissions from concrete and asphalt manufacture for infrastructure materials are estimated to be 3,735 and 471 tonnes CO_2, respectively.

3.3 Transportation of Materials for Infrastructure

ENVIRON estimated the emissions from the transportation of the infrastructure materials. Newhall provided approximate distances between the materials' source locations and the development site. Using the infrastructure material quantities specified in Table 3, ENVIRON estimated emissions of 291 tonnes CO_2 from the transportation of the concrete and asphalt in infrastructure and buildings.[26] Details of the calculations are outlined in Table 4.

3.3.1 Calculation of Emissions from Transportation of Materials for Buildings

Although each particular shipper operates with greater or lesser efficiencies, ENVIRON assumed an average GHG emission rate per tonne-mile[27] for each mode of transportation. Although it is likely that more dense material has a slightly lower GHG shipping intensity than does less dense material, this analysis developed a single emission factor per tonne-mile of material moved, regardless of density, for each mode of transportation.

3.3.1.1 Emissions associated with transporting the material

Emission factors were calculated from DOE EERE energy intensity indicators.[28] EERE data is presented in terms of energy per mile traveled. These were converted using AP-42 conversion factors[29] for energy in different types of fuel, and California Climate Action Registry (CCAR) General Reporting Protocol (GRP)[30] emission factors for mass of CO_2 emitted per gallon of fuel. Trains and trucks are assumed to run on diesel. These emission factors are listed in Table 4. The emission factors developed above were multiplied by the distances traveled by each type of transportation.

3.4 Summary of Emissions from Buildings and Infrastructure

Table 5 presents the summary of the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of Mission Village. The life cycle GHG emissions include the embodied energy from the materials

[25] Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp

[26] For the estimates of emissions from material transportation, ENVIRON conservatively assumed that the entire concrete mix, not just cement, is transported from the source locations to the development site.

[27] A tonne-mile refers to the amount of material (in tonnes) moved a distance of one mile.

[28] Grams CO_2 / tonne mile. See http://intensityindicators.pnl.gov/trend_data.stm Transportation sector data.

[29] AP42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

[30] The GRP is available online at http://www.climateregistry.org/docs/PROTOCOLS/GRP%20V2-March2007_web.pdf

manufacture and the energy used to transport those materials to the site. The materials analyzed include materials for 1) residential and non-residential buildings and 2) site infrastructure. This report calculates the overall life cycle emissions from construction materials to be 686-6,291 tonnes per year, or 1.1 – 10% of the overall Mission Village project emissions.

Table 1
Life Cycle Greenhouse Gas (GHG) Emissions From Materials[1] Used for Buildings
Mission Village
Newhall Ranch, California

Residential and Non-Residential Buildings[2]	**Embodied Energy as Percentage of Overall Energy[3]**	
	3%	**25%**
(tonnes CO_2 / year)		
18,535	573	6,178

Notes:
1. All materials were analyzed. See references below for more details.
2. Represents CO_2 emissions from electricity and natural gas use. From the Mission Village Climate Change Technical Report.
3. Percentages are based upon LCA studies below. The studies compared energy used in the manufacture and transport of materials to energy use from electricity and natural gas. Varying lifetimes of homes were assumed in each study. As homes become more energy efficient, the portion of GHGs from embodied energy increases.

Abbreviations:
CO_2 = Carbon Dioxide
GHG = Greenhouse Gas
LCA = Life Cycle Analysis

Sources:
Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings* , **35**(10): p. 1049.
Keoleian, G.A., S. Blanchard, and P. Reppe. (2000) Life-cycle energy, costs, and strategies for improving a single-family house. *Journal of Industrial Ecology* , **4**(2): p. 135.
Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings* , **39**(3): p. 249.

Winther, B.N. and A.G. Hestnes. (1999) Solar versus green: The analysis of a Norwegian row house. *Solar Energy* , **66**(6): p. 387.

Adalberth, K., A. Almgren, and E.H. Petersen. (2001) Life Cycle Assessment of Four Multi-Family Buildings. *International Journal of Low Energy and Sustainable Buildings* , **2**.

Table 2
Greenhouse Gas (GHG) Emission Factors for the Manufacture of Cement
Mission Village
Newhall Ranch, California

Data Source	Calcining Emissions[4]	Fossil Fuel Emissions[5]
	(tonnes CO_2/tonne cement)	
EIA[1]	0.5	NA
EPA AP-42[2]	0.5	NA
	0.75 - 1.19	
	0.92	
Battelle[3]	0.99	

Notes:

1. From the Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. Calculations are detailed in the Documentation for Emissions of Greenhouse Gases in the United States 2004, pg 35 - 38.
2. From AP-42 section 11.6: Portland Cement Manufacturing. Approximately 500 kg of CO_2 are released per Mg of cement produced during the calcining process; total manufacturing emissions depend on energy consumption (pg 11.6-6). Table 11.6-8 specifies 2,100 lbs CO_2 per ton of clinker produced (ENVIRON used the higher value instead of 1,800 lbs / ton to be conservative). Clinker is a precursor to cement. Using a clinker factor of 0.88 lb clinker/lb cement (from the Battelle report) yields an emission factor of 0.92 tonnes CO_2/tonne cement.
3. From Table 1-2 of the Battelle report. The North American average emission factor is 0.99 kg CO_2/kg cement; the global average is 0.87 kg CO_2/kg cement.
4. There are two main sources of CO_2 emissions from the manufacture of cement: the calcining process and fossil fuel combustion. Calcining emissions result from the chemical reaction of converting limestone ($CaCO_3$) to calcium oxide (CaO) and carbon dioxide (CO_2). CaO is a precursor to concrete and CO_2 is released to the atmosphere.
5. Fossil fuel combustion usually provides the energy necessary to manufacture cement. The emissions from the fossil fuel combustion vary depending on the type of fuel used; in general the combustion accounts for slightly less than half of the CO_2 emissions from the manufacture of cement.

Abbreviations:

AP-42 = Compilation of Air Pollutant Emission Factors
CO_2 = carbon dioxide
EIA = Energy Information Administration
EPA = Environmental Protection Agency
kg = kilogram
NA = Not Available
Mg = megagram = 1,000 kg

Sources:

EIA Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. August 2007. http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html
EPA AP42 Section 11.6: Portland Cement Manufacturing.
http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s06.pdf
Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.

Table 3
Greenhouse Gas (GHG) Emissions from Manufacture of Materials
Mission Village
Newhall Ranch, California

Material	Emission Factor	Volume of Material	Mass of Material	Emissions from Manufacture of Material[4]
	(tonnes CO_2/tonne material)	(yd^3)	(tonnes)	(tonnes CO_2)
Infrastructure[1]				
Cement (in concrete)[2]	0.990	3,327	3,773	3,735
Asphalt[3]	0.018	34,289	26,921	471
TOTAL				**4,206**

Notes:

1. Quantity of material for infrastructure is estimated using the quantities required for Newhall Ranch and scaling by total building area.

2. Concrete is composed of cement, water, aggregate, and chemical admixtures; concrete mixtures are approximately 15% cement by volume (Portland Cement Association). Cement accounts for almost all of the CO_2 emissions associated with the manufacture of conrete. The cement emission factors provided by AP-42 cover a wide range of processing technologies and emission factors, so ENVIRON used the cement emission factor provided by the Battelle report.

3. From AP-42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7. ENVIRON assumed an average emission factor from batch mix hot asphalt plants and drum mix hot asphalt plants.

4. Because the manufacture of cement is the main contributor to CO_2 emissions in the production of concrete, ENVIRON assumed that the emissions from the manufacture of cement are equal to the emissions from the overall manufacture of concrete.

Abbreviations:

CO_2 = carbon dioxide
yd^3 = cubic yard
MGD = million gallons per day

Sources:

Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.
EPA AP42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7.
http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf

CH2MHill. Conceptual Design Report: Newhall Ranch Water Reclamation Facility, Los Angeles County, California. July 31, 2006.

Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp

Zhang, Z. and Wilson, F. Life-Cycle Assessment of a Sewage-Treatment Plant in South-East Asia. J.CIWEM, 2000, 14, February.
Kiewit. South Bay Water Reclamation Plant. http://www.kiewit.com/markets/pro_2098031.html
AP-42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

Table 4
Greenhouse Gas (GHG) Emissions from Transportation of Buildings and Infrastructure Raw Materials
Mission Village
Newhall Ranch, CA

Material	Total Mass Transported[2]	Distance from Source Location			Mass-Distance[5]			Emission Factor[6]		Emissions to Transport to Construction Site[7]			
		Santa Clarita Valley[3]	San Fernando Valley[3]	Port of Los Angeles[4]	Santa Clarita Valley	San Fernando Valley	Port of Los Angeles	Rail	Trucks	Santa Clarita Valley	San Fernando Valley	Port of Los Angeles	Total
	(tonnes material)	(miles)			(tonne-miles)			(grams CO_2/tonne-mile)		(tonnes CO_2)			
Infrastructure													
Concrete[1]	40,244	12	20	50	241,462	402,437	--	26	253	61	102	--	**163**
Asphalt	26,921	12	20	50	148,604	247,674	107,684			38	63	27	**128**
TOTAL													**291**

Notes:

1. For manufacturing emissions, only the amount of cement is considered; however, for transportation emissions, the entire mass of concrete is considered because the concrete mix is transported from the source locations.

2. Mass of material is estimated using the quantities provided for Newhall Ranch and scaling by total building area. Moving a tonne of asphalt is assumed to be as energy intensive as moving a tonne of concrete.

3. Distances from the Santa Clarita Valley and San Fernando locations are provided by Newhall.
4. Distance from the Port of Los Angeles is estimated using Google Earth.
5. Mass distance is the mass of material multipled by the distance traveled. Newhall estimates that half of the concrete and asphalt come from the Santa Clarita Valley source and the other half come from the San Fernando Valley Source. The petroleum used in the asphalt comes from the Port of Los Angeles. Asphalt is roughly 92% by weight aggregate, so ENVIRON assumed that the remaining 8% is representative of the mass of petroleum transported from the Port of Los Angeles.
6. Emission factors for rail and truck calculated from DOE EERE energy intensity indicators. EERE data is presented in Btu / ton mile. These were converted using AP-42 conversion factors for energy in different types of fuel, and CCAR GRP emission factors for mass CO_2 emitted per gallon of fuel. Rail and Trucks are assumed to run on diesel.
7. Emissions calculated by multiplying the mass-distance by the emission factor. Because of the close proximity of the source locations to Newhall, ENVIRON conservatively assumed that all materials will be transported by truck. The emission factor for rail transportation is significantly lower; transporting materials by rail instead of truck will result in lower emissions.

Sources:

DOE EERE energy intensity indicators. http://intensityindicators.pnl.gov/trend_data.stm Transportation sector data.

AP42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

Table 5
Summary of Life Cycle Greenhouse Gas (GHG) Emissions from Buildings and Infrastructure
Mission Village
Newhall Ranch, California

Emissions Source[1]		Emissions from Manufacture of Materials[3]	Emissions from Transportation of Materials[4]	Total Emissions	Assumed Lifetime of Emissions Source[5]	Total Annualized Emissions[6]	Total Annual Emissions[7]	LCA Fraction of Total Emissions[8]
		(tonnes CO_2)			(years)	(tonnes CO_2 / year)	(tonnes CO_2 / year)	(%)
Buildings[2]	Low Estimate	22,930		22,930	40	573	61,284	0.9%
	High Estimate	247,140		247,140		6,178		10.1%
Infrastructure		4,206	291	4,497		112		0.2%
TOTAL		27,428 - 251,637		27,428 - 251,637		686 - 6,291		1.1% - 10%

Notes:
1. ENVIRON estimated LCA emissions from two sources: buildings and infrastructure.
2. Emissions from buildings are shown as a range from a low to a high estimate based on the range presented in Table 1. The values in Table 1 are multiplied by the assumed lifetime of of 40 years to yield total emissions in tonnes CO_2.
3. Emissions from the manufacture of materials for infrastructure are from Table 3.
4. Emissions from the transportation of materials for infrastructure are from Table 4.
5. The assumed lifetime of emissions source may be adjusted; here ENVIRON has assumed a conservatively short lifetime of 40 years.
6. Total emissions are divided by the assumed lifetime of emissions sources to yield the total annualized emissions.
7. From the Climate Change Technical Report.
8. The LCA fraction of total emissions is calculated by dividing the total annualized emissions by the total emissions.

Abbreviations:
CO_2 = carbon dioxide
LCA = Life Cycle Assessment

Sources:
Values are calculated using Tables 1 through 4 and the emissions presented in the Climate Change Technical Report.

APPENDIX E
Utilities Technical Report

Utilities Technical Report
Mission Village

April 2010

Prepared for:

Newhall Land
Valencia, CA

Prepared by:

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Emeryville, CA

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Tables

Table 1 Summary of Electricity Usage for Mission Village
Table 2 Summary of Natural Gas Usage for Mission Village

Acronyms

BARBD	Building America Research Benchmark Definition
CEC	California Energy Commission
CEUS	California Commercial End-Use Survey
DU	dwelling unit
kWh/yr	kilowatt hours per year
MVCCTR	Mission Village Climate Change Technical Report
MMBTU/yr	million British Thermal Units per year
SCE	Southern California Edison
SCGC	Southern California Gas Company

1.0 EXECUTIVE SUMMARY

Mission Village is a proposed mixed use community within the approved Newhall Ranch Specific Plan area. This community would be located in northern, unincorporated Los Angeles County, within the Santa Clarita Valley planning area. The Mission Village development would contain 4,412 residences, including 382 single-family homes and 4,030 multi-family units; up to 1,703,100 square feet of commercial and mixed-use space; as well as a library, schools, fire station, recreation facilities, and various road improvements.

In this report, ENVIRON summarizes the overall electricity and natural gas use for Mission Village reported in the Mission Village Climate Change Technical Report (MVCCTR), dated April 2010. Close reference to the MVCCTR should be made when reviewing this report to better understand the energy use estimations presented below.

Buildout of Mission Village would place new demands on electrical and natural gas services provided by Southern California Edison (SCE) and Southern California Gas Company (SCGC). Tables 1 and 2 show the Mission Village annual electricity and natural gas usage. These tables show two scenarios: the baseline energy use (i.e., the standard energy use associated with buildout of residential and non-residential buildings in compliance with the 2008 Title 24 standards,[1] and the standard operation of recreation center pools), and the Mission Village energy use (i.e., the energy use associated with buildout of residential and non-residential buildings that are 15 percent more energy efficient than required by the 2008 Title 24 standards, and the use of solar heating at all recreation center pools). The Mission Village scenario results in future electricity and natural gas use of 46,948,413 kWh/yr and 168,728 MMBTU/yr, respectively. The baseline scenario results in future electricity and natural gas use of 50,292,202 kWh/yr and 223,429 MMBTU/yr, respectively. Some of the electricity reported here, for both the Mission Village and baseline scenarios, is for water conveyance that will not be spent in the area; therefore, infrastructure for that need not necessarily be included.

2.0 ESTIMATION OF ANNUAL ELECTRICITY AND NATURAL GAS USAGE FROM RESIDENTIAL BUILDINGS

Residential buildings include single-family homes, attached homes, apartments, and condominiums. This section describes the methods used to estimate the electricity and natural gas use associated with activities in those buildings.

ENVIRON calculated annual electricity and natural gas use for each residential building type as described in the MVCCTR. The project applicant has committed to (i) a 15 percent improvement over 2008 Title 24 standards for all residential buildings and (ii) a renewable electricity equivalent for all single-family detached homes. In this Utilities Technical Report, ENVIRON incorporated the 15 percent improvement over Title 24, but did not account for renewable energy, as it is uncertain if the renewable energy commitment made by the project applicant would come from the utility provider or from local distributed generation. If this renewable energy was to come from the utility provider, the transmission and distribution systems needed to deliver the electricity would be the

[1] Title 24 – California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code

same as if there were no renewable electricity. Therefore, in an effort to be conservative, ENVIRON estimated the electricity use assuming the renewable portion would come from the utility provider.

To calculate overall electricity and natural gas usage, ENVIRON multiplied the number of dwelling units for each housing type by the annual electricity and natural gas usage per dwelling unit. The total electricity and natural gas usage from these three housing types is given in Tables 1 and 2.

If the residential units at Mission Village are minimally compliant with the 2008 Title 24 standards (i.e., the baseline scenario), the total electricity and natural gas use is estimated to be 18,400,291 kWh/yr and 178,395 MMBTU/yr, respectively. The total electricity and natural gas use in residential buildings in Mission Village, assuming the residential dwellings are 15 percent more efficient than the 2008 Title 24 standards require, is estimated to be 17,643,509 kWh/yr and 156,055 MMBTU/yr, respectively.

3.0 ESTIMATION OF ANNUAL ELECTRICITY AND NATURAL GAS USAGE FROM NON-RESIDENTIAL BUILDINGS

Non-residential buildings include all structures, except residences, that may exist in a development, such as government, municipal, commercial, retail, and office space. This section describes the methods used to estimate the electricity and natural gas use associated with activities in those buildings.

As detailed in the MVCCTR, the overall electricity and natural gas use for Mission Village non-residential buildings was calculated based on data provided in the 2006 California Commercial End-Use Survey (CEUS), as developed by the California Energy Commission (CEC); see the MVCCTR for detailed calculations and methodologies.

ENVIRON calculated annual electricity and natural gas use for each type of non-residential building as described in the MVCCTR. The project applicant has committed to (i) a 15 percent improvement over the 2008 Title 24 standards for all non-residential buildings, and (ii) a renewable electricity equivalent for every 1,600 square feet of roof space (approximately 8% of the rooftop building space). In this Utilities Technical Report, ENVIRON incorporated the 15 percent improvement over Title 24, but did not account for renewable energy, as it is uncertain if the renewable energy commitment made by the project applicant would come from the utility provider or from local distributed generation. If this renewable energy was to come from the utility provider, the transmission and distribution systems needed to deliver the electricity would be the same as if there were no renewable electricity. Therefore, in an effort to be conservative, ENVIRON estimated the electricity use assuming the renewable portion would come from the utility provider.

To calculate overall electricity and natural gas usage, ENVIRON multiplied the building type-specific annual electricity and natural gas usage per square footage by the total square footage for that building type. The total electricity and natural gas usage from these three housing types is given in Tables 1 and 2.

If the non-residential buildings at Mission Village are minimally compliant with the 2008 Title 24 standards (i.e., the baseline scenario), the total electricity and natural gas use is estimated to be 24,242,382 kWh/yr and 14,763 MMBTU/yr, respectively. The total electricity and natural gas use

in non-residential buildings in Mission Village, assuming the residential dwellings are 15 percent more efficient than 2008 Title 24 requires, is estimated to be 21,655,375 kWh/yr and 12,673 MMBTU/yr, respectively.

4.0 ESTIMATION OF ANNUAL ELECTRICITY AND NATURAL GAS USAGE FROM MUNICIPAL SOURCES

Municipal sources include public lighting and the supply, treatment, and distribution of water and wastewater. These sources use electricity, but do not use natural gas. The MVCCTR calculates electricity usage for these sources based upon CEC data. Mission Village municipal sources will use 6,554,382 kWh/yr. Here, we conservatively list baseline and Mission Village electricity use as the same value. Most of the municipal electricity use is for water conveyance, and most of that will not be spent in the area. Therefore, infrastructure for water conveyance electricity use need not necessarily be included.

5.0 ESTIMATION OF ANNUAL ELECTRICITY AND NATURAL GAS USAGE FROM RECREATIONAL CENTERS (POOLS)

As described in the MVCCTR, ENVIRON assumed that outdoor competition-size swimming pools would be the main sources of energy use in Mission Village recreation centers. The project applicant has committed to using solar heating to heat the pools; pools will not use natural gas for heating. The baseline scenario, which uses traditional natural gas heating, would use 30,271 MMBTU/yr, as calculated in the MVCCTR. Table 1 lists electricity required to run the pool filter pumps as calculated in the MVCCTR. The Mission Village pools' electricity usage is equivalent to the baseline electricity usage, a total of 1,095,147 kWh/yr.

6.0 OVERALL ELECTRICITY AND NATURAL GAS USE

Tables 1 and 2 show the future electricity and natural gas use at Mission Village. These tables present two scenarios: the baseline scenario represents Mission Village without certain energy efficiency project design features, and the Mission Village scenario incorporates energy efficient project design features. The baseline total electricity and natural gas use are 50,292,202 kWh/yr and 223,429 MMBTU/yr, respectively. Mission Village total electricity and natural gas use are 46,948,413 kWh/yr and 168,728 MMBTU/yr, respectively. Mission Village, therefore, uses 7% less electricity and 24% less natural gas than the baseline scenario.

Residential buildings, if minimally compliant with the 2008 Title 24 standards, would account for electricity and natural gas use of 18,400,291 kWh/yr and 178,395 MMBTU/yr, respectively. Residential buildings, if 15% more efficient than the 2008 Title 24 standards require, would account for electricity and natural gas use of 17,643,509 kWh/yr and 156,055 MMBTU/yr, respectively. Therefore, residential buildings use 4% less electricity and 13% less natural gas than minimally Title 24 compliant buildings.

Non-residential buildings, if minimally compliant with the 2008 Title 24 standards, would account for electricity and natural gas use of 24,242,382 kWh/yr and 14,763 MMBTU/yr, respectively. Non-residential buildings, if 15% more efficient than the 2008 Title 24 standards require, would

account for electricity and natural gas use of 21,655,375 kWh/yr and 12,673 MMBTU/yr, respectively. Therefore, non-residential buildings use 11% less electricity and 14% less natural gas than minimally Title 24 compliant buildings.

Recreation centers (pools) would use of 30,271 MMBTU/yr of natural gas if the pools were heated using traditional natural gas heaters. If heated with solar heating systems, as proposed, the pools would require no natural gas. This is a 100% natural gas savings over the baseline scenario.

7.0 UNCERTAINTIES IN ELECTRICITY AND NATURAL GAS CALCULATIONS

It should be noted that that the calculations presented above rely on assumptions made in the MVCCTR. These assumptions, and the uncertainties that result from them, are restated below:

Residential

- Although all buildings in the development will be Title 24 compliant, Title 24 does not specify building dimensions (e.g., size, height, or orientation). Title 24 also provides significant flexibility for window types, window amounts, insulation choice, and other parameters. This uncertainty is expected to neither over- nor underestimate emissions. Title 24 grants enough flexibility that if a designer puts in more windows than is "allowed" under the prescriptive measures, the energy efficiency losses can be offset by improving the window quality, or installing a more efficient HVAC system. Although it is unknown how exactly the buildings will be designed, each home will be Title 24 compliant, and thereby all design features of the home that make it less energy efficient will be offset by design features that make it more energy efficient.
- Energy use will vary considerably depending upon the design of the home. The residential units to be built in Mission Village will vary considerably in size, layout, and overall design. The parameters used here are intended to represent the upper quartile of homes relative to sizes in each category. As such, energy use from the homes that will actually be built in Mission Village are anticipated to be lower.
- Built environment energy use will vary considerably depending upon the homeowners' habits regarding energy use. For instance, homeowners determine the set point of thermostats, the duration of showers, the usage of lights, if they are to have a second refrigerator, and the temperature of the refrigerator, among other things. The project applicant will have little, if any, influence over homeowner behavior. Current median behavior attributes are presented here. To the extent that individuals are becoming more energy conscious, this will tend to overestimate energy use in the future.
- Plug-in energy use will vary considerably depending upon the appliances, lights, and other plug-ins installed by the homeowner. The project applicant will have little, if any, influence over these choices made by the homeowner. As above, the current median behavior attributes are presented here. To the extent that individuals are becoming more energy conscious, or appliances are becoming more energy efficient, this will tend to overestimate energy use in the future.

Non-Residential

- For new developments, the exact types of buildings are typically unknown. As such, not all building categories that may actually exist in Mission Village are represented in this analysis. However, all of the non-residential building area is accounted for and the best available assessment of the building type composition of Mission Village was used.
- Although it is unknown exactly how the buildings will be designed, each building will be Title 24 compliant. Therefore all design features of the building that make it less energy efficient will be offset by design features that make it more energy efficient.

Table 1
Summary of Electricity Usage for Mission Village
Mission Village
Newhall, California

Source	Annual Electricity Usage			Improvement over Baseline
	Unit	Baseline[4]	Mission Village[4]	
Residential[1]	kWh/yr	18,400,291	17,643,509	4%
Non-Residential[1]		24,242,382	21,655,375	11%
Municipal[2]		6,133,350	6,133,350	0%
Recreational (Pools)[3]		1,095,147	1,095,147	0%
Total		**49,871,169**	**46,527,381**	**7%**

Notes:
1. Baseline annual electricity usage reflects the electricity usage from residential and non-residential buildings which are minimally compliant with 2008 Title 24 standards. The calculation of Mission Village annual electricity usage incorporates Newhall's commitment to 15% better than 2008 Title 24 for residential and non-residential buildings. Although Newhall committed to using renewable electricity equivalent to putting photovoltaic systems on all single family detached residences and on every 1,600 square feet of roof space (approximately 8% of the rooftop building space) of non-residential buildings, ENVIRON did not incorporate this electricity savings in this Utilities Technical Report, as it is uncertain if the renewable energy would come from the utility provider or from local distributed generation.
2. Baseline Municipal electricity usage is equivalent to the Mission Village Municipal electricity usage. Most of the municipal energy use is for water conveyance, and most of that will not be spent in the area, therefore, infrastructure for that need not necessarily be included.
3. Recreation Center (Pools) electricity usage reflects the amount of electricity required to run the pool filter pumps. The Mission Village electricity usage is expected to be equivalent to the Baseline electricity usage.
4. See individual category footnotes for the definitions of Baseline and Mission Village annual electricity usage.

Abbreviations:
kWh - kilowatt-hour
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code
yr - year

Table 2
Summary of Natural Gas Usage for Mission Village
Mission Village
Newhall, California

Source	Annual Natural Gas Usage			Improvement over Baseline
	Unit	Baseline[3]	Mission Village[3]	
Residential[1]	MMBTU/yr	178,395	156,055	13%
Non-Residential[1]		14,763	12,673	14%
Recreational (Pools)[2]		30,271	0	100%
Total		**223,429**	**168,728**	**24%**

Notes:

1. Baseline annual natural gas usage reflects the natural gas usage from residential and non-residential buildings which are minimally compliant with 2008 Title 24 standards. The calculation of Mission Village annual natural gas usage incorporates Newhall's commitment to 15% better than 2008 Title 24 for residential and non-residential buildings.
2. Baseline annual natural gas usage reflects the amount of natural gas required to heat Recreation Center pools using traditional heaters. The calculation of Mission Village annual natural gas usage incorporates Newhall's committment to using solar heating rather than natural gas heating for all Recreation Center pools.
3. See individual category footnotes for the definitions of Baseline and Mission Village annual natural gas usage.

Abbreviations:

MMBTU - Million British Thermal Units
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code
yr - year

APPENDIX F
Existing Conditions Analysis

Summary of Existing Emissions
This appendix summarizes ENVIRON International Corporation's (ENVIRON) estimates for existing greenhouse gas (GHG) emissions associated with the project site.

By way of background, the applicant periodically leases the Mission Village area to the movie industry for set locations. Minor existing on-site structures within the Mission Village area include employee houses, an oil company office, and miscellaneous structures. Portions of the Mission Village area are leased for cattle grazing and agricultural operations. All existing emission sources would be eliminated during project buildout.

In light of the existing conditions, ENVIRON evaluated the following sources that currently exist on the project site:

1. Farmland/Agricultural Operations
    a. Water use
    b. Fertilizer
    c. Equipment

Please note that emissions associated with the periodic lease of the Mission Village area to the movie industry were not accounted for in this emissions estimate as such activities are intermittent, limited, and unpredictable. Additionally, the emissions estimate does not account for the minor existing structures within the Mission Village area due to the lack of data for these accessory structures. Finally, the cattle grazing and ranching activities were not accounted for as the lease of the project site for such uses is minimal. Because the emissions estimate does not fully account for these existing emission sources, the estimate likely understates existing emission levels on the project site.

That said, ENVIRON estimated the emissions associated with existing site conditions, and particularly farmland, to be roughly 363 metric tonnes of CO_2e per year (Table B2).

Farming/Agricultural Operations
Table B1 outlines ENVIRON's approach to calculating GHG emissions from farming operations that would be eliminated due to project buildout. GHG emissions include indirect emission associated with estimated water use, and direct emissions associated with fertilizer and equipment use. A variety of crops currently is grown on the site; however, because of limited data availability, ENVIRON relied upon general crop water use factors, general corn fertilizer factors, and general barley equipment-use factors. ENVIRON does not expect these assumptions to systematically over- or under-estimate actual emissions. ENVIRON then used appropriate emission factors to determine GHG emissions from water use, fertilizer emissions, and equipment fuel use.

Table B1 - Baseline Conditions
FARMING

Description	Activity Data	Units	Source(s)
Area of disturbed farmland	224	acres	Mission Village Climate Change Technical Report
US average amount of water used for irrigation, in 2003	1.65	acre-feet water/acre irrigated	USDA. *Farm and Ranch Irrigation Survey (2003).* Table E (PDF page 20). (available from: http://www.agcensus.usda.gov/Publications/2002/FRIS/fris03.pdf Accessed April 9, 2010).
Total acre-feet used	370	acre-feet	Calculations: Area of disturbed farmland * US average amount of water used for irrigation, in 2003
kWh/acre-foot	3,170	kWh/acre-foot	Chino estimate. Mission Village Climate Change Technical Report
Electricity use for water	1,171,632	kWh/year	Calculations: Total acre-feet used x kWh/acre-foot
Crop grown on an acre, per year	3,421	kg	Source: US Life Cycle Inventory (via SimaPro). "Corn, at field/kg/US". Included processes: Initially derived from data on farming of corn on 1 planted acre for 1 year (**yield=3421kg**). The module includes: - seed production, - tillage, - fertilizer and pesticide application, - crop residue management, - irrigation, - harvesting. Remark: Agricultural Crop Production, Harvested acres represent 91% of the planted acres (1998-2000 US average). 1 bu (corn) = 56 lbs. The impacts of producing 1 kg of seed are assumed equal to those of producing 1kg of grain.
Nitrogen fertilizer required to produce 1 kg of crop	0.0169	kg	Ibid.
Nitrogen fertilizer required for one acre of crop production	57.7	kg	Calculations: Crop grown on an acre, per year x Nitrogen fertilizer required to produce 1 kg of crop
Nitrogen fertilizer required for acreage	12,934	kg	Calculations: Area of disturbed farmland x Nitrogen fertilizer required for one acre of crop production
N2O Emission Factor for emissions from N inputs	1%		UNFCCC Clean Development Mechanism. "Estimation of direct nitrous oxide emission from nitrogen fertilization" Page 3. (Available from: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-07-v1.pdf Accessed April 10, 2010)
Total N2O Emissions	129	kg	Calculations: Nitrogen fertilizer required for acreage x N2O Emission Factor for emissions from N inputs
Total N2O Emissions (in CO2e)	40,097	kg	Calculations: Total N2O Emissions * GWP of N2O using IPCC Second Assessment Report references (310)
Tractor diesel fuel usage rate	6	gallons/acre	USDA estimates that the typical cropping and tillage system in the area requires six gallons of diesel per acre of barley.
Diesel fuel usage for acreage	1,344	gallons	Calculations: Area of disturbed farmland * Tractor diesel fuel usage rate

Acronyms:
bu - bushel
CO2e - carbon dioxide equivalents
GWP - global warming potential
hp - horsepower
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kW - kilowatts
kWh - kilowatt-hour
lb - pound
N - nitrogen
N2O - nitrous oxide

UNFCCC - United Nations Framework Convention on Climate Change
USDA - Unites States Department of Agriculture

Table B2 - Baseline Conditions
TOTAL EMISSIONS

Description	Emissions	Units	Source(s)
Energy use associated with water	310	tonnes CO2e	Calculations: 582.7 lbs per MWh/2,205 lbs per metric ton x Electricity use for water / 1000 kWh per MWh. The Mission VIllage 2010 RPS emission factor is 582.7 lbs CO2/MWh.
N2O emissions associated with fertilizer use	40	tonnes CO2e	Calculations: Total N2O Emissions (in CO2e) / 1000 kg per metric ton
Diesel fuel usage	14	tonnes CO2e	Calculations: Diesel fuel usage * 10.15 kg CO2 per gallon / 1000 kg per metric ton. 10.15 kg CO2 is produced by combusting one gallon of diesel fuel. This data is from The Climate Registry's General Reporting Protocol, Table 13.1.
TOTAL EMISSIONS	363	tonnes CO2e	

Acronyms:
bu - bushel
CO2e - carbon dioxide equivalents
kg - kilogram
kWh - kilowatt-hour
lb - pound
MWh - megawatt-hour
RPS - renewable portfolio standard

GSI Water Solutions, Inc., "Technical Memorandum Regarding Potential Effects of Climate Change on Groundwater Supplies for Newhall Ranch Specific Plan, Santa Clarita Valley, California," March 18, 2008

Technical Memorandum

To: Susan Tebo – Impact Sciences, Inc.

From: John Porcello – GSI Water Solutions, Inc.

Date: March 18, 2008

Re: Potential Effects of Climate Change on Groundwater Supplies for the Newhall Ranch Specific Plan, Santa Clarita Valley, California

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Introduction

This technical memorandum (TM) evaluates the potential effects of future climate change on the groundwater supplies for the Newhall Ranch Specific Plan (Specific Plan) development. As discussed in the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, 2001), Alluvial Aquifer groundwater wells along the Santa Clara River west of Interstate 5 (I-5) (see Figure 1) will provide 7,038 acre-feet (AF) of water to the Specific Plan development on an annual basis. This water will be provided by converting historical and present-day Alluvial Aquifer groundwater pumping (by The Newhall Land and Farming Company) from agricultural uses to urban uses. Notably, no additional groundwater pumping over historical and present amounts will occur; instead, water currently used to irrigate crops on Newhall Land's property will be treated and used to meet most of the potable water needs of the Specific Plan development's urban uses (e.g., residential; nonresidential; etc.).

GSI Water Solutions, Inc. (GSI) prepared this TM at the request of Impact Sciences, Inc., to specifically address whether future climate change may preclude the Alluvial Aquifer from providing sufficient yield to accommodate the future water demand of the Specific Plan development. The remainder of this TM discusses the following:

- The climate of the Santa Clarita Valley;
- An overview of the current understanding of future potential changes in temperature, annual rainfall, and rainfall timing and intensity (statewide and in southern California);

- The corresponding influence of rainfall and temperature changes on groundwater recharge to the Alluvial Aquifer in the Santa Clarita Valley as understood to date, including ongoing work by the local water purveyors to study this further; and

- A summary of historical data that indicate how the Alluvial Aquifer west of I-5 may be affected in the future (as gathered from records of historical fluctuations in local hydrologic and groundwater conditions).

Local Climate

The climate of the Santa Clarita Valley is discussed by CH2M HILL (2004). The valley has a semi-arid Mediterranean-type climate, characterized by long, dry summers and relatively short, wet winters. Temperatures in the valley range from a minimum of 20 to 30 degrees Fahrenheit (°F) in the winter to a maximum of approximately 100 to 110°F during the summer. Mean monthly temperatures range between approximately 48°F in the winter and 77°F in the summer.

The average rainfall since the 1880s, and also since 1950, has been approximately 18 inches per year, but varies considerably from year to year (ranging from less than 5 inches to nearly 50 inches). Additionally, rainfall is not only variable on an annual basis, but is also highly seasonal. Approximately 80 percent of the annual precipitation in the valley falls between November and March. Most of the precipitation comes from winter storms that last only a few days and are separated by relatively long periods of clear weather. Additionally, as shown in Figure 2, rainfall patterns vary considerably across the watershed because of the considerable variation in topography and the watershed's location between the coastal climates in Ventura County and the inland deserts to the east.

The major sources of natural recharge to Alluvial Aquifer groundwater include deep percolation (infiltration) of direct precipitation within the valley, and percolation of stream runoff flowing into the valley along the Santa Clara River and its tributaries. Recharge occurs primarily in the eastern portion of the valley, as conceptually shown in Figure 3. Natural groundwater discharge occurs primarily in the western portion of the valley (west of Interstate 5 [I-5]), occurring as discharge to the Santa Clara River and evapotranspiration by the riparian vegetation growing along the river corridor.

Global-Scale and Regional-Scale Predictions of Future Rainfall and Temperature Trends

Considerable research and predictive modeling work have been performed by climatologists and other scientists to understand the nature of historic and future global-scale climate changes. The largest body of this work has been conducted under the auspices of the Intergovernmental Panel

on Climate Change (IPCC), which has published four comprehensive assessment reports since 1990, with the most recent reports issued in 2007 (IPCC, 2007a and 2007b).

Additionally, in 2006, the California Department of Water Resources (DWR), the California Climate Change Center (CCCC), and the California Climate Action Team (CAT; an inter-agency team managed by the California Environmental Protection Agency) published several studies evaluating the potential effects of climate change on the water resources of the State of California. These California-specific studies focus primarily on the central and northern parts of the state, where rainfall and snowfall provide water to two statewide water delivery systems (the State Water Project [SWP] and the Central Valley Project [CVP]). However, the state studies and other literature do provide some insight as to the nature of potential future climate changes in southern California. The discussion below focuses on the low-elevation mountains and valleys that are characteristic of much of the South Coast Hydrologic Region (as defined by DWR), which includes the Santa Clara River watershed.

As discussed by CCCC (2006a) and Milly (2007), global climate models (GCMs) have not been designed to support hydrologic analysis. The GCMs describe continental water fluxes and processes at very large scales. For example, two GCMs evaluated by Cayan et al. (2008) rely on a grid containing rectangular cells that are 137 to 186 miles long. The use of a discrete global grid renders the GCMs too coarse to adequately depict the complex structure of temperature and precipitation that characterizes and distinguishes each of the DWR Hydrologic Regions. Additionally, the various GCMs that have been developed by the research community and incorporated into the IPCC assessments vary in design and incorporate varied assumptions, thereby providing different results regarding the potential magnitude of future changes in rainfall and temperature in various parts of the world (including southern California).

In general, the GCMs agree that temperatures will continue to rise globally for the next several decades and that longer-term temperature trends will depend on the magnitude of future greenhouse gas emissions. As noted by the IPCC (2007a), the GCMs also predict that precipitation increases are very likely in high latitudes, while decreases are likely in most subtropical regions. However, there is somewhat less agreement among the GCMs regarding future precipitation changes. As explained by CCCC (2006b), the variability and uncertainty in the GCMs arises in part because of uncertainties about the “feedbacks” that might amplify or lessen global warming. For example, as heat-trapping emissions cause temperatures to rise, the atmosphere can hold more water vapor, which traps heat and raises temperatures further—a positive feedback. Clouds created by this water vapor could absorb and re-radiate outgoing infrared radiation from Earth’s surface (another positive feedback) or reflect more incoming shortwave radiation from the sun before it reaches Earth’s surface (a negative feedback). Because many of these processes and their feedbacks are not yet fully understood, they are represented somewhat differently in each GCM.

The GCMs also do not account for elevation-related differences in rainfall and recharge patterns, which are important at the local scale (e.g., DWR-designated hydrologic regions and individual

watersheds). To account for the importance of elevation at the local scale, researchers have taken the GCMs and "down-scaled" them to create regional models that estimate the spatial variability in future rainfall and temperature trends in California (CCCC, 2006c; DWR, 2006). The down-scaling process consists of using statistical techniques and local, physically based hydrologic models to "downscale" the GCMs to a finer spatial resolution. This procedure "distributes" the GCM predictions over the complex landscape of California. Because the distribution procedure required to acquire local-scale projections is dependent upon the simulation results from the GCMs, the individual regional models (like their GCM counterparts) also create different projections of future climate trends. Nevertheless, taken together, the GCMs and regional-scale models are useful for understanding the general magnitudes of changes in temperature and rainfall patterns that could occur in the future as a result of global warming.

In summary, the regional-scale climatologic modeling work conducted by DWR, CAT, and CCCC indicates the following:

1. On a statewide basis, the various models indicate that there will be relatively little change in annual precipitation, with a tendency toward slightly greater winter precipitation and lower spring precipitation (CAT, 2006). Dettinger (2005) summarized the primary finding from these same models as follows: "The distribution of precipitation changes includes both positive and negative changes that cluster with little change around present-day averages." CCCC (2006a) notes that the models project that (a) variability in precipitation on a year-to-year and decade-to-decade time-scale will continue, as in the past; and (b) the frequency of warm tropical events (El Niños) will remain about the same, creating anomalous precipitation patterns in California. The models, as a group, also project that summer precipitation will change only incrementally, and may even decrease, indicating that there is little evidence for a stronger summer-time monsoon influence (CCCC, 2006a).

2. For southern California, average annual precipitation during the period 2035 through 2064 is projected to decrease only slightly, probably by less than ¼-inch per year, even under the scenario involving the highest IPCC estimate of future greenhouse gas emissions (DWR, 2006). During this period, average temperatures in southern California are projected to be 1.6 to 4.2°F (0.9 to 2.3°C) higher than present-day temperatures. Although these projections were published in 2006 (DWR, 2006), they are based on GCMs (and subsequent down-scaled regional models) that were developed in support of the IPCC's most recent (fourth) assessment of global climate change (IPCC, 2007a and 2007b).

There is evidence that these projected changes are similar to trends in the recent historical record. Specifically:

1. DWR (2006) discusses an analysis of rainfall records across the state from 1890 through 2002, using data compiled by former state climatologist James Goodridge. The analysis

indicates that average annual precipitation on a statewide basis appears to be relatively flat (no increase or decrease) over the entire record. However, the report notes that an upward trend in statewide precipitation may have occurred toward the latter portion of this period. The analysis also identified a very slight decrease in annual precipitation from 1890 through 2002 for both central California and southern California (amounting to about 0.77 inch during a 100-year period).

2. A statistical analysis of water-year (October through September) and April-July flows of four rivers in central-coast and south-coast watersheds found no statistical changes in flow in any of these rivers (DWR, 2006). This analysis included two river systems in metropolitan Los Angeles – the Santa Ana River (based on data from 1901 through 2005) and the Arroyo Seco near Pasadena (based on data from 1911 through 2005). The lack of statistically identifiable changes in the flows of these rivers is consistent with the slight decrease, if any, in southern California annual rainfall that has occurred since 1890.

While the historical data and the projections from GCMs and regional-scale climate models together suggest that a slight decrease in annual rainfall could occur, the possibility that rainfall could increase slightly also cannot be ruled out completely. DWR (2006) notes that the National Weather Service's Climate Prediction Center found evidence that annual precipitation has increased in much of California, the Colorado River Basin, and the West since the mid-1960s. Additionally, some GCMs have suggested that annual average rainfall could increase slightly in southern California (Bachelet et al., 2007, using analyses by Price et al., 2004).

Rainfall Timing and Intensity

Of equal, if not greater, importance to the question of how global climate change potentially could affect aquifer recharge is the timing and intensity of precipitation. As described by CH2M HILL (2004) and CH2M HILL and LSCE (2005), rainfall in the Santa Clarita Valley and southern California occurs predominantly during the winter months, and most groundwater recharge, therefore, occurs during that time of year. Most of the recharge to the Alluvial Aquifer occurs along the Santa Clara River corridor in the eastern part of the valley below the Lang stream gage – several miles east of the Specific Plan development (see Figures 1 and 3). During low flow events, recharge and river flow may occur only a short distance below the Lang gage, whereas during high flow events the river can recharge the groundwater as far downstream as the area between the Saugus water reclamation plant (WRP) and I-5. This recharge occurs mainly in response to heavy rainfall events that are sufficiently strong to create flow in the ephemeral reaches of the Santa Clara River (in the eastern part of the valley). This periodic river flow is an important source of recharge to the Alluvial Aquifer and occurs in some, but not all, years. The historical record shows several multi-year periods of little to no river flow (for example, 1984 through 1991 and 1999 through 2004), followed by brief periods of very high river flows and rapidly rising groundwater elevations in the eastern part of the valley where most of the recharge takes place (as occurred in 1992, 1993, 1998, and late December 2004 through January 2005).

On a global scale, the IPCC's most recent assessment (2007a) concluded that the frequency of heavy precipitation events and/or the proportion of total rainfall from heavy events has "likely" increased over most areas since 1960 and is "a very likely" trend for the 21st century. As discussed previously, CCCC (2006a) concluded that there will continue to be variability in California's precipitation on a year-to-year and decade-to-decade time-scale, as has been observed in the past. DWR (2006) concluded from a statistical analysis of the 1890-2002 historical statewide precipitation data that an increase in the variability of annual precipitation has occurred in the historical record and is a possible continued outcome of global climate change in the future. This finding by DWR was based on a 10-year moving average of mean and standard deviation values for statewide annual average precipitation, which showed end-of-period variability values about 75 percent larger than beginning-of-period values. This indicates that there tended to be more extreme wet and dry years at the end of the 20th century than occurred at the beginning of that century. DWR concluded that this trend may continue with on-going climate change.

DWR (2006) also noted that river flow records show evidence of a change in variability, as manifested by changes in flood flows (which are related to rainfall intensity). Specifically, from examination of streamflow records in another South Coast Basin watershed (the Santa Margarita River near Temecula), DWR found that the 10-year, 50-year, and 100-year flood flows have increased about 22 percent since 1955. Because this river and its watershed are in the same DWR hydrologic region as the Santa Clara River, this may be an indicator that the increasing variability and intensity of rainfall have begun creating larger high-flow events in rivers in southern California, and that this trend may continue in the future (including in the reach of the Santa Clara River that passes through the Santa Clarita Valley). The importance of river flows on groundwater recharge is discussed below.

Potential Effects on Groundwater Recharge (Current Knowledge and Ongoing Studies)

On a watershed scale, the amount of surface water runoff and groundwater recharge generated by individual storm event is controlled primarily by soil infiltration capacity, soil moisture levels, and evapotranspiration (ET) demands. ET consists of evaporation (vaporization) of water from soil and wet plant surfaces, and water uptake and subsequent transpiration by plants. DWR (2006) states that there are two reasons it is difficult to accurately estimate the effect of changes in global temperature on ET. First, no net change in ET will occur as long as the minimum temperature and dew point temperature continue to increase faster than the maximum temperature, as has occurred during the past five decades of global temperature rise. Second, the effect of increased air temperature on plant transpiration is at least partially offset by the increasing CO_2 concentrations that arise from increasing greenhouse gas emissions. Although these observations would suggest that ET demands could be small, it is also possible that ET demands could increase over time because of lengthening of the dry season and the corresponding decrease in the length of the rainy season.

Dettinger and Earman (2007) and Milly (2007) indicate that in general, a reduction in precipitation in the western United States would be expected to reduce runoff, which in turn potentially would decrease groundwater recharge as well. Milly (2007), citing a report by Milly et al. (2005) that discusses global-scale patterns of trends in streamflow and water availability, provides a map of the United States indicating that 90 percent of the GCMs predict decreases in annual runoff of 10 to 20 percent in California, Nevada, Utah, and western Colorado during the period 2041 to 2060, compared with runoff during the period 1900 through 1970.

Christensen and Lettenmaier (2007) down-scaled 11 GCMs to create corresponding regional-scale models for the Colorado River Basin, then used these models to project runoff trends in the basin for two future greenhouse gas emissions scenarios. They projected that on a basin-wide basis: (1) a 10 percent decrease or increase in winter-time rainfall would result in a 13 percent decrease and a 15 percent increase, respectively, in winter-time runoff; and (2) a 10 percent decrease or increase in summer-time rainfall would result in a 7 percent decrease and an 8.5 percent increase, respectively, in summer-time runoff. However, these researchers, as well as Dettinger and Earman (2007), point out that future changes in runoff could differ considerably for mountain ranges versus the alluvial fans and groundwater basins that lie below. This is because global warming would create more rain than snow, thereby reducing the amount of high-elevation snowpack available to recharge mountain groundwater supplies and instead creating unrecharged water that may run off into the fans and basins below. This potentially could increase recharge on fans and basin floors. Alternatively, if the unrecharged water is instead mostly evapotranspired from the mountain soils, then the overall recharge (mountain plus basin) may decline.

Because the boundaries of the Santa Clara River watershed lie in low-elevation mountains, rainfall is a far more significant contributor to the flow of this river than snowfall. Consequently, rainfall runoff from these mountains and from within the Santa Clarita Valley and other valleys can be expected to continue to be the predominant source of flow to the river, and therefore the predominant source of groundwater recharge. Additionally, future groundwater recharge potentially may increase because most recharge occurs during high-rainfall storm events, and climate change may intensify these events. However, the magnitude of potential increases or decreases in recharge is difficult to project.

Dettinger and Earman (2007) conclude that, in general, it is unknown whether groundwater recharge will increase, decrease, or stay the same “at any scale” in the western United States; and, while groundwater supplies may fare well, they also may fare poorly. They conclude that, in general, the tools and data are currently unavailable to allow for confident detection or prediction of groundwater responses to changes in climate. While this may be true in some locations, the water purveyors in the Santa Clarita Valley have a considerable “head start” on this process. Specifically:

- The agricultural and urban water purveyors in the valley have monitored groundwater levels and pumping volumes for many years. This monitoring began in the1940s, when groundwater was pumped exclusively for agricultural purposes, mainly in the western portion of the valley, and mainly from the Alluvial Aquifer. The historical record illustrates how the aquifer systems in the valley have responded over time as groundwater pumping has expanded to include urban uses, with the urban pumping extending into other portions of the valley, as well as into a deeper aquifer system (in the Saugus Formation).

- Rainfall and streamflow records are available in the valley, dating back to the early 1900s. These records have provided important information that the local water purveyors have used to understand the relationship between rainfall, streamflow, and groundwater recharge.

- In 2004, the local water purveyors completed the calibration of a detailed numerical model of the valley's groundwater systems, using the historical data for 1980 through 1999 to calibrate the model. The calibration process, described by CH2M HILL (2004), consisted of adjusting model parameters until the model was able to replicate the time-varying nature of groundwater elevations and streamflows across the valley. A later update (check) of the model's calibration identified that the model also was capable of simulating the hydrologic conditions that were observed from 2000 through 2004 (CH2M HILL, 2005).

The process of calibrating the groundwater model resulted in the derivation of a rainfall-runoff relationship for the Santa Clarita Valley. This relationship, shown in Figure 4, was developed for annual rainfall and runoff, and is based on a relationship derived by Turner (1986) for a large number of watersheds in California. Through the model calibration process, the empirical parameters contained in this relationship were adjusted to improve the model's simulation of recharge patterns and historic groundwater elevations and river flows. As shown in Figure 4, according to the final relationship that was established from this model calibration process, little recharge occurs when annual rainfall is less than 15 inches per year; recharge for the average rainfall of 18 inches per year is only about 2 inches per year; and years with rainfall of 32 inches or more can produce 10 inches per year or more of recharge (for example, as much as 20 inches per year of recharge can occur when rainfall is 45 inches).

During 2008, the local water purveyors will use this model to further evaluate how to manage pumping from the local groundwater system while maintaining its sustainability and will address in more detail the effect of global climate change on rainfall and recharge in the Santa Clarita Valley. Meanwhile, the historical record of rainfall, streamflows, and groundwater elevations in the Santa Clarita Valley provides evidence of how the Alluvial Aquifer has responded to other changes in the hydrologic system in the past. This evidence, which is discussed below, provides insight as to how the portion of the Alluvial Aquifer along the Santa Clara River corridor west of I-5 may respond to future changes in rainfall and recharge.

Evidence from Historical Fluctuations in Local Hydrology and Groundwater Conditions

Before 1970, agriculture was the predominant land use in the Santa Clarita Valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 AF per year (AF/yr). Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr again until 1993. Since then, pumping has ranged between about 33,000 and 43,000 AF/yr, and has averaged slightly less than 38,000 AF/yr.

Figure 5 shows trends in groundwater elevations since 1950 in two Alluvial Aquifer wells (NLF-C5 and NLF-C7) located near the western end of the basin (just west of I-5) and two Alluvial Aquifer wells (VWC-N and NLF-S) located 2 to 3 miles east of I-5. The charts in Figure 5 show how Alluvial Aquifer groundwater levels have varied in comparison with fluctuations in Alluvial Aquifer pumping, rainfall, municipal WRP discharges to the Santa Clara River, and seasonal low flows in the river. The charts show the following:

- In the area west of I-5, including the locations of Alluvial Aquifer wells that will provide water to the Specific Plan development, groundwater in the Alluvial Aquifer discharges to the river and is consumed by riparian vegetation located along the river corridor. Additionally, deeper Saugus Formation groundwater discharges to the overlying Alluvial Aquifer. Because this area is a regional groundwater discharge zone for the Saugus Formation (as illustrated in Figure 3), Alluvial Aquifer groundwater levels in this area have been relatively stable over time with only modest seasonal fluctuations, as shown by the hydrographs for wells NLF-C5 and NLF-C7. This stability has occurred despite annual variations in rainfall, increased WRP discharges to the river, and the corresponding increases in the river baseflow (which is displayed in Figure 5 as the flow during the lowest-flow month of each year).

- In the area just east of I-5, Alluvial Aquifer groundwater levels are more variable on a seasonal basis as shown in Figure 5 by the hydrographs for two Alluvial Aquifer wells (VWC-N and NLF-S) that are located in this area. Additionally, groundwater elevations in these wells rose as pumping decreased from the mid-1960s through the 1980s, then were relatively stable during the 1990s despite increased pumping from the Alluvial Aquifer.

The historical hydrographs for these four wells provide insight as to the potential future effects on the aquifer system of climate change-induced variations in groundwater recharge. Specifically, the figures show the historical effect on the Alluvial Aquifer of marked changes in groundwater pumping and surface water flows that began during the 1960s and continue to this

day. The hydrographs show that Alluvial Aquifer groundwater levels west of I-5 have shown little variation over time despite the following changes to the hydrologic system in the valley:

1. Decreased pumping upstream east of I-5 in the 1970s and 1980s, followed by increased pumping in this reach during the 1990s;

2. Fluctuations in annual rainfall;

3. Introduction of treated water discharges to the Santa Clara River during the 1960s and the steady increase in these flows since that time; and

4. Resulting increases in river flows, including summer-time (seasonal low) flows, since the 1960s.

In summary, Alluvial Aquifer groundwater levels along the Santa Clara River corridor west of I-5 are controlled less by pumping than by the discharge of Saugus Formation groundwater into the Alluvial Aquifer. This, in turn, indicates that groundwater levels in this portion of the groundwater system are relatively insensitive to changes in recharge compared with other portions of the valley. As discussed by CH2M HILL (2004), even the remainder of the valley historically has not shown long-term water level declines. Specifically, hydrographs in these areas indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above normal rainfall patterns return. Because the western part of the Alluvial Aquifer system (where some of the historical pumping would be converted from agricultural to urban water supplies for the Specific Plan development) occupies the regional groundwater discharge zone in the valley, it is unlikely that significant changes will occur to the aquifer system in this area, especially given that the climate projections indicate a continuance of the periodic large storm events that recharge the groundwater system in the valley.

Conclusions

The historical hydrograph records indicate that the groundwater resources in the western portion of the Santa Clarita Valley are relatively unaffected by local fluctuations in rainfall. Instead, as discussed in detail by CH2M HILL (2004) and CH2M HILL and LSCE (2005), the available data and groundwater modeling simulations indicate that rainfall fluctuations primarily affect groundwater levels and groundwater availability in the easternmost portion of the valley, where most of the recharge occurs to the Alluvial Aquifer. Consequently, if rainfall and groundwater recharge rates were to decline in the future because of climate change, these changes are likely to be fairly small as indicated by the various climatologic studies (discussed previously in this TM) that have been conducted by the various California state agencies involved in water resources management and planning. For this reason, and also because of the well-developed understanding to date of the valley's hydrology and its shallow and deep aquifer systems, it is

anticipated that only minor fluctuations in groundwater levels will occur in the Alluvial Aquifer west of I-5, and that these fluctuations will not reduce the availability or sustainability of Alluvial Aquifer groundwater in this area.

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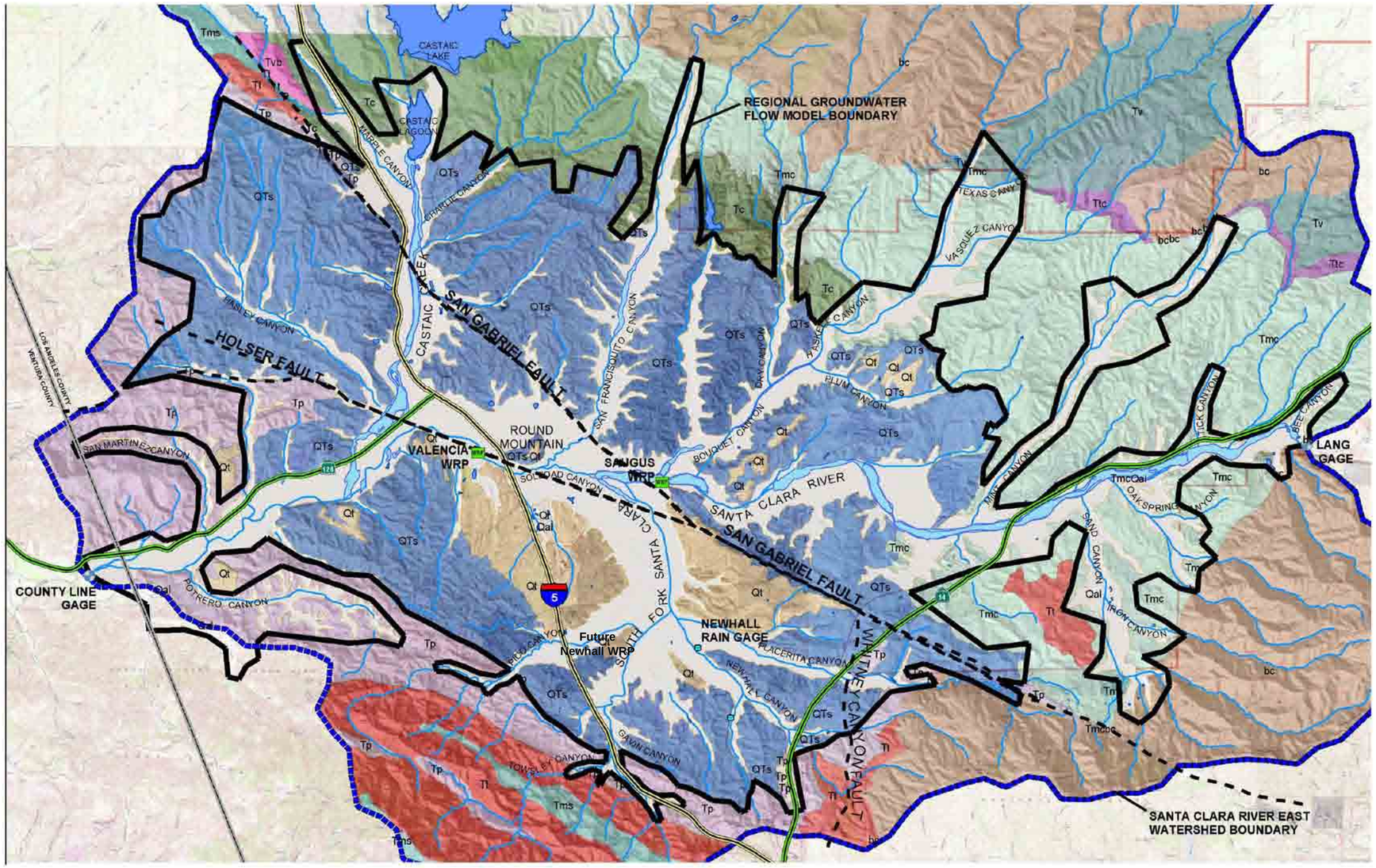

Newhall Ranch

Santa Clarita

Ventura County

Los Angeles County

LEGEND

NEWHALL RANCH

VALENCIA WATER COMPANY MUNICIPAL WELLS FOR NEWHALL RANCH

GEOLOGY

- UNDIFFERENTIATED ALLUVIUM (Qal)
- TERRACE DEPOSITS (Qt)
- SAUGUS FORMATION (QTs)
- PICO FORMATION (Tp)
- TOWSLEY FORMATION (Tt)
- MODELO FORMATION (Tms)
- CASTAIC FORMATION (Tc)
- VIOLIN BRECCIA (Tvb)
- MINT CANYON FORMATION (Tmc)
- TICK CANYON FORMATION (Ttc)
- VASQUEZ FORMATION (Tv)
- UNDIFFERENTIATED BASEMENT COMPLEX (bc)

HYDROGRAPHY

- LAKE
- STREAM
- STREAM GAGE

MAJOR ROAD

- INTERSTATE
- STATE HIGHWAY

Figure 1

Santa Clarita Valley
Geologic Map

Newhall Land and Farming Company

GSI Water Solutions, Inc.

Prepared From Map By
CH2M HILL (2004)

March 2008

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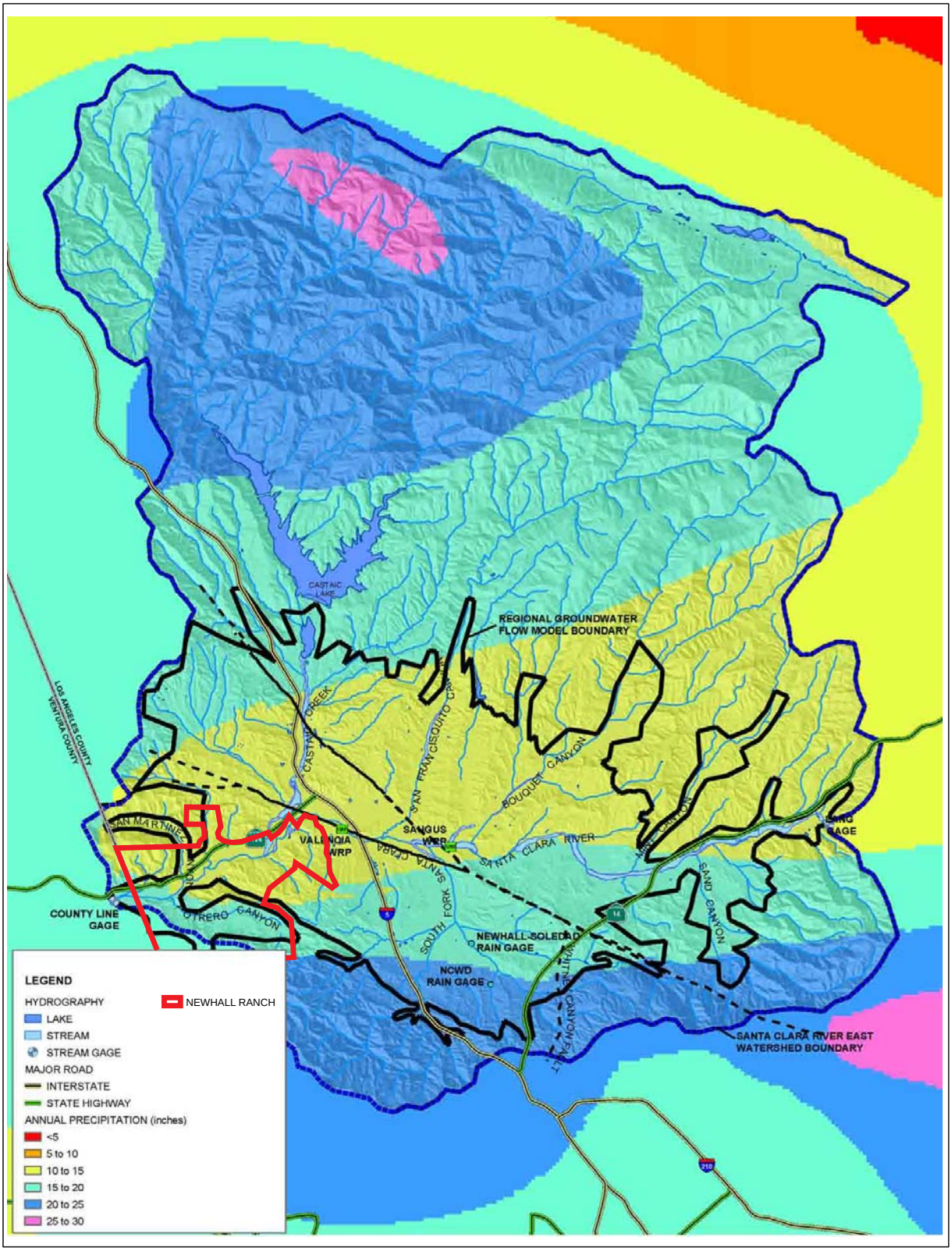

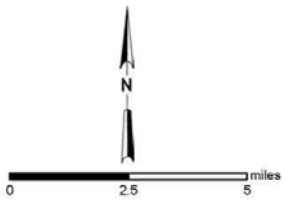

Figure 2

Isohyetal Map Showing Average Annual Precipitation Pattern From 1900 to 1960

Newhall Land and Farming Company

GSI Water Solutions, Inc.

Prepared From Map By CH2M HILL (2004)

March 2008

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Newhall Ranch Specific Plan

Figure 3

Schematic Cross-Section Showing
Santa Clarita Valley Hydrology

Newhall Land and Farming Company

GSI Water Solutions, Inc.

Prepared From Figure
By CH2M HILL (2004)

March 2008

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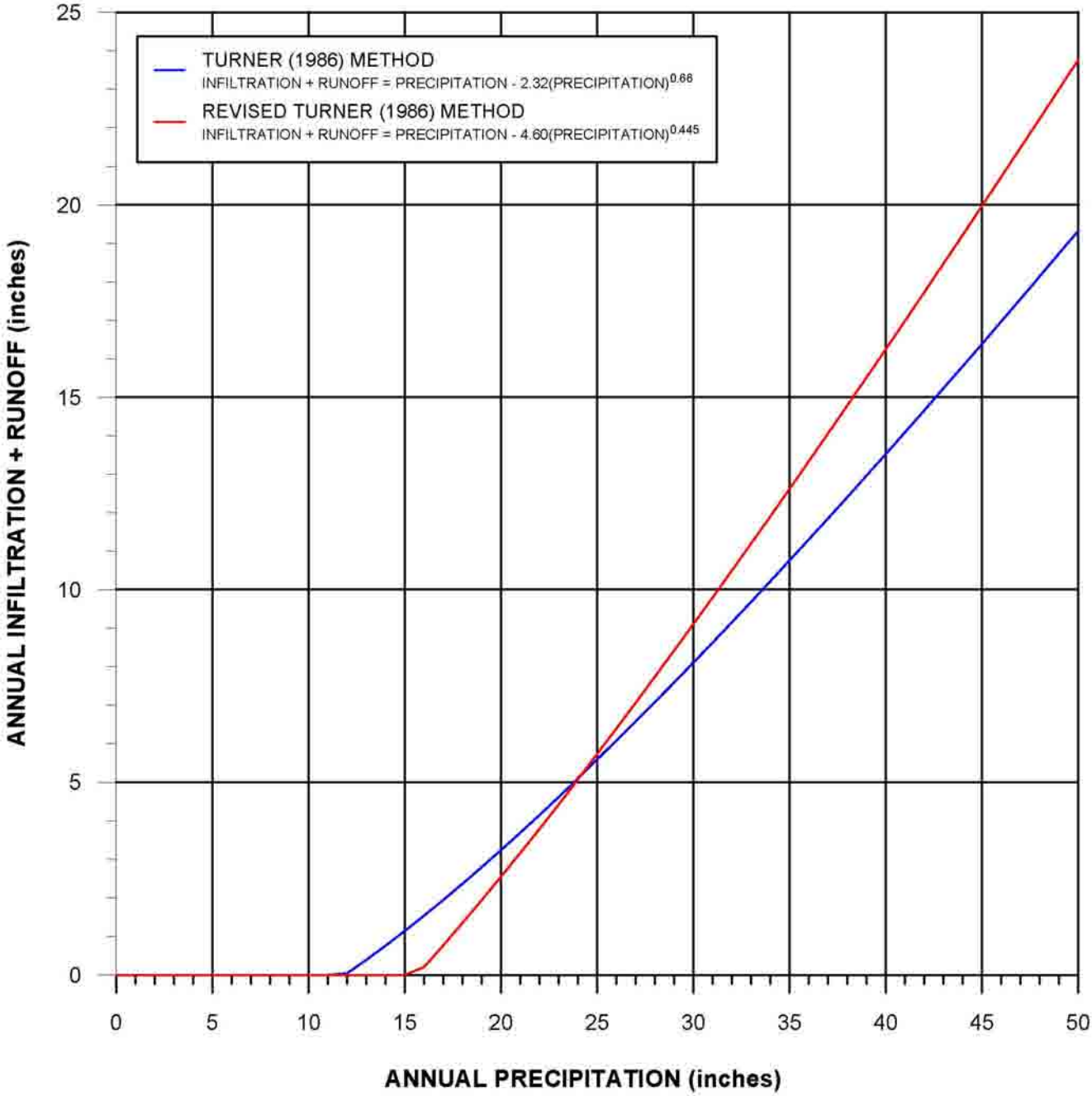

Figure 4

Infiltration and Runoff as a Function of Precipitation in the Santa Clarita Valley

Newhall Land and Farming Company

GSI Water Solutions, Inc.

Prepared From Figure
By CH2M HILL (2004)

March 2008

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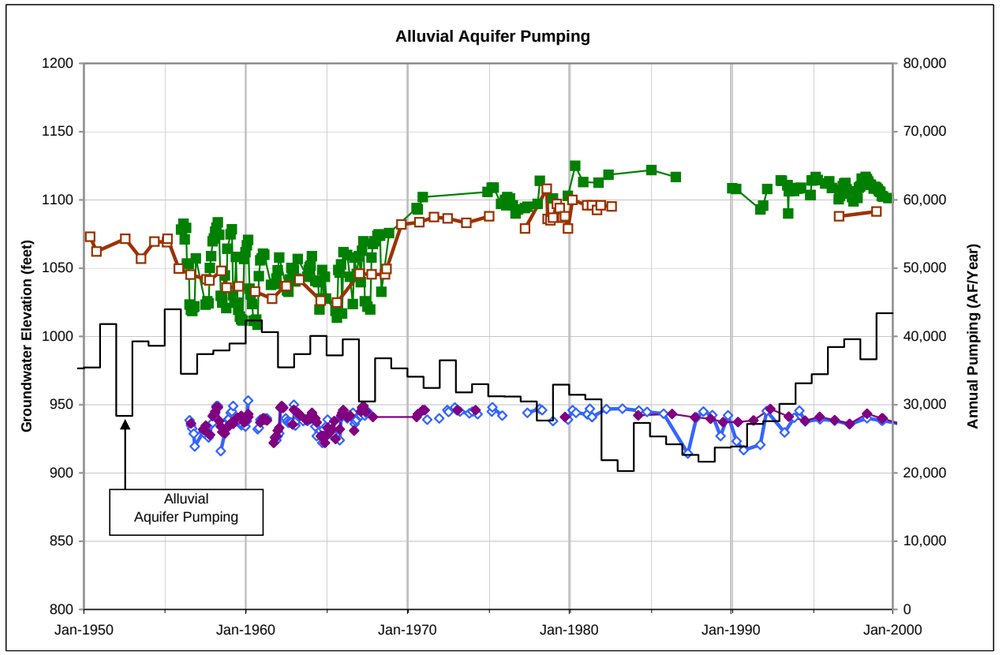
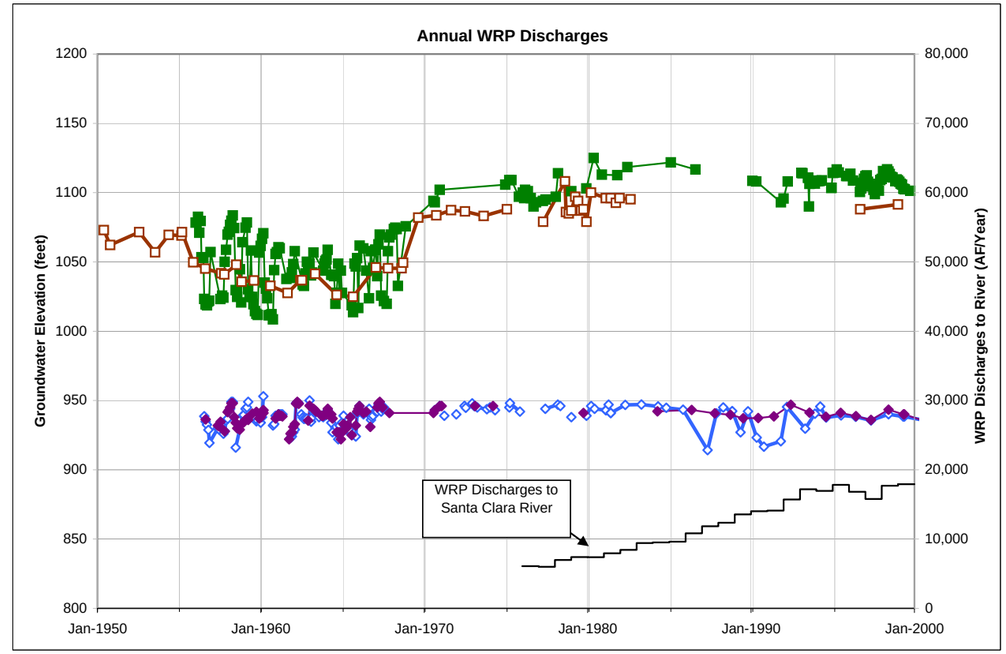
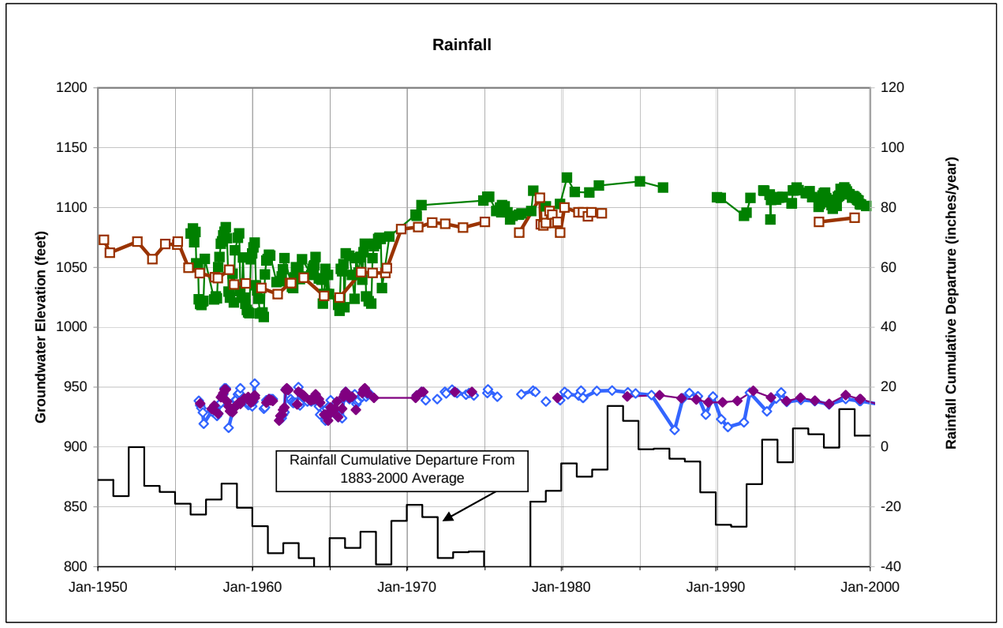
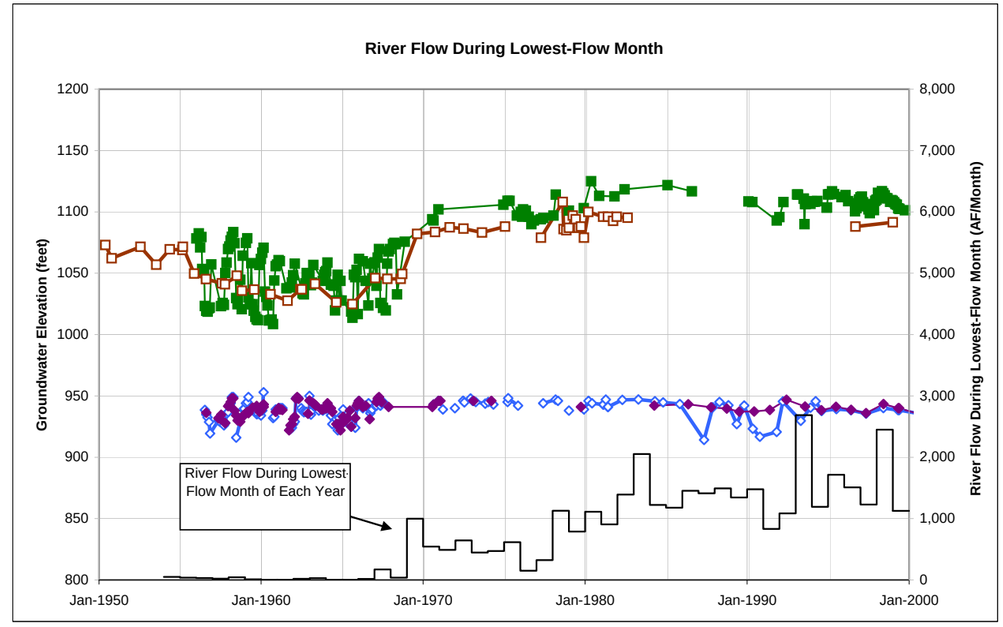








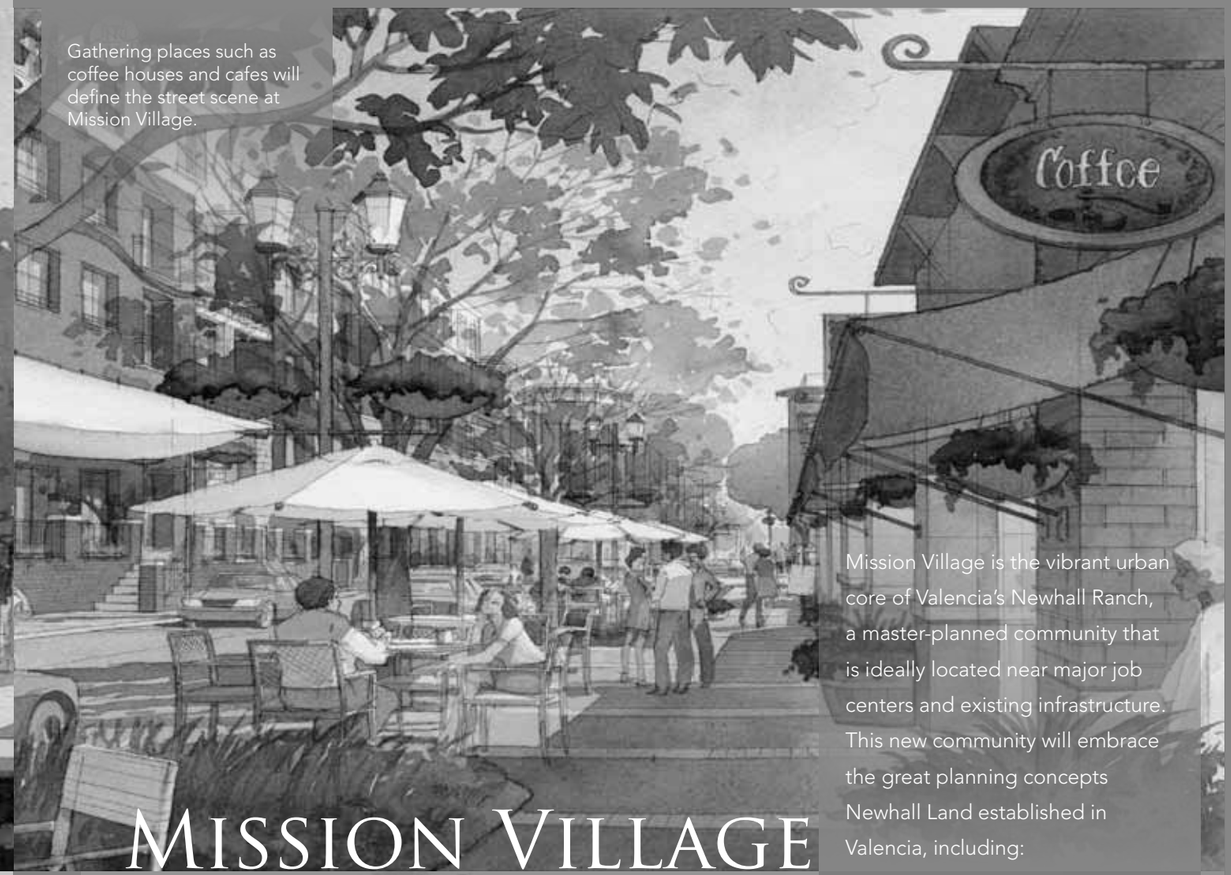
VWC-N
NLF-S
NLF-C5
NLF-C7

NOTE: Wells VWC-N and NLF-S are Just east of I-5, near the mouth of the South Fork Santa Clara River. Wells NLF-C5 and NLF-C7 are west of I-5 and east of the Log Angeles/Ventura County line. WRP = water reclamation plant.

Figure 5
Alluvial Groundwater Elevations versus Groundwater Recharge and Discharge Mechanisms (1950-2000)
Prepared from figures by CH2M HILL (2004).

GSI Water Solutions, Inc.

Porches, walkways, bike paths and narrow streets will help to create a welcoming community environment at Mission Village that will encourage residents to walk or pedal, not drive.



Gathering places such as coffee houses and cafes will define the street scene at Mission Village.

Mission Village
Sustainability Overview

Mission Village is the vibrant urban core of Valencia's Newhall Ranch, a master-planned community that is ideally located near major job centers and existing infrastructure. This new community will embrace the great planning concepts Newhall Land established in Valencia, including:

Jobs – Create significant jobs and economic activity for future residents and the region, totalling 120,000 jobs

Natural – Protect the Santa Clara River and sensitive habitat

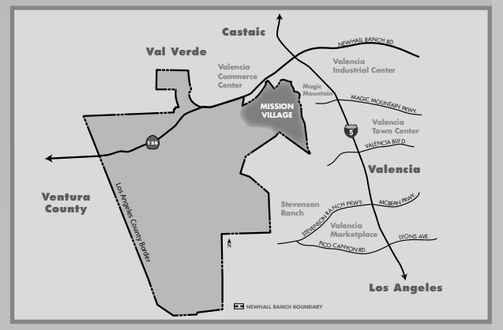
Efficient – Embrace green technologies to conserve energy and water

Linked – Establish a smart circulation plan for vehicular and pedestrian movement

Social – Create places for residents and visitors to live and thrive

Mission Village - At a glance

1,250	Total acres
4,030	Condos, townhomes and apartments
382	Single-family detached homes
560	Acres of open space and recreation
	(7,800 acres total within Newhall Ranch)
25	Acres of public parks
6	Miles of trails and paseos
65	Acres of habitat preserve
1	Public library
1	Elementary school
1.5	Million square-feet of mixed-use and commercial space
1	Fire station
1	Bus transfer station (plus multiple bus stops)



Valencia's Newhall Ranch is an approved master planned community located near major job centers, existing infrastructure and neighboring development. It is a maturation of Valencia, a well-established community with homes, jobs and services.

Mission Village is going through the County of Los Angeles approval process. The information depicted and written about in this document is subject to change and modification.

NEWHALL RANCH

www.NewhallRanch.net

NEWHALL LAND™

The Urban Core of Valencia's Newhall Ranch

The sustainable design of Mission Village features a wide selection of home types within walking distance to jobs, schools, shops, offices, parks and open space.

Job center

Mission Village offices and shops will bring more jobs close to the community's residents, and complement the Valencia Commerce Center and Valencia Industrial Center to create an even stronger job base in the region.

River and habitat protection

A majority of the Santa Clara River that runs through Mission Village will be left in its natural state and protections will be put in place to ensure the long-term health of the entire river corridor. Mission Village also includes one of five spineflower preserves designed to provide undisturbed habitat for this rare species.

Recreation

Key to Mission Village's sustainable design are recreation centers, community and neighborhood parks, and bike and walking paths located throughout the community. In time, hiking trails will connect to the Newhall Ranch High Country and Santa Clara River trail systems.

Village center

The Village Center is fashioned after classic downtowns built before the automobile made urban design less intimate. It features a variety of home styles with shops, restaurants, offices and civic buildings all linked together for walkability. The vertical architecture takes its design cues from traditional urban settings.

Transportation solutions

The Mission Village circulation plan places homes near jobs, shops and public transportation options to reduce vehicle miles traveled and resulting greenhouse gas emissions. Trails and bike paths are also included in the plan to encourage residents to leave their cars behind.

New homes

A mix of home types will create a diversity of residences within an eclectic community. The plan includes options from live-work and apartment homes in the heart of the Village Center to one-acre hillside estates. An active adult neighborhood is also proposed.

Civic buildings

Mission Village's library and fire station will be built to LEED Silver standards. A centrally located school site is also included in the plan.

Green Building Program

Exceed Title 24 by 15%

RENEWABLE ENERGY

Explore and identify renewable energy sources for Newhall Ranch (including Mission Village). Renewable energy sources could include solar, wind, cogeneration and other feasible sources.

WATER CONSERVATION

- Water efficient fixtures in homes, commercial and public buildings
- Drought-tolerant landscaping
- Use of recycled water for irrigation
- Use of local groundwater for potable needs
- Smart irrigation technology to reduce water use and runoff

FIRE STATION AND LIBRARY

- Built to LEED Silver standards

ALL RESIDENTIAL BUILDINGS

- Improved insulation and ducting
- Low E glass
- High efficiency HVAC
- Radiant barrier in attics – as needed to achieve goal

ALL COMMERCIAL BUILDINGS

- Improved insulation and ducting
- Low E glass
- High efficiency HVAC equipment
- Energy efficient lighting design with occupancy sensors

Global Climate Change and Its Effects on Sensitive Biological Resources, July 2010

GLOBAL CLIMATE CHANGE AND ITS EFFECTS ON SENSITIVE BIOLOGICAL RESOURCES

Global climate change may affect sensitive biological resources (e.g., endangered, threatened, rare, and/or special-status species) through potential, though uncertain, changes related to future air and water temperatures; such effects may impact the timing of seasons, affect a species' range, and a species' ability to adapt to changing temperatures. At the same time, the ways in which global climate change may impact sensitive species and biological resources are varied and often complicated due to the intersection of numerous causal forces.

In order to better understand and evaluate the potential impacts to sensitive biological resources as a result of global climate change, a literature survey was undertaken, as set forth below. The results of this survey confirm that, at this time, impacts to sensitive biological resources are speculative and cannot be assessed with much certainty. Accordingly, the analysis of sensitive biological resources is terminated under CEQA.

ARTICLES ADDRESSING GLOBAL CLIMATE CHANGE AND ITS EFFECTS ON SENSITIVE BIOLOGICAL RESOURCES

(a) *Rising to the Challenge: Strategic Plan for Responding to Accelerating Climate Change (Draft)* (September 21, 2009) -- U.S. Fish and Wildlife Service ("Draft Strategic Plan")

The September 2009 Draft Strategic Plan sets forth the U.S. Fish and Wildlife Service's ("USFWS") programmatic three-part strategy with respect to climate change, which turns on adaptation, mitigation, and engagement. Within each component of the strategy, the following goals are identified:

Adaptation

1. Develop long-term capacity for biological planning and conservation design and apply it to drive conservation at broad, landscape scales.

2. Plan and deliver near-term and long-term landscape conservation actions that support climate change adaptations by fish, plants, wildlife, and habitats of ecological and societal significance.

3. Develop monitoring and research partnerships that make available complete and objective information to plan, deliver, evaluate, and improve actions that facilitate fish and wildlife adaptations to accelerating climate change.

Mitigation

4. Change agency business practices to achieve carbon neutrality by the Year 2020.

5. To conserve and restore fish and wildlife habitats at landscape scales, build agency capacity to understand, apply, and share biological carbon sequestration science; and work with partners to sequester atmospheric greenhouse gases in strategic locations.

Engagement

6. Engage agency employees; local, state, national, and international partners in the public and private sectors; key constituencies and stakeholders; and everyday citizens in a new era of collaborative conservation in which, together, we seek solutions to the impacts of climate change and other 21st century stressors of fish, wildlife and habitats.

In the Draft Strategic Plan, the USFWS underscores that "[o]ne of the major challenges of addressing climate change effects on fish and wildlife will be identifying and accounting for the uncertainty that remains in our understanding of future climate change and how that change will affect ecological systems." (Draft Strategic Plan, p. 8.) Currently, impacts are assessed from global climate change models; however, the USFWS notes the import of "downscaling" such models to better account for regional and local impacts.[1]

(b) *Global Climate Change Impacts in the United States* (2009) -- U.S. Global Climate Research Program ("Impacts in the United States")

This report summarizes the science of climate change, and the current and projected impacts of climate change on the United States. The report observes that "[m]any factors affect biodiversity including: climatic conditions; the influences of competitors, predators, parasites, and diseases; disturbances such as fire; and other physical factors. Human-induced climate change, in conjunction with other stresses, is exerting major influences on natural environments and biodiversity, and these influences are generally expected to grow with increased warming." (Impacts in the United States, p. 79.) The report further notes that the distribution of species is modulating in response to the timing of the seasons. (*Id*. at pp. 80-82.)

With that said, the report "identifies a number of areas in which inadequate information or understanding hampers our ability to estimate future climate change and its impacts." (*Id*. at p. 11.) The potential impact to sensitive biological resources is one of those areas, as the report found that "[r]esearch

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[1] The import of this finding recently was confirmed in the *5-Year Review: Summary and Evaluation for the Unarmored Threespine Stickleback*, issued by the Ventura Fish and Wildlife Office on May 29, 2009. On page 25 of the *5-Year Review*, the USFWS noted that "predictions of climatic conditions for smaller sub-regions, such as California, remain uncertain." Therefore, USFWS concluded that it lacked "adequate information to make accurate predictions" regarding the effects of climate change on this particular species.

on ecological responses to climate change is also limited." (*Ibid*.) The report recommended that additional research focus on improving the models used to project impacts to ecosystems:

> [Ecosystem simulation] models, when rigorously developed and tested, provide powerful tools for exploring the ecosystem consequences of alternative future climates. The incorporation of ecosystem models into an integrated assessment framework that includes socioeconomic, atmospheric and ocean chemistry, and atmosphere-ocean general circulation models should be a major goal of impacts research. This knowledge can provide a base for research studies into ways to manage critical ecosystems in an environment that is continually changing.

(*Id*. at p. 153.) In that regard, the report underscores the "indisputable need" for the development of regional, small scale modeling to enable local decision makers to render informed choices. (*Id*. at p. 154.)

(c) ***A Framework for Categorizing the Relative Vulnerability of Threatened and Endangered Species to Climate Change*** **(February 2009) -- Hector Galbraith and Jeff Price for the Global Change Research Program, National Center for Environmental Assessment in the U.S. Environmental Protection Agency's Office of Research and Development ("Framework for Categorizing")**

The Framework for Categorizing report describes an evaluative framework that may be used to categorize the relative vulnerability of threatened and endangered species to climate change. The report relies on four modules to assess vulnerability:

> Module 1 categorizes the baseline vulnerability of species to extinction or major population reduction through the use of 11 variables/stressors (not including climate change);
>
> Module 2 scores the likely vulnerability of a species to future climate change through the use of 10 variables;
>
> Module 3 combines the results of Modules 1 and 2 into a matrix to produce an overall score of the species' vulnerability to climate change -- the score mapped to categories such as "critically vulnerable," "highly vulnerable," "less vulnerable," and "least vulnerable;"
>
> Module 4 assigns a qualitative determination of uncertainty of overall vulnerability.

The four-module framework was applied to six threatened and endangered species: the golden-cheeked warbler; salt marsh harvest mouse; Mount Graham red squirrel; Lahontan cutthroat trout; desert tortoise; and, bald eagle. The first four species were categorized as "critically vulnerable," the fifth was categorized as "highly vulnerable," and the sixth was categorized as "less vulnerable." (Framework for Categorizing, pp. vii-viii.)

Based on the modules and the species studied, the Framework for Categorizing report presents the following conclusion:

> Species that are most vulnerable tend to be: restricted in their distributions, small in population size, undergoing population reductions, habitat specialists, and found in habitats that are likely to be most adversely affected by future climate change. Conversely, species . . . which are widely distributed, are flexible in their habitat preferences and are considered to be stable or increasing, scored least vulnerable. . . . The results also indicate that major areas of uncertainty complicate any evaluations of vulnerability. For the species tested, the greatest uncertainties are associated with a relatively poor knowledge about the potential for direct, physiological effects on animal species; relationships between changes in temperature and precipitation regimes and the physiologies and behaviors of animals are, apparently, only poorly understood.

(*Id*. at p. viii; see also *id*. at p. 36.)

(d) ***The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*** **(May 2008) -- Synthesis and Assessment Product 4.3 Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research ("CCSP 2008 Report")**

This report assesses, among other issues, the effect of climate change on biodiversity, and is one of a series of 21 synthesis and assessment products being produced under the auspices of the U.S. Climate Change Service Program ("CCSP"). The lead sponsor of the CCSP 2008 Report summarized here is the U.S. Department of Agriculture.

The CCSP 2008 Report was prepared following the extensive review of scientific literature, measurements and data collected and published by U.S. government agencies in more than 1,000 separate publications. (CCSP 2008 Report, p. 1.) The overarching conclusions reached as a result of the CCSP's literature survey include findings that:

- Climate change already is affecting biodiversity in the United States;
- Climate change will continue to have significant effects on biodiversity over the next few decades and beyond;
- Many *other* stresses and disturbances, not related to climate change, also affect biodiversity;
- Climate change impacts on ecosystems will affect the services (e.g., carbon sequestration) that ecosystems provide, but we do not yet possess sufficient understanding to project the timing, magnitude, and consequences of these effects -- "there is not yet adequate integrated analysis of how climate change could affect ecosystem services;" "there is no analysis specifically devoted to understanding changes in ecosystem services in the United States from climate change and associated stresses," which constitutes a "significant gap in our knowledge base," and

- Existing monitoring systems, while useful for many purposes, are *not* optimized for detecting impacts to ecosystems resulting from global climate change.

(*Id*. at pp. 3-4.)

With respect to biodiversity, the report addresses impacts on species diversity and rare and sensitive ecosystems. (CCSP 2008 Report, p. 1.) The basic findings reached with respect to biodiversity include conclusions that:

- There has been a significant lengthening in the growing season and increase in net primary productivity in the high latitudes of North America;
- Many species studied have exhibited shifts in their distributions;
- Coral reefs are suffering major bleaching due to increases in sea surface temperatures and oceanic acidity;
- The rate of warming projected for the next century in the Arctic will reduce snow and ice cover, impacting polar bears;
- There are other possible impacts for which there is not yet a substantial observational database;
- It is difficult to pinpoint changes in ecosystem services that are related to changes in biological diversity, particularly as a specific assessment of changes resulting from climate shifts or other drivers of change has not been done; and
- Current modeling systems have not been developed with climate variability in mind, so the information derived from their results (with respect to climate change) is somewhat limited.

(*Id*. at pp. 9-10.)

(e) ***Climate Change 2007: Climate Change Impacts, Adaptation, and Vulnerability*** **(April 6, 2007) -- Working Group II Contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report ("IPCC WGII 2007 Report")**

This report addresses the "relationship between observed climate change and recent observed changes in the natural and human environment." (IPCC WGII 2007 Report, p. 2.) Based upon global assessment of data since 1970, the report concludes that "anthropogenic warming has had a discernable influence on many physical and biological systems." (Id. at p. 3.) The report notes that recent warming "strongly" affects terrestrial biological systems, such that there is an earlier timing of spring events, and poleward/upward shifts in the ranges in plant and animal species. (Id. at p. 3.) Similarly, with regard to marine and freshwater biological systems, there is evidence that impacts are occurring due to rising water temperatures, which impact ice cover, salinity, oxygen levels, and circulation. (Ibid.) The specific impacts to marine and freshwater biological systems include range shifts, the earlier migration of fish in rivers,

and changing abundance levels of algal, plankton, and fish in high-latitude oceans and high-altitude lakes. (Ibid.) If temperature increases exceed 1.5-2.5°C, major changes are projected for ecosystem structure and function, species' ecological interactions, and species' geographic ranges - all resulting in predominantly negative consequences for biodiversity. (Id. at p. 8.)

The IPCC WGII 2007 Report also summarizes, however, the considerable scientific uncertainty associated with global climate change and its causes and effects on sensitive biological resources:

> Limitations and gaps prevent more complete attribution of the causes of observed system responses to anthropogenic warming. First, the available analyses are limited in the number of systems and locations considered. Second, natural temperature variability is larger at the regional than the global scale, thus affecting identification of changes due to external forcing. Finally, at the regional scale other factors (such as land-use change, pollution, and invasive species) are influential.

(Id. at p. 4.) Similarly, the report notes that while climate change is beginning to have effects on many natural and human environments, "based on the published literature, the impacts have not yet become established trends." *(Ibid.)*

(f) ***Observed Impacts of Global Climate Change in the U.S.*** **(November 2004), prepared for the PEW Center on Global Climate Change, Camille Parmesan, Hector Galbraith ("Parmesan and Galbraith 2004")**

Camille Parmesan and Hector Galbraith undertook a literature review to assess "the scientific evidence compiled to date on the observed ecological effects of climate change in the United States and their consequences" and the strength of that evidence. (Parmesan and Galbraith 2004 at p. iii.) The review included more than 40 studies showing a possible tie between global warming and ecological changes in the United States. In twenty of the studies, the authors found "strong evidence of a direct link" between climate change and observed ecological impacts in the United States. *(Ibid.)*

While the report identified general trends, such as shifts in the timing of ecological events and habitat ranges, it also noted that "many species and ecological systems of interest have yet to be studied (often due to inherent limitations of available data) and the attribution of ecological changes to a particular cause remains challenging." (*Id.* at pp. iii; see also p. 13 [there are "enormous difficulties biologists have encountered in tackling the question of climate change impacts"].) Further, "[m]any if not most of the ecosystems and organisms in the United States are already suffering from other anthropogenic stressors . . . [and] [a]s yet, scientists do not have a clear idea how climate change might affect this already fragile situation." (*Id.* at p. v.) Accordingly, the report recommends that scientists achieve a better understanding of which systems or species are most or least susceptible to projected climate change in order to better evaluate and mitigate potential impacts. (*Id.* at p. 41.)

In response to Parmesan and Galbraith 2004, other scientists have noted that plants and animals have adapted to climate change for millions of years and that it is not surprising to see plants and animals respond to present-day temperature changes.[2] Such responses to climate change do not necessarily show the changes are linked to fossil fuel emissions and human-caused climate change. *(Ibid.)*

Some concern has been articulated that the Edith's, Quino, Bay, and Taylor's checkerspot butterfly species may be adversely impacted by global climate change. However, in a related context, USFWS has rejected similar claims that butterfly species may be endangered or threatened due to global climate change.[3] In the context of the Thorne's Hairstreak Butterfly, USFWS recognized recent evaluations by Parmesan and Galbraith 2004 that whole ecosystems are seemingly being shifted northward; however, USFWS found that the type, magnitude, or temporal effects of ecosystem changes that may be brought about by global climate change are speculative and stated it was not aware of any available documentation that directly links global warming as a threat to the butterfly. *(Ibid.)*

In addition, it should be noted that the butterfly species of concern are not believed to be present on the Project site. For example, the Quino checkerspot butterfly has been identified as a species that is *not* expected to be found on the Project site, because its presence was last documented in Los Angeles County in 1954.

(g) *Status and Trends of the Nation's Biological Resources* (1998), U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division ("USGS 1998 Status/Trends Report")

A chapter of this report addresses the impacts of climate change on the nations biological resources. (USGS 1998 Status/Trends, at pp. 89-116.) The report closely considers impacts to avian species, and notes that "the ranges of most species moved north, up mountain slopes, or both." (*Id.* at p. 101.) Accordingly, such range shifts "could cause local extinctions in the more southern portions of the birds ranges, and, if movement to the north is impossible, extinctions of entire species could occur." (*Ibid.*) The report also considers impacts to reptiles and amphibians, and notes that they are likely to be impacted because they are especially susceptible to extreme temperature, must remain close to water sources, and are not able to disperse at a rapid rate. (*Ibid*.) In addition, "[i]n general, animals most likely to be affected earliest by climatic change are those in which populations are fairly small and limited to isolated habitats." (*Id.* at p. 102.)

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[2] Tom Stohigren, a U.S. Geological Survey ecologist, Fort Collins, Colorado.

[3] See, USFWS 90-day finding on petition to list the Thorne's Hairstreak Butterfly as threatened or endangered (2006 Federal Register, 71 FR 44980-44988).

Significantly, this report notes that "[w]hat is most needed to evaluate potential biological effects of temperature change is a regional projection of climatic changes that can be applied to ecosystems at a regional or local scale" and "estimates of climatic variability during the transition to a new equilibrium, particularly at the regional scale." *(Id.* at pp. 94-95.) In addition, "[a} focus of climate research toward changing climatic variability [citations] might be more useful for ecological impact assessments than the current focus among climatic modelers on climatic means." *(Id.* at p. 112.) Finally, these projections, in order to be "more realistic and useful . . . [require a] multiscale, multispecies, multitaxa analysis driven by regionally specific, transient climatic change forecasts." *(Ibid.)*

The report also states that "at present [transient regional changes] are very difficult to predict credibly." *(Id.* at p. 95; see also p. 110 [As contrasted with regional assessments, "[t]he most reliable projects for climatic models are for global-scale temperature changes."].) This point is further underscored by the conclusion that climate forecast models are "fraught with uncertainties," leading to "the perplexing question" of "whether they can be trusted as a reliable basis for altering social policies, such as those governing CO_2 emissions or the shape and location of wildlife reserves." *(Ibid.)*

After disclosing the inadequacies of the projection models, this report assesses the policy implications:

> Climatic change as now envisioned is not necessarily a threat to the well-being of all climate-sensitive species. However, the transient nature of most projected human- induced climatic change scenarios suggests that significant alterations are likely on a scale of decades, whereas the adaptability of many species - especially those upon which faster responding species depend - is on a scale of centuries. . . . The only forecast that seems unassailable is that the more rapidly the climate changes and the more extensively other human disturbances are forced on nature, the higher the probability of substantial disruption and surprise within natural systems.
>
> To forecast possible consequences of the projected climate changes, single-species studies should be guided by the overall effects that climate may have at the large scale or on range limits and abundance patterns, and on the interactions among species. Coupling such results with information from climatologists, geologists, and others will allow interdisciplinary teams to more reliably forecast the possible biological consequences of scenarios of global warming and other global changes. These forecasts can then be used by policy makers and the general public to determine what types of actions might be effective to mitigate potential impacts of forecasted climate changes. Research can help put such policy making of a firmer factual basis, but any plausible level of effort is not likely to reduce all important uncertainties before the global change experiment now under way on Earth is played out [citation].

(Id. at p. 113.)

(h) ***The Regional Impacts of Climate Change: An Assessment of Vulnerability (1997),*** **Intergovernmental Panel on Climate Change, Special Report ("IPCC 1997 Report")**

This report evaluates the regional impacts of climate change across the globe. With regard to impacts to North America, this report concludes that "the characteristics of the subregions and sectors . . . suggest that neither the impacts of climate change nor the response options will be uniform." (IPCC 1997 Report, Chapter 8 Executive Summary.) Nonetheless, the report concludes that reductions in terrestrial biological diversity are likely due to loss of habitat. *(Ibid.)* The same conclusion is reached as to fisheries and aquatic systems because of expected increases to water temperature, changes in freshwater flows and mixing regimes, and alterations to water quality. *(Ibid.)* In spite of the anticipated impacts, the report discloses significant scientific uncertainties:

> Our current understanding of the potential impacts of climate change is limited by critical uncertainties. One important uncertainty relates to the inadequacy of regional- scale climate projections relative to the spatial scales of variability in North American natural and human systems. This uncertainty is compounded further by the uncertainties inherent in ecological, economic, and social models - which thereby further limit our ability to identify the full extent of impacts or prescriptive adaptation measures. Given these uncertainties, particularly the inability to forecast futures, conclusions about regional impacts are not yet reliable and are limited to the sensitivity and vulnerability of physical, biological, and socioeconomic systems to climate change and climate variability.

(Ibid., italics added.) More simply, the report concludes "[u]certainty exists in our ability to predict ecosystem or individual species responses to elevated CO2 and global warming at either the regional or global scale." *(Ibid.)*

Conclusions Reached From Literature Survey

In light of the information provided above, evidence exists linking global climate change to ecological effects; however, the precise causes, extent, magnitude, and timing of such effects remain uncertain and preclude reliable forecasts of possible ecological effects resulting from global climate change. Therefore, and again based on the information presented herein, the effect of global climate change on sensitive species and other biological resources is too speculative at this time for any further evaluation. Accordingly, it is appropriate to terminate any further analysis of such effects, consistent with Section 15145 of the CEQA Guidelines.

Global Climate Change and Its Effects on California Water Supplies, July 2010

GLOBAL CLIMATE CHANGE AND ITS EFFECTS ON CALIFORNIA WATER SUPPLIES

Future global climatic conditions may affect California's water supplies through potential, though uncertain, changes related to air temperatures and precipitation and their resulting effects on water temperatures, water project operations, reservoir operations, stream runoff, and rise in sea levels affecting Delta water quality. Accordingly, in order to better understand the impacts to California's water supply associated with global climate change, a literature survey, as set forth below, was undertaken.

To preface, though, this discussion relies primarily upon information provided by the California Department of Water Resources (DWR). The focus is on DWR's assessment of such global climate change issues because DWR operates the SWP water storage and conveyance system, one of two major water projects that convey potable water to California's population. The other water storage and conveyance project is the federal Central Valley Project (CVP), which is operated by the U.S. Bureau of Reclamation (Reclamation). These two water systems are operated by DWR and Reclamation for water supply, flood management, environmental protection, and recreation.

DWR and Reclamation have formed a work team to address water resources related to issues of global climate change. The mission of the work team is to coordinate with other state and federal agencies to incorporate climate change science into California's water resources planning and management. The team will provide and regularly update information for decision makers on potential impacts and risks of global climate change, flexibility of existing facilities to accommodate climate change, and available mitigation measures.

The first product of the work team's efforts is DWR's technical report titled, "Progress on Incorporating Climate Change into Management of California's Water Resources," dated July 2006 (Progress Report). The report responds to the Governor's Executive Order S-3-05, which requires biennial reports on climate change impacts to various areas, including water resources. It provides information on potential impacts of selected climate change scenarios to operations of the SWP and CVP, Delta water quality, flood management, and evapotranspiration. The technical chapters of the report underwent peer review.

DWR's reporting and assessment on global climate changes and its effects on California's water supplies are important, because California's water supplies depend heavily on the accumulation of winter mountain snow melting into spring and summer runoff. As stated by DWR, "[a] warming planet may reduce this natural water storage mechanism . . . [and] [p]rojected increases in air temperature may lead to changes in the timing, amount and form of precipitation -- rain or snow, changes in runoff timing and

volume, sea level rise effects on [Sacramento-San Joaquin] Delta water quality, and changes in the amount of irrigation water needed due to modified evapotranspiration rates." (Progress Report, p. 1-2.)

In summary, DWR's planning documents, discussed below, address the uncertainties surrounding global climate change and its effects on California's water supplies. According to information currently available, DWR has reported that California's future hydrologic conditions will likely be different from patterns observed over the past century -- although the precise causes, extent, and timing of the changes remain uncertain. And while DWR has acknowledged that better quantification will be possible as more sophisticated tools are developed and additional studies are completed, DWR currently is incorporating the potential effects of global climate change on water resources into its modeling projections and reliability forecasts.

The following discussion primarily summarizes DWR's plans and reports related to potential impacts of global climate change on California's future water supplies. The discussion also lists and describes other selected reports and studies concerning global climate change and its effects on water supplies. In addition, the discussion identifies the previously adopted mitigation measures relative to water supplies, which conserve water supplies and lessen greenhouse gas emissions that contribute to global climate change.

DWR Plans and Reports

DWR's SWP Delivery Reliability Report (2005)

DWR's 2005 SWP Delivery Reliability Report, April 2006 (Reliability Report), presents information from computer simulation studies of the operation of the SWP. Using the CalSim-II model, DWR has simulated SWP operations, using historical rainfall and runoff data, which is then adjusted for changes in water and land use that have occurred or may occur in the future. The computer simulations were conducted over a 73-year period (1922-1994) of the adjusted historical rainfall/runoff data. This modeling approach incorporates the assumption that the next 73 years will have the same or similar rainfall/snowmelt amount and pattern, both within-year and from year-to-year, as the historical 1922-1994 period.

Based on this modeling assumption, DWR has noted that, currently, the CalSim-II model does "not incorporate any modifications to account for changes related to climate change" that could disrupt SWP deliveries. (Reliability Report, Chap. 3, p. 7.) Earlier in the Reliability Report, DWR also has acknowledged that that CalSim modeling and study approach includes the assumption that past rainfall-runoff patterns will be repeated in the future and that this assumption has an "inherent uncertainty, especially given the evolving information on the potential effects of global climate change." (*Id.* at p. 4.) Relying upon the 2005 update to the California Water Plan, DWR summarized the potential effects of global climate change on future water supplies, as follows:

> California's water systems have been designed and operated based on data from a relatively short hydrologic record. Mounting scientific evidence suggests that forecasted climate changes could significantly change California's precipitation pattern and amount from that shown by the record. Less snowpack would mean less natural water storage. More variability in rainfall, wetter at times and drier at times, would place more stress on the reliability of existing flood management and water systems. California's high dependence on reservoir storage and snowpack for water supply and flood management makes us particularly vulnerable to these types of projected hydrologic changes.

(*California Water Plan Update*, December 2005, Vol. 1, page 3-15.) DWR also stated in its Reliability Report that:

> Potential changes in climate patterns are becoming better defined and attempts to quantify the resulting impacts to SWP water supply are underway. Broad brush estimates are being developed of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. As this information becomes more refined, it will be helpful in guiding the development of statewide strategies for the future management and development of water resources facilities, including the SWP.

(Reliability Report, Chap. 2, p. 4.) In the meantime, however, DWR has confirmed that the results of CalSim-II model studies conducted for the Reliability Report "represent the best available assessment of the delivery capability of the SWP." (Reliability Report, Chap. 3, p. 7.)

In response to concerns about future climate conditions that may affect water supplies, DWR has stated that information pertinent to climate change and its effects on water supplies "is evolving rapidly, but has not reached a level at which it can be quantitatively incorporated into delivery projections of the SWP."[1] Nonetheless, DWR has acknowledged that the published literature and other information are "helpful in developing strategies for the future management and development of the State's water resources, including improvements to the SWP." (*Ibid.*)

DWR's California Water Plan Update (2005)

DWR's California Water Plan Update of 2005 (2005 Water Plan) also addresses uncertainties associated with global climate change and its potential effect on water supplies. In Chapter 4 of the 2005 Water Plan, DWR summarizes the "predictions" surrounding global climate change, and they "include increased temperatures, reductions to the Sierra snowpack, earlier snowmelt, and a rise in sea level, although the

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[1] See, DWR letter to Mindy McIntyre, Water Program Manager, Planning and Conservation League, dated April 20, 2006 (DWR's April 20, 2006 letter), which is found in Appendix G to DWR's 2005 SWP Delivery Reliability Report (April 2006).

extent and timing of the changes remain uncertain." (*Id*. at p. 32.) DWR further states that these predicted changes "could have major implications for water supply, flood management, and ecosystem health. The prospect of significant climate change warrants examination of how California's water infrastructure and natural systems can be managed to accommodate or adapt to these changes, and whether more needs to be done." (*Ibid*.) DWR also acknowledges that, for over the past ten years, "scientists have been publishing formal, peer-reviewed recommendations for integrating the results of climate change research into policy." (*Ibid*.)

For example, in conjunction with affected state agencies, the Public Interest Energy Research Program (PIER) administered by the California Energy Commission has developed and is implementing a climate change research plan for California. The PIER program established a regional climate change research center with the goals of: (1) improving the understanding of the possible physical and economic impacts of climate change; and (2) developing robust adaptation and mitigation strategies for California. (See, 2005 Water Plan, p. 32, Box 4-9, PIER Program and Climate Change Research.) In support of future updates of the 2005 Water Plan, the newly-created research center is funding: (1) development and maintenance of a comprehensive climatic database for California and the analysis of meteorological and hydrological trends; (2) monitoring of meteorological and hydrological parameters in some key remote locations using innovative remote sensing devices; (3) development of climate projections for the state using regional climate models at levels of resolution appropriate for water resources impact analyses; and (4) study of water resources impacts under different climatic projections. DWR is a key co-sponsor of these research activities, and DWR staff is participating in the modeling efforts. (*Ibid*.)

Climate Change Report

DWR's 2005 Water Plan also referenced the work performed by the Pacific Institute for Studies in Development, Environment and Security (Pacific Institute). The Pacific Institute, in a literature search report for DWR, summarized recommendations for coping with and adapting to climate change from key peer-reviewed publications. The Pacific Institute's report is titled, "Climate Change and California Water Resources: A Survey and Summary of the Literature," by Michael Diparsky and Peter H. Gleick, Pacific Institute, July 2003 (Climate Change Report). This report is included in the Volume 4 Reference Guide to the 2005 Water Plan.

In the Climate Change Report, the Pacific Institute surveyed existing literature on climate change and its impacts on water resources in California. This report reviewed projected effects of climate change on the state's water supply, delivery, and quality, and explored the economics involved in meeting the challenges that those effects could bring about. (Climate Change Report, p. vii.) In general, the report confirmed temperature increases and their effects include a snowpack higher in elevation, with either

lower or higher precipitation depending upon the information source (*id*. at pp. 6, 10); either greater or lesser amounts of runoff depending upon the information source (*id*. at p. 14); a greater number of extreme flood and drought events (*id*. at p. 13); and reductions or increases in projected water use by plants (*id.* at p. 10), again, depending upon the information source. Thus, depending upon the information presented, California could have more water available due to increased humidity and rainfall, or less water available due to reductions in snowpack, greater evaporation, and no change or slightly less rainfall.

The Climate Change Report concluded that managing water resources to address climate changes could prove different than managing for historical climate variability because: (1) climate changes could produce hydrologic conditions and extremes of a different nature than current systems were designed to manage; (2) they may produce similar kinds of variability but outside of the range for which current infrastructure was designed; (3) traditional water resource management assumes that sufficient time and information will be available before the onset of large or irreversible climate impacts to permit managers to respond appropriately; and (4) traditional management assumes that no special efforts or plans are required to protect against such uncertainties.

The Climate Change Report's literature survey resulted in specific recommendations for the following areas:

- Water planning and management
- Sea level concerns
- Modifying operation of existing systems
- New supply options
- Demand management, conservation, and efficiency
- Economics, pricing, and markets
- State water law
- Hydrologic and environmental monitoring.

The Climate Change Report further recommended that a more comprehensive assessment of all of these areas, supported by multiple state agencies and including the participation of a wide range of stakeholders, would be a valuable tool for policymakers and planners, and it was urged that such an assessment to be undertaken in the near future. (*Ibid*.)

The subject of groundwater also was addressed in the Climate Change Report. The report concedes that the impacts of global climate change on groundwater basins, and groundwater recharge characteristics are largely unknown. For example, the report notes that changes in groundwater recharge will result

from changes in effective rainfall as well as a change in the timing of the recharge season. (*Id*. at p. 20.) Increased winter rainfall may be expected in some regions, leading to increased groundwater recharge. Conversely, higher evaporation or shorter rainfall seasons in other regions could mean that soil deficits persist for longer periods of time, shortening recharge seasons, citing Leonard, *et al*., 1999. However, warmer, wetter winters would increase the amount of runoff available for groundwater recharge. This additional runoff in the winter would be occurring at a time when some basins are either being recharged at their maximum capacity or are already "full." (*Ibid.*) On the other hand, reductions in spring runoff and higher evapotranspiration because of higher temperatures, could reduce the amount of water available for recharge.

However, "[t]he extent to which climate will change and the impact of that change are both unknown." (*Ibid*.) Overall, the recommendation is that possible climate changes may require more sophisticated conjunctive management programs in which "the aquifers are more effectively used as storage facilities." (*Ibid*.)

Although the data is still developing, the Climate Change Report has confirmed that a consensus in the literature is emerging to suggest that temperatures globally are increasing. Given that climate change is a complex topic, and that the world's climate has changed in cycles for hundreds of thousands, if not yet millions, of years, according to DWR, the cause of these climate changes and their effects have not reached a level at which such information can be quantitatively incorporated into the delivery projections of the SWP.[2]

Accounting for Climate Change Report

In addition, a DWR report on climate change impacts and the recommendations for further research has been prepared and included in the Volume 4 Reference Guide to the 2005 Water Plan. The report is entitled, "Accounting for Climate Change," by Maurice Roos, Chief Hydrologist, DWR (Accounting Report).

The Accounting Report noted that evidence of global climate changes continues to develop, and this developing information has suggested that global climate change can affect the amount, timing, and form of precipitation (whether rain or snow) that California receives, as well as the sea level of the Pacific Ocean. This report disclosed that changes in weather, especially temperature and atmospheric composition, can affect water use and consumption. (Accounting Report, p. 1.) In addition, the Accounting Report indicated that most scientists feel that changes during the last several decades are

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[2] DWR's April 20, 2006 letter, p. 2 (*supra* footnote 2).

likely mostly due to human activities, but natural causes and variability cannot be ruled out as significant components. The Accounting Report also stated that projections of the amount of warming and other climate changes during the 21st century are wide-ranging, depending on assumptions and models. The findings summarized in the Accounting Report provide that:

Whatever the causes, the prospects of significant changes warrant examination of how the State's water infrastructure and natural systems can accommodate or adapt to climate changes and whether more needs to be done to detect, evaluate and respond to water resource system effects. Many uncertainties remain, primarily on the degree of change to be expected. Responsible planning requires that the California water planning community work with climate scientists and others to reduce these uncertainties and to begin to prepare for those impacts that are well understood, already appearing as trends, or likely to appear.

(*Ibid.*)

Modeling Efforts

DWR's 2005 Water Plan also has referenced modeling efforts undertaken by the University of California, Davis (with funding from the Resource Agency, CALFED, and the California Energy Commission). The University used the "CALVIN" model to evaluate how California's water system might adapt to long-term climate warming. This preliminary analytical tool was used to integrate "existing surface water, groundwater, and water demand data in an integrated economic-engineering framework for California's inter-tied water system (covering 92 percent of California's population and 88 percent of its irrigated area)." (2005 Water Plan, p. 33.) Although a useful analytical tool, DWR noted that:

In developing the computer model [CALVIN], significant weaknesses and gaps in water data were identified and documented. The model and its results have been peer reviewed and show preliminary insights into economically promising possibilities for California water management. More importantly, the tool demonstrated concepts in advanced data management, documentation, and analysis that may be useful for future statewide and regional water policy and planning analysis. The CALVIN model has been applied preliminarily to examine statewide potential for regional and statewide water markets and how California's water system might adapt to long-term climate warming (through the [PIER] Program).

(*Ibid.*)

In addition, DWR's 2005 Water Plan has referenced computer modeling of global climate change scenarios, which predict significant future reductions in the Sierra snowpack.[3] (*Id.* at pp. 33-34.) The model's simulation of potential changes in snowpack during the 21st century predicts a 52 percent reduction in the annual April through July runoff for a 2.1 degree C (3.8 F) of warming, which, according to DWR, is "well within the 1.4 to 5.8 degrees C (2.5 - 10.4 F) range predicted by global climate models for this century." (*Id*. at p. 34.) According to DWR, "[c]hanges in the timing of snowfall and snowmelt, as a result of climate change, may make it more difficult to fill reservoir flood control space during late spring and early summer, potentially reducing the amount of surface water available during the dry season. . . . Reductions in snowpack may require changes in the operation of California's water systems and infrastructure, and increase the value of additional flood control space in reservoirs." (*Ibid*.)

DWR's Progress Report (2006)

As stated above, in July 2006, DWR issued its report titled, "Progress on Incorporating Climate Change into Management of California's Water Resources" (Progress Report). In this report, DWR describes progress made on incorporating climate change into existing water resources planning and management techniques and methodologies. The report was prepared in response to the Governor's Executive Order S-3-05, and as an opportunity to begin addressing limitations identified in DWR's 2005 Update to the California Water Plan.

Chapter 2 provides a statewide overview of California's water resources, and includes a summary of potential causes of global climate change with an emphasis on aspects of climate change that pose a potential threat to California's water supplies, including: (i) observed and projected changes in air temperature, precipitation and runoff, and sea level rise, including potential effects on groundwater and Delta water quality; (ii) potential effects of climate change on future water demands, Colorado River basin, and sensitive fish species; (iii) sudden climate change; and (iv) climate change and water supply planning challenges. Chapter 3 provides an overview of global climate change studies being conducted by DWR. DWR's study efforts, whenever appropriate, focused on the four climate change scenarios selected by the "Climate Action Team" (CAT), which was formed in response to Executive Order S-3-05. Specifically, DWR's initial studies focused on the potential effects of climate change to four main California water resources areas: (i) SWP and CVP operations; (ii) Delta water quality, including possible increases in sea level; (iii) flood management and water supply forecasting; and (iv) changes in evapotranspiration rates and the consumptive use of irrigation water.

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[3] The source of this modeling is cited in the 2005 Water Plan References as: Knowles Noah, and Cayan D. 2002. Global Climate Change: Potential Effects on the Sacramento/San Joaquin Watershed and the San Francisco Estuary. Geophysical Research Letters 29.

Chapters 4 and 5 are of particular importance because they focus on climate change impacts on SWP and CVP operations and on the Delta. The results of the analysis undertaken in Chapter 4 suggest several potential climate change impacts on overall SWP and CVP operations and deliveries. For example, in three of the four climate scenarios simulated, CVP north-of-Delta reservoirs experienced shortages during droughts. DWR recommends that future studies examine operational changes that could avoid these shortages. At present, DWR concludes it is not clear whether such operational changes "will be insignificant or substantial." (Progress Report, p. III.)

The report also found that changes in annual average SWP south-of-Delta Table A deliveries ranged from a slight increase of about 1% for a wetter scenario to about a 10% reduction for one of the drier climate change scenarios. In three drier climate change scenarios, increased winter runoff and lower Table A allocations resulted in somewhat higher annual average Article 21 deliveries (Article 21 of the SWP long-term water supply contracts permits delivery of water excess to the delivery of Table A water and some other water types to those SWP contractors requesting it). The increase in Article 21 deliveries did not fully offset losses to Table A. In contrast, the wetter scenario with higher Table A allocations results in fewer Article 21 delivery opportunities and decreased annual average Article 21 deliveries. Changes in annual average CVP south-of-Delta deliveries ranged from increases of about 2.5% for the wetter scenario and decreases of up to 10% for drier climate change scenarios. Future studies will have to address how north-of-Delta shortages could impact south-of-Delta CVP deliveries. For both the SWP and CVP, carryover storage (*i.e.*, water stored from one year over the next) was negatively affected in the drier climate change scenarios and slightly increased in the wetter scenario.

DWR also pointed out that sea level rise effects on water project operations were not examined due to lack of existing tools for that type of analysis. DWR noted that future work in this area will include the development of the necessary tools to quantify the impacts of sea level rise on saltwater intrusion and the incremental water supply impacts to repulse greater saltwater intrusion forces into the Delta. Chapter 5 focuses on potential impacts of climate change on Delta water quality and water levels. DWR concluded that while tools are being developed to quantify the incremental impacts of sea level rise on water supplies to counteract increased saltwater intrusion, until such tools become available, DWR's preliminary analysis provided an indication of the water project operational challenges due to sea level rise.

DWR's Progress Report (2006) is not without its critics. However, DWR is making progress on incorporating global climate change issues into its management of California's water supplies and DWR's efforts are responsive to the directives of both the Governor and the Legislature to make progress toward assessing the impacts to California on global warming, including impacts to water supplies.

In short, the literature cited by DWR, and the most recent report prepared by DWR, confirm that, over time, California water supply managers will need to modify the methods used to manage water supplies in order to build-in the flexibility needed to address a dynamic water supply environment. However, it appears that more information is needed in order to draw definitive conclusions regarding the implications of climate change on water supplies. DWR has also committed to continue to incorporate new information in successive updates to the California Water Plan. At the same time, though, DWR itself concedes that its latest reporting effort is preliminary, incorporates several assumptions, reflects a limited number of climate change scenarios, and does not address the likelihood of occurrence of each scenario. For those reasons, DWR has concluded that the literature and study results to date are not sufficient by themselves to make "policy decisions." (Progress Report, p. II.)

Monterey Plus Draft EIR (October 2007)

In October 2007, DWR issued the Draft EIR for the Monterey Amendments to the State Water Project Contracts (including Kern Water Bank Transfer) and associated actions as part of the Monterey Settlement Agreement (Monterey Plus Draft EIR; SCH No. 2003011118). In Section 12 of the Monterey Plus Draft EIR, DWR considered the impacts of climate change on the proposed project and the impacts of the proposed project on climate change.

When evaluating the potential impacts to water resources in California resulting from global climate change, DWR noted the lack of cohesive results among the various water modeling programs:

> Although current models are broadly consistent in predicting probable increases in global air temperatures and levels of GHGs resulting from human activities, there are considerable uncertainties about precipitation estimates. For example, many regional modeling analyses conducted for the western United States indicate that overall precipitation will increase, but uncertainties remain due to differences among larger-scale General Circulation Models (GCMs). Some researchers believe that climate warming might push the storm track on the West Coast further north, which would result in drier conditions in California. At the same time, relatively newer GCMs, including those used in the National Water Assessment, predict increases in California precipitation.

(Monterey Plus Draft EIR, pp. 12-3 through 12-4.) DWR further noted that while GCMs and hydrologic models (*i.e.*, CALSIM) have been utilized in a number of California climate change studies, many of the studies have failed to "address inter-annual variability or scaling issues inherent in mapping GCM model output to more detailed watershed hydrologic models. As a result, such studies do little more than make qualitative statements about the implications of these changes to environmental impacts (e.g., water quality, agriculture, fisheries.)" (*Id.* at. p. 12-4.)

In light of the lack of uniformity between the modeling programs, and the inconsistent results produced by various modeling program, DWR concluded that "[o]ne of the most important areas of research associated with the potential impacts of climate change on California's water resources is the further development of tools to predict changes in the timing or amount of future water availability." (Monterey Plus Draft EIR, p. 12-9.) According to DWR:

> To effectively assess the potential impacts of climate change on California's water system, a model is needed that represents the operation of the system and has the ability to accept input from climate change impact studies related to the Central Valley. The model requires a descriptive, rather than prescriptive approach. A descriptive approach would use observed data in the model without regulatory limits on operations to represent a more realistic view of the operation of California's water system.

(*Id*. at p. 12-10.) DWR further stated that the "major fault" with CALSIM is its "inability to utilize hydrologic data not related to the 73 years of historical data for which the model has been validated." (*Ibid*.)

Accordingly, as no model currently exists to accurately forecast the impacts to water resources resulting from climate change, and because the "degree to which these [climate change] effects will be felt between now and 2020 has not been studied and remains unknown," the Monterey Plus Draft EIR did not incorporate climate change into the CALSIM II modeling. (Monterey Plus Draft EIR, p. 12-12.) Nonetheless, citing its Progress Report, DWR concluded that it is likely that SWP water supplies will become less reliable "under the trends that have been identified with climate change." (*Id*. at p. 12-14.)

The Monterey Plus Draft EIR also briefly considered its carbon footprint, noting that the proposed project "could result in some added GHG emissions as a result of post-Monterey Amendment SWP operations." (Monterey Plus Draft EIR, p. 12-14.) DWR underscored it commitment to reduce its carbon intensity reliance, noting that: (i) it does not intend to renew its contract for power from a coal-fired power plant; (ii) it recently filed an intent to register with the California Climate Action Registry; and (iii) it is evaluating alternative power sources. (*Ibid*.) However, after concluding that there is no applicable significance threshold, DWR did not prepare an emissions inventory for the proposed project. DWR did conclude in the Monterey Plus Draft EIR, though, that while the proposed project is not significant on a project-specific basis, the proposed project may be cumulatively significant due to "a lack of clear scientific and regulatory criteria for determining the level of significance of the project's contribution." (*Id*. at p. 12-15.)

Citing a recently published California Energy Commission report, titled Climate Change and California Water Resources: A Survey and Summary of the Literature, DWR concluded that managing water

resources in light of the changing climate will likely prove to be different than managing for historic variability, particularly due to the lack of "accurate and consistent information about how precipitation patterns, timing, and intensity will change" and the lack of "methodologies and tools to incorporate future climate change scenarios into current hydrologic models." (Monterey Plus Draft EIR, p. 12-16.)

DWR's SWP Delivery Reliability Report (2007)

DWR issued "The State Water Project Delivery Reliability Report 2007" (August 2008) (2007 Reliability Report). The 2007 Reliability Report updates the 2005 Reliability Report, and describes three areas of significant uncertainty to SWP delivery reliability: (a) the recent and significant decline in pelagic organisms in the Delta (open-water fish such as striped bass, Delta smelt, and longfin smelt); (b) climate change and sea level rise; and (c) the vulnerability and potential failure of Delta levees. The inclusion of new areas of uncertainty distinguishes the 2007 Reliability Report from earlier reports by including estimates of the potential reductions to SWP delivery reliability due to the pelagic organism decline and future climate changes.

As described in the 2007 Reliability Report, simulations to evaluate future (2027) SWP delivery reliability incorporate the current interim court-ordered operating rules related to Delta smelt and a range of possible climate change impacts to hydrology in the Central Valley. Therefore, for 2027, ten simulations were used to reflect the four assumed scenarios for climate change and the two levels of operating rules.

The 2007 Reliability Report observes that "climate change can potentially affect SWP delivery by altering the timing and amount of source water." (2007 Reliability Report, p. 31.) In order to evaluate water availability, the report "estimates climate change impact to SWP deliveries by interpolating between future studies that assume no climate change and studies that assume 2050 emissions." (*Id*. at p. 32; see also 2007 Reliability Report, Appendix B.)

Progress Report Update (2008)

In 2008, DWR, in connection with Reclamation and the Department of Land, Air and Water Resources at the University of California, Davis, published an article in *Climatic Change* titled "Progress on Incorporating Climate Change into Management of California's Water Resources" (Progress Report Update). The Progress Report Update presents "preliminary efforts by agencies managing California's water resources to incorporate climate change research into their planning and management tools." (Progress Report Update, p. 1.) The Progress Report Update also provides an "overview" of the efforts documented in the original Progress Report (2006), and presents an impact analysis that focuses on five (5) issues: (1) snowpack; (2) runoff; (3) operations of the SWP and CVP; (4) water quality and water levels

in the Sacramento-San Joaquin Delta for both present and future sea level rise conditions; and (5) evapotranspiration rates. (*Ibid.*)

The preliminary impact assessments were conducted using four (4) climate change scenarios that represent two (2) greenhouse gas emission scenarios identified by the Intergovermental Panel on Climate Change that were simulated by two (2) global climate models. (Progress Report Update, p. 5.) In order to examine potential impacts, the authors relied on a sequence of four models -- a global climate model (*i.e.*, GFDL or PCM); a regional downscaling model (*i.e.*, VIC); a SWP-CVP-specific impacts model (*i.e.*, CalSim-II); and a Delta-specific impacts model (*i.e.*, DSM2). (*Ibid.*; see also Figure 6: Approach for Analyzing Potential Water Resources Impacts on Climate Change.)

Anticipated impacts include greater amounts of winter-season runoff, which could lead to greater uncontrolled releases from the SWP and CVP reservoirs (should flood protection rules remain static), and reduced spring-season runoff, which could lead to decreased water supplies and deliveries. (Progress Report Update, p. 16.) The analysis concludes that while there is "general consensus" regarding the expected impacts, "the magnitudes and onset-timing of impacts . . . are uncertain and scenario dependent." (*Ibid*.) Accordingly, the authors recommend that the analytical mindset be expanded from assessing potential impacts to assessing the risk potential associated with individual climate scenarios, and, in that regard, note that DWR, Reclamation, and climate researchers currently are undertaking a project that evaluates how to apply risk assessment principles to the study of climate change impacts. (*Ibid*.)

Managing An Uncertain Future (2008)

In October 2008, DWR issued a new white paper, titled "Managing An Uncertain Future: Climate Change Adaptation Strategies for California's Water" (Managing An Uncertain Future), as part of its update to the California Water Plan and in connection with the California Resources Agency's preparation of the draft statewide Climate Adaptation Plan.[4] This white paper is not focused on forecasting specific quantities of future water supply or demands, but instead "recommends a series of adaptation strategies for state and local water managers to improve their capacity to handle change." (Managing An Uncertain Future, p. 1.)

The white paper begins with a bulleted list of "[w]hat we know," which includes findings that: "[h]istoric hydrologic patterns can no longer be solely relied upon to forecast the water future;" precipitation and runoff patterns are changing, increasing uncertainty in water supply; additional monitoring and

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[4] The purpose of the Climate Adaptation Plan is not to develop strategies to reduce GHG emissions, but to develop mechanisms that ensure California is able to efficiently adapt to the changing climate. (See www.climatechange.ca.gov/adaptation.)

researching is required to understand the connection between the changing climate, water resources, and the environment; "[e]xtreme climatic events will become more frequent;" "[i]mpacts and vulnerability will vary by region;" and, an "array" of adaptation strategies is necessary to ensure that the state responds to climate change as best as possible. (Managing An Uncertain Future, p. 2.) In contrast to findings regarding "[w]hat we know," is the white paper's observation that "the exact conditions of future climate change remain uncertain," further evidencing the general conclusion that the exact implications of climate change on water resources is unknown at this time -- the white paper observes that change is coming; however, the parameters of that change are unknown. (*Id*. at p. 3.) Nonetheless, the white paper highlights some anticipated "challenges ahead," which include: the loss of natural snowpack storage; an increase in the frequency and intensity of drought in some regions; an increase in high frequency flood events in some regions; changes in water quality; an increase in the sea level; and, a reduction in the reliability of California's hydroelectricity operations. (*Id*. at p. 4-7.)

The white paper then proceeds to present 10 climate change adaptation strategies, as summarized below:

1. Provide sustainable funding for statewide and integrated regional water management.
2. Fully develop the potential of integrated regional water management, which provides a "comprehensive approach for determining the appropriate mix of water demand and supply management options and water quality actions. (Managing An Uncertain Future, p. 11.)
3. Aggressively increase water use efficiency in order to meet Governor Schwarzenegger's goal to achieve a statewide 20 percent reduction in per capita water use by 2020. (*Id*. at p. 13.)
4. Practice and promote integrated flood management.
5. Enhance and sustain ecosystems because "integrated systems . . . suffer less damage from, and recover more quickly after, severe natural disruptions." (*Id*. at p. 21.)
6. Expand water storage and conjunctive management of surface and groundwater resources.
7. Fix Delta water supply, quality and ecosystem issues.
8. Preserve, upgrade and increase monitoring, data analysis and management in order to remedy the "large gaps in the hydrologic observational network (*e.g.*, rain and snow gauges) in the areas of California most vulnerable to climate change." (*Id*. at p. 27.)
9. Plan for and adapt to sea level rise.
10. Identify and fund focused climate change impacts and adaptation research and analysis.

As noted in the white paper, "[s]everal of the recommendations . . . are ready for immediate adoption, while others need additional public deliberation and development. Some can be implemented under existing resources and authority, while the majority will require new resources, sustained financial investment and significant collaborative investment." (Managing An Uncertain Future, p. 1.)

Using Future Climate Change Projections (2009)

In April 2009, DWR issued a draft paper, titled "Using Future Climate Projections to Support Water Resources Decision Making in California" (Using Future Climate Change Projections).[5] The key findings of that report, which are based on 12 modeled climate change scenarios, follow:

Since the 2006 climate change assessment (DWR 2006), several advances have been made in using future climate projection information in water resources planning in California, including improved understanding of how well selected climate models represent historical climate conditions and refined methodologies for representing streamflows, outdoor urban and agricultural water demands, and sea level rise in planning tools. The range of impacts presented in this paper indicates the need for adaptation measures to improve the reliability of future water supplies in California (DWR 2008).

Possible climate change impacts to SWP and CVP operations were assessed using 12 future climate projections (Section 2.2). . . . Uncertainties in the results increase as the projections move further into the future. . . . The reliability of the SWP and CVP water supply systems is expected to be reduced for the range of future climate projections studied (Section 5.2.3).[6]

The report also found, however, that the following additional work is needed to better improve the use of future climate change projection information in water resources planning:

- Improve understanding of the uncertainties associated with future climate projections including relative likelihoods of future greenhouse gas emissions scenarios and sea level rise estimates.
- Improve understanding about how uncertainties and unknowns in each step of developing the simulations, scaling the data, and representing system operations affect the final information provided to decision makers.
- Develop and apply enhanced downscaling techniques that can account for the physical processes as well as statistical properties.
- Develop a dynamical downscaling technique for the state.
- Develop and apply a meso-scale model (such as MM5) or Weather Research and Forecasting (WRF) Model for California, and archive the data for public dissemination.
- Explore methods for incorporating possible changes in variability in future climate and hydrologic conditions (non-stationarity) into impact analyses.

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[5] See http://baydeltaoffice.water.ca.gov/climatechange/ClimateChangeApr09.pdf.

[6] *Id*. at pp. 2-3.

- Further enhance existing management decision support tools or develop new tools for assessing risks of climate change on California's water systems and for exploring adaptation measures such as possible re-operation of existing or projected future water resources systems to reduce the impacts of climate change.

- Develop guidelines for climate change analysis for selection of future climate projections, proper length of planning horizon, etc.

- Improve cross-sector coordination and integration of climate change related analyses.[7]

As such, DWR's Using Future Climate Change Projections report supports the conclusion that while regional modeling efforts have improved over the years, uncertainty still remains regarding potential climate change effects on water supply reliability.

DWR's SWP Delivery Reliability Report (2009)

In January 2010, DWR released the "Draft State Water Project Delivery Reliability Report" (2009 Draft Reliability Report).[8] As in previous reports, estimates of SWP deliveries are based on operation simulations run with the CalSim II model using an extended record of runoff patterns; these patterns have been adjusted to reflect the levels of development in the source areas and, for future conditions, possible impact due to climate change accompanying sea level rise. The 2009 Draft Reliability Report also incorporates regulatory requirements for SWP and CVP operations in accordance with recent biological opinions from federal agencies.

Per the 2009 Draft Reliability Report, there are "three significant factors contributing to uncertainty" in SWP delivery reliability, one of which includes the "possible effects from climate change and sea level rise."[9] In order to better understand the potential effects, the 2009 Draft Reliability Report utilized in its modeling a climate change scenario that represents the median effects of 12 scenarios addressed in DWR's Using Future Climate Change Projections report, summarized immediately above. The draft report found that "climate changes have the potential to simultaneously affect the availability of source water, the ability to convey water, and users' demands for water."[10]

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[7] *Id.* at p. 46.

[8] *See* http://baydeltaoffice.water.ca.gov/swpreliability/DRAFT-DelRelRep2009.pdf.

[9] *Id.* at p. 17.

[10] *Id.* at p. 18.

Other Selected Reports and Studies

Urban Water Management Plan (December 2005)

The 2005 Urban Water Management Plan (UWMP) for the CLWA service area addresses the potential effects of global warming on California's future water supplies. Relying upon DWR's California Water Plan Update (2005), the UWMP identifies some potential impacts of global warming, based on more than a decade of scientific studies on the subject. The potential impacts include the production of hydrologic conditions, variability, and extremes that are different than what current water systems are designed to manage. Other potential impacts consist of questions on how rapidly impacts may occur to water supplies, and whether water planners and managers can protect against sudden changes.

Like other water purveyors, CLWA is relying upon DWR's commitment to continue to update and refine modeling efforts based on on-going scientific data, and to incorporate that information into future plans, reports, and studies issued by DWR. In the interim, however, CLWA and the retail purveyors in the Santa Clarita Valley have thoroughly described the available water resources in the Valley, including available local groundwater supplies, for the 25-year period covered by the UWMP. By law, the UWMP must be updated every five years, with the next update to occur no later than December 2010. The update also may be amended at any time, based on the discretion of CLWA and the retail purveyors in the Santa Clarita Valley. This five-year updating requirement ensures that global climate change and its effects on local and imported supplies will be taken into account and regularly reported.

As to local groundwater supplies, the UWMP summarizes well-established findings from recent studies and groundwater modeling, which confirm that the local groundwater basin (Alluvial aquifer and Saugus Formation) is operating within sustainable yields and, as such, the basin remains in good operating condition and can continue to support pumping in the operating ranges reflected in the 2005 UWMP, or slightly higher, without adverse results (e.g., long-term water level decline, "overdraft," or degradation of groundwater quality). The primary studies that support these findings are as follows:

(a) Richard C. Slade & Associates, LLC, "2001 Update Report, Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems," prepared for Santa Clarita Valley Water Purveyors (July 2002);

(b) CH2MHill "Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration" (April 2004);

(c) CH2MHill, Technical Memorandum "Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California" (August 2005);

(d) CH2MHill and Luhdorff & Scalmanini, Consulting Engineers, "Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California" (August 2005);

(e) UWMP, including Appendix C, "Groundwater Resources and Yield in the Santa Clarita Valley" (December 2005); and

(f) 2006 Santa Clarita Valley Water Report (May 2007).

The August 2005 Basin Yield Report described and modeled the groundwater operating plan for the Valley. The model simulated a 78-year period of groundwater pumping, natural groundwater recharge (from rainfall and river storm flows), and natural groundwater flow and discharge that occurs in the basin. This 78-year rainfall record was derived from historical rainfall records dating back to the 1920s. Based on a review of those historical records, the simulated rainfall pattern was derived with two objectives in mind. First, the record was designed to capture historic cycles in rainfall, alternating periods of below-normal rainfall, then periods of above-normal rainfall, followed by periods of below-normal rainfall, etc. The 78-year rainfall record contained four periods of generally below-normal rainfall (ranging in length from seven to 15 years) and five periods of generally above-normal rainfall (ranging in length from six to eight years). Second, the record was designed to have a long-term volume of rainfall equal to the historic long-term average rainfall over the past several decades.

In summary, the rainfall pattern that was used in the modeling analysis was based on actual historic long-term rainfall and historic dry cycles and wet cycles. Thus, changes in climatic conditions over the past 78-year period were taken into account. If future climate change studies are published by DWR that predict changes in the strengths of future droughts and future wet periods, these effects could then be incorporated into the groundwater model to test the potential influence of climate change on the groundwater system; of course, any future studies that attempt to predict climate change effects on future local rainfall patterns are likely to have significant uncertainties. Nonetheless, when such studies are completed and available, CLWA and the local purveyors will consider them in local water planning efforts. Until then, however, CLWA and the local purveyors are relying upon the best available information presented in the reports and studies referenced above.

Emissions Pathway Report

"Emissions Pathways, Climate Change, Impacts on California," by Katharine Hayhoe, *et al.*, dated August 24, 2004 (Hayhoe 2004), has discussed the magnitude of future climate changes based on climate projections from the modeling of greenhouse gas emissions scenarios out to the year 2100. This report shows that, by the end of the century, due to increased temperatures, the Sierra snowpack could be reduced by 30-70 percent under one emissions scenario, and as high as 73-90 percent under another

emissions scenario. The increased temperatures, along with impacts on runoff and stream flow, combined with modest declines in winter precipitation, could fundamentally disrupt California's water resources. (Emissions Pathway Report, p. 1.)

Pondering a Climate Conundrum

Other literature calls attention to the ongoing debate over global warming and its effects. For example, in an article presented in *Nature* (Online Version) entitled, "Pondering a Climate Conundrum in Antarctic," it has been suggested that there are cooling trends, not necessarily global warming. In that article, the authors noted a "[u]nique, distinct cooling trend discovered on the Earth's southernmost continent Antarctica overall has cooled measurably during the last 35 years - despite a global average increase in air temperature of 0.06 degrees Celsius during the 20th century - making it unique among the Earth's continental landmasses."

Water Management Strategies

The Natural Resources Defense Council has prepared a report summarizing the "broad potential water management impacts of climate change, the many existing climate-related activities of water managers around the West, and a full range of recommendations for water managers and staff to consider as they incorporate global warming into the planning and management of their agencies."[11] After generally surveying the potential impacts of global climate change to water supply, flood management, water quality, aquatic ecosystems, and hydropower, and the effectiveness of presently utilized water management strategies to combat climate change impacts, the report proposes a four-part water management strategy for use by water managers that consists of: (i) evaluation of a water system's potential vulnerabilities at both a local and regional level; (ii) development of responsive strategies; (iii) commitment to global climate change prevention and the endorsement of GHG emissions reductions; and (iv) increased public outreach to improve awareness of global warming and climate change. As part of this strategy, and in order to better understand and prepare for the potential impacts to water resources as a result of global climate change, the report calls on various entities and individuals to provide additional funding for research.

Climate Warming and Water Management Adaptation for California

Tanaka *et al.* (2006) explore the ability of California's water supply system to adapt to long-term climatic and demographic changes using the California Value Integrated Network (CALVIN), a statewide

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[11] See, Nelson, Barry, et al., July 2007, "In Hot Water: Water Management Strategies to Weather the Effects of Global Warming."

economic-engineering optimization model of water supply management.[12] The results show agricultural water users in the Central Valley are the most sensitive to climate change, particularly under the driest and warmest scenario (*i.e.*, PCM 2100), and predict a 37% reduction of Valley agricultural water deliveries and a rise in Valley water scarcity costs by $1.7 billion. Though the results of the study are only preliminary, they suggest that California's water supply system appears "physically capable of adapting to significant changes in climate and population, albeit at a significant cost." Such adaptation would entail changes in California's groundwater storage capacity, water transfers, and adoption of new technology.

Trends in Snowfall versus Rainfall in the Western United States

To better understand the nature of the observed changes in snowpack and streamflow timing in the west, Knowles *et al.* (2006) address historical changes in the relative contributions of rainfall and snowfall.[13] The study documents a regional trend toward smaller ratios of winter-total snowfall water to winter-total precipitation during the period of 1949-2004. The trends toward decreased winter-total snowfall are a response to warming across the region, with the most significant decreases occurring where winter wet-day minimum temperatures were on average warmer than -5° over the study period. The authors suggest that, if warming trends continue, the snowfall fraction of precipitation is likely to continue to decline, which combined with earlier melting of the remaining accumulations of snowpack, will diminish the West's natural freshwater storage capacity. This trend could, in turn, exacerbate tensions between flood control and storage priorities that many western reservoir managers face.

Climate Change Impacts on Water for Agriculture in California:
A Case Study in the Sacramento Valley

Joyce *et al.* (2006) employ the Water Evaluation and Planning (WEAP) system, a hydrologic model that was developed for the Sacramento River Basin.[14] The study found that increasing temperatures could put a strain on the basin's water resources. Assuming an increasing urban demand for water, the effects of climate change could be mitigated if the agricultural sector adapts to the new environment. The authors considered the effect of increased irrigation efficiency and shifts in cropping and found that groundwater pumping between 2070 and 2100 was reduced when these practices were adopted.

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[12] See, Tanaka, S.K., et al., 2006. "Climate Warming and Water Management Adaptation for California. *Climatic Change*," Vol. 76, No. 3-4, June 10, 2006.

[13] Knowles, N., and D. R. Cayan. 2002. "Potential Effects of Global Warming on the Sacramento/San Joaquin Watershed and the San Francisco Estuary." *Geophysical Research Letters* 29(18):1891, doi:10.1029/2001GL014339.

[14] Joyce, B., et al. 2006. "Climate Change Impacts on Water for Agriculture in California: A Case Study in the Sacramento Valley." California Climate Change Center, State of California. White Paper, CEC-5500-2005-194-SF, March 2006.

Climate Scenarios for California

Cayan *et al.* (2006) consider two GHG emissions scenarios, a medium-high and a low.[15] The study found that California will experience a warming trend from 2000 to 2100, with temperatures rising between 1.7 and 5.8E C, depending on the model and the scenario chosen. This increase in temperature could potentially impact snowpack levels as the state experiences less snow and more rain. The results also indicate that snowpack in the Sierra Nevada could be reduced 32-79%, depending on the model and scenario chosen. The study does not consider the ability of California's water supply system to adapt to these potential changes.

Global Climate Change Impacts in the United States (2009)

This report summarizes the science of climate change, and the current and projected impacts of climate change on the United States.[16] With respect to water resources, the report concludes that "[t]he impacts of climate change include too little water in some places, too much water in other places, and degraded water quality."[17] With respect to the southwest regional analysis, the report found that "[w]ater supplies are projected to become increasingly scarce, calling from trade-offs among competing uses, and potentially leaded to conflict."[18] With that said, the report underscores:

> One of the main messages to emerge from the past decade of synthesis and assessments is that while climate change is a global issue, it has a great deal of regional variability. There is an indisputable need to improve understanding of climate system effects at these smaller scales, because these are often the scales of decision making in society. Understanding impacts at local scales will also help to target finite resources for adaptation measures. . . Further work is needed on how to quantify cumulative uncertainties across spatial scales and the uncertainties associated with complex, intertwined natural and social systems.[19]

Analysis of Groundwater Supplies in the Santa Clarita Valley (August 2009)

The Santa Clarita Valley Purveyors (comprised of the Los Angeles County Waterworks District 36, Newhall County Water District, Santa Clarita Water Division of the Castaic Lake Water Agency and Valencia Water Company) recently analyzed the groundwater development potential and possible

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[15] Cayan, D., et al. 2006. "Climate Scenarios for California. California Climate Change Center, State of California. White Paper" CEC-500-2005-203-SF, March 2006.

[16] U.S. Global Climate Research Program, 2009, *Global Climate Change Impacts in the United States*.

[17] *Id.* at p. 41.

[18] *Id.* at p. 129.

[19] *Id.* at p. 154.

augmentation of the groundwater operating plan for Santa Clarita Valley. This analysis was undertaken in part for preparation of the next UWMP (anticipated in 2010) and in part because of recent events that are expected to impact the future reliability of the principal supplemental water supply for Santa Clarita Valley (i.e., the State Water Project). The analysis, entitled *Analysis of Groundwater Supplies and Groundwater Basin Yield Upper Santa Clara River Groundwater Basin, East Subbasin*, was published in August 2009.

The primary objective of the updated analysis of groundwater basin yield in the Santa Clarita Valley was to evaluate the planned utilization of groundwater by the Purveyors, after their consideration of potential impacts on traditional supplemental water supplies from the SWP, and with recognition of (i) the ongoing pumping by others for agricultural and other private water supply, (ii) the sustainability of the groundwater resource, and (iii) the physical ability to extract groundwater at desired rates.

A second objective of the updated groundwater basin yield analysis was to investigate and describe potential impacts of expected climate change on the groundwater basin and its yield. A third objective was to consider potential augmentation of basin yield via potential artificial groundwater recharge using storm water runoff in selected areas of the basin as being planned by the Los Angeles County Flood Control District.

With respect to the second objective, and as stated in Section 5.4, Climate Change Summary, of the analysis:

> Examination of the three simulated climate change scenarios was undertaken to provide a level of quantification to the possible impact of climate change on local groundwater basin yield and availability of groundwater as part of overall water supply to the Valley. In light of the range of global climate model output that was considered for development of the local scenarios analyzed herein, it is obvious that there is neither a unique result that can be expected to become a representative hydrologic condition in the Valley, nor is there a unique result that can be expected in terms of basin yield and associated sustainable groundwater supply as an outcome of climate change. Obviously, the Valley does not get to "choose" a future climate scenario, but rather will have to manage within whatever future patterns of rainfall actually occur over time, whether the future rainfall exhibit wet-dry cycles that are similar to or different from historically recorded conditions.
>
> [¶] Perhaps most useful in the consideration of climate change effects analyzed herein is with respect to results over the UWMP planning horizon of 20 to 25 years. For the range of relatively wet to relatively dry conditions analyzed herein, all three scenarios suggest that the 2008 Operating Plan can be considered sustainable and, with the same local exceptions as simulated through a repetition of historical hydrology (e.g. mainly at and above Mint Canyon), achievable over the UWMP planning horizon. Beyond that horizon,

greater uncertainty exists because the global climate models use different emissions scenarios and also become increasingly uncertain over time because of predictive uncertainty pertaining to the forward-looking representation of the many physical processes that affect climate into the future. As a result, for time periods beyond the UWMP planning horizon, some models predict long-term drying and subsequent sustained declines in groundwater levels, which would result in a smaller local groundwater supply over time, while other models predict hydrologic conditions similar to or wetter than those that have been historically observed, in which case the 2008 Operating Plan can be considered sustainable, albeit with some local issues relative to actual pumping capability at certain times (mainly in the Alluvium at the eastern end of the Valley).

Conclusions Reached From Literature Survey

In summary, DWR has not yet fully incorporated parameters to account for climate change; however, as the literature and modeling tools continue to develop in order to assess such risks, DWR will incorporate such information into successive updates to the California Water Plan. In addition, DWR is committed to the preparation of the biennial assessment reports of SWP delivery reliability. In the meantime, DWR reports that the results of its updated reports represent the best available information at this time.

Based on the above data, DWR should continue to utilize on-going studies, as they become available, in developing strategies for the future management and development of California's water resources. At this time, however, it is appropriate to terminate any further analysis of potential future global climatic changes and their effects on California's water supplies, consistent with Section 15145 of the CEQA Guidelines.

APPENDIX 5.0

Project Alternatives

Emissions Calculations

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: M:\Work\Pasadena Server-Alan Sako\032.223 Mission Village\AQ\Alternatives\Alt 3 Mission Village Operational.urb924
Project Name: Mission Village - Alternative 3 Operational
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	146.03	49.27	62.56	0.00	0.21	0.21
TOTALS (lbs/day, mitigated)	146.03	49.27	62.56	0.00	0.21	0.21
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	156.77	162.98	1,617.44	3.25	526.26	102.45
TOTALS (lbs/day, mitigated)	142.74	145.66	1,445.42	2.89	470.30	91.53
Percent Reduction	8.95	10.63	10.64	11.08	10.63	10.66

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	302.80	212.25	1,680.00	3.25	526.47	102.66
TOTALS (lbs/day, mitigated)	288.77	194.93	1,507.98	2.89	470.51	91.74
Percent Reduction	4.63	8.16	10.24	11.08	10.63	10.64

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	3.74	48.80	23.73	0.00	0.09	0.09
Hearth - No Summer Emissions						
Landscape	5.30	0.47	38.83	0.00	0.12	0.12
Consumer Products	125.27					
Architectural Coatings	11.72					
TOTALS (lbs/day, unmitigated)	146.03	49.27	62.56	0.00	0.21	0.21

Area Source Mitigated Detail Report:

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AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Mitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	3.74	48.80	23.73	0.00	0.09	0.09
Hearth - No Summer Emissions						
Landscape	5.30	0.47	38.83	0.00	0.12	0.12
Consumer Products	125.27					
Architectural Coatings	11.72					
TOTALS (lbs/day, mitigated)	146.03	49.27	62.56	0.00	0.21	0.21

Area Source Changes to Defaults

Percent residential using natural gas changed from 78% to 100%

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 100%

The number of persons per household for consumer product use changed from 3 persons to 2.45 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	7.03	7.80	78.30	0.16	25.41	4.95
Apartments low rise	19.46	20.50	205.95	0.41	66.84	13.01
Condo/townhouse general	56.39	60.78	610.51	1.22	198.14	38.57
Retirement community	6.04	5.58	56.07	0.11	18.20	3.54
Congregate care (Assisted Living)	3.80	3.24	32.54	0.07	10.56	2.06
Elementary school	8.49	4.59	44.63	0.09	14.42	2.81
Library	8.47	8.90	84.95	0.17	27.05	5.27
City park	0.53	0.40	3.81	0.01	1.27	0.25
Regnl shop. center	13.50	14.62	139.01	0.28	45.35	8.83
General office building	15.96	17.57	172.92	0.35	56.91	11.07
Office park	16.66	18.51	183.91	0.37	60.48	11.77
Firestation	0.44	0.49	4.84	0.01	1.63	0.32
TOTALS (lbs/day, unmitigated)	156.77	162.98	1,617.44	3.25	526.26	102.45

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Operational Mitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Mitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	6.51	7.14	71.73	0.14	23.28	4.53
Apartments low rise	17.49	18.03	181.15	0.36	58.79	11.44
Condo/townhouse general	51.37	54.47	547.10	1.09	177.56	34.56
Retirement community	5.04	4.33	43.51	0.09	14.12	2.75
Congregate care (Assisted Living)	3.04	2.28	22.92	0.05	7.44	1.45
Elementary school	8.14	4.19	40.76	0.08	13.16	2.56
Library	7.75	8.12	77.57	0.15	24.70	4.81
City park	0.50	0.36	3.48	0.01	1.16	0.23
Regnl shop. center	12.38	13.35	126.94	0.25	41.41	8.06
General office building	14.73	16.04	157.90	0.32	51.97	10.11
Office park	15.38	16.90	167.94	0.34	55.23	10.74
Firestation	0.41	0.45	4.42	0.01	1.48	0.29
TOTALS (lbs/day, mitigated)	142.74	145.66	1,445.42	2.89	470.30	91.53

Operational Settings:

Includes correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2020 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	56.00	9.90	dwelling units	168.00	1,663.20	14,711.01
Apartments low rise	39.62	6.90	dwelling units	634.00	4,374.60	38,693.34
Condo/townhouse general	101.31	8.00	dwelling units	1,621.00	12,968.00	114,701.98
Retirement community	64.20	3.71	dwelling units	321.00	1,190.91	10,533.60
Congregate care (Assisted Living) Facility	15.38	2.81	dwelling units	246.00	691.26	6,114.20
Elementary school		1.45	students	900.00	1,305.00	8,344.59
Library		84.98	1000 sq ft	36.00	3,059.28	15,657.36
City park		2.60	acres	40.90	106.34	736.93
Regnl shop. center		37.06	1000 sq ft	123.66	4,582.84	26,256.28
General office building		11.56	1000 sq ft	349.84	4,044.15	32,948.05
Office park		10.20	1000 sq ft	384.60	3,922.92	35,017.46
Firestation		7.41	1000 sq ft	13.50	100.03	941.75
					38,008.53	304,656.55

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	50.6	0.0	100.0	0.0
Light Truck < 3750 lbs	7.2	0.0	98.6	1.4
Light Truck 3751-5750 lbs	23.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	11.0	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.7	0.0	82.4	17.6
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.6	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.9	41.4	58.6	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	12.7	7.0	9.5	13.3	7.4	8.9
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
Library				5.0	2.5	92.5
City park				5.0	2.5	92.5
Regnl shop. center				2.0	1.0	97.0
General office building				35.0	17.5	47.5
Office park				48.0	24.0	28.0
Firestation				35.0	17.5	47.5

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: M:\Work\Pasadena Server-Alan Sako\032.223 Mission Village\AQ\Alternatives\Alt 3 Mission Village Operational.urb924
Project Name: Mission Village - Alternative 3 Operational
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	141.78	66.68	31.34	0.11	1.54	1.52
TOTALS (lbs/day, mitigated)	141.78	66.68	31.34	0.11	1.54	1.52
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	164.74	195.70	1,533.85	2.69	526.26	102.45
TOTALS (lbs/day, mitigated)	148.61	174.92	1,370.83	2.42	470.30	91.53
Percent Reduction	9.79	10.62	10.63	10.04	10.63	10.66

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	306.52	262.38	1,565.19	2.80	527.80	103.97
TOTALS (lbs/day, mitigated)	290.39	241.60	1,402.17	2.53	471.84	93.05
Percent Reduction	5.26	7.92	10.42	9.64	10.60	10.50

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	3.74	48.80	23.73	0.00	0.09	0.09
Hearth	1.05	17.88	7.61	0.11	1.45	1.43
Landscaping - No Winter Emissions						
Consumer Products	125.27					
Architectural Coatings	11.72					
TOTALS (lbs/day, unmitigated)	141.78	66.68	31.34	0.11	1.54	1.52

Area Source Mitigated Detail Report:

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AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Mitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	3.74	48.80	23.73	0.00	0.09	0.09
Hearth	1.05	17.88	7.61	0.11	1.45	1.43
Landscaping - No Winter Emissions						
Consumer Products	125.27					
Architectural Coatings	11.72					
TOTALS (lbs/day, mitigated)	141.78	66.68	31.34	0.11	1.54	1.52

Area Source Changes to Defaults

Percent residential using natural gas changed from 78% to 100%

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 100%

The number of persons per household for consumer product use changed from 3 persons to 2.45 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	7.51	9.37	73.92	0.13	25.41	4.95
Apartments low rise	20.21	24.63	194.43	0.34	66.84	13.01
Condo/townhouse general	59.29	73.03	576.36	1.02	198.14	38.57
Retirement community	5.86	6.71	52.93	0.09	18.20	3.54
Congregate care (Assisted Living)	3.55	3.89	30.72	0.05	10.56	2.06
Elementary school	6.87	5.50	42.86	0.07	14.42	2.81
Library	9.88	10.65	82.99	0.14	27.05	5.27
City park	0.48	0.48	3.65	0.01	1.27	0.25
Regnl shop. center	15.40	17.51	134.85	0.23	45.35	8.83
General office building	17.29	21.10	163.58	0.29	56.91	11.07
Office park	17.94	22.24	173.01	0.31	60.48	11.77
Firestation	0.46	0.59	4.55	0.01	1.63	0.32
TOTALS (lbs/day, unmitigated)	164.74	195.70	1,533.85	2.69	526.26	102.45

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Operational Mitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Mitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	6.91	8.58	67.72	0.12	23.28	4.53
Apartments low rise	17.97	21.67	171.01	0.30	58.79	11.44
Condo/townhouse general	53.54	65.44	516.49	0.91	177.56	34.56
Retirement community	4.73	5.20	41.07	0.07	14.12	2.75
Congregate care (Assisted Living)	2.68	2.74	21.64	0.04	7.44	1.45
Elementary school	6.46	5.02	39.14	0.07	13.16	2.56
Library	9.03	9.72	75.78	0.13	24.70	4.81
City park	0.45	0.44	3.33	0.01	1.16	0.23
Regnl shop. center	14.09	15.99	123.14	0.21	41.41	8.06
General office building	15.86	19.27	149.37	0.27	51.97	10.11
Office park	16.46	20.31	157.99	0.28	55.23	10.74
Firestation	0.43	0.54	4.15	0.01	1.48	0.29
TOTALS (lbs/day, mitigated)	148.61	174.92	1,370.83	2.42	470.30	91.53

Operational Settings:

Includes correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2020 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	56.00	9.90	dwelling units	168.00	1,663.20	14,711.01
Apartments low rise	39.62	6.90	dwelling units	634.00	4,374.60	38,693.34
Condo/townhouse general	101.31	8.00	dwelling units	1,621.00	12,968.00	114,701.98
Retirement community	64.20	3.71	dwelling units	321.00	1,190.91	10,533.60
Congregate care (Assisted Living) Facility	15.38	2.81	dwelling units	246.00	691.26	6,114.20
Elementary school		1.45	students	900.00	1,305.00	8,344.59
Library		84.98	1000 sq ft	36.00	3,059.28	15,657.36
City park		2.60	acres	40.90	106.34	736.93
Regnl shop. center		37.06	1000 sq ft	123.66	4,582.84	26,256.28
General office building		11.56	1000 sq ft	349.84	4,044.15	32,948.05
Office park		10.20	1000 sq ft	384.60	3,922.92	35,017.46
Firestation		7.41	1000 sq ft	13.50	100.03	941.75
					38,008.53	304,656.55

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	50.6	0.0	100.0	0.0
Light Truck < 3750 lbs	7.2	0.0	98.6	1.4
Light Truck 3751-5750 lbs	23.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	11.0	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.7	0.0	82.4	17.6
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.6	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.9	41.4	58.6	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	12.7	7.0	9.5	13.3	7.4	8.9
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
Library				5.0	2.5	92.5
City park				5.0	2.5	92.5
Regnl shop. center				2.0	1.0	97.0
General office building				35.0	17.5	47.5
Office park				48.0	24.0	28.0
Firestation				35.0	17.5	47.5

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\032.223 Mission Village\Alternatives\Alt 4 Mission Village Operational.urb924
Project Name: Mission Village - Alternative 4 Operational
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	176.48	62.63	78.46	0.00	0.26	0.26
TOTALS (lbs/day, mitigated)	176.48	62.63	78.46	0.00	0.26	0.26
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	212.20	223.39	2,213.41	4.42	721.16	140.36
TOTALS (lbs/day, mitigated)	188.99	194.75	1,929.19	3.87	628.62	122.33
Percent Reduction	10.94	12.82	12.84	12.44	12.83	12.85

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	388.68	286.02	2,291.87	4.42	721.42	140.62
TOTALS (lbs/day, mitigated)	365.47	257.38	2,007.65	3.87	628.88	122.59
Percent Reduction	5.97	10.01	12.40	12.44	12.83	12.82

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	4.74	62.06	31.42	0.00	0.12	0.12
Hearth - No Summer Emissions						
Landscape	6.78	0.57	47.04	0.00	0.14	0.14
Consumer Products	147.89					
Architectural Coatings	17.07					
TOTALS (lbs/day, unmitigated)	176.48	62.63	78.46	0.00	0.26	0.26

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Area Source Mitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Mitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	4.74	62.06	31.42	0.00	0.12	0.12
Hearth - No Summer Emissions						
Landscape	6.78	0.57	47.04	0.00	0.14	0.14
Consumer Products	147.89					
Architectural Coatings	17.07					
TOTALS (lbs/day, mitigated)	176.48	62.63	78.46	0.00	0.26	0.26

Area Source Changes to Defaults

Percent residential using natural gas changed from 78% to 100%

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 100%

The number of persons per household for consumer product use changed from 3 persons to 2.45 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	12.81	14.20	142.62	0.28	46.29	9.01
Apartments low rise	22.22	23.41	235.19	0.47	76.33	14.86
Condo/townhouse general	64.42	69.44	697.51	1.39	226.38	44.07
Retirement community	6.90	6.38	64.10	0.13	20.80	4.05
Congregate care (Assisted Living)	4.34	3.70	37.17	0.07	12.06	2.35
Elementary school	8.49	4.59	44.63	0.09	14.42	2.81
Library	8.47	8.90	84.95	0.17	27.05	5.27
City park	0.53	0.40	3.81	0.01	1.27	0.25
Regnl shop. center	24.47	26.50	251.92	0.50	82.19	15.99
General office building	28.92	31.84	313.37	0.63	103.13	20.06
Office park	30.19	33.54	333.30	0.67	109.61	21.32
Firestation	0.44	0.49	4.84	0.01	1.63	0.32
TOTALS (lbs/day, unmitigated)	212.20	223.39	2,213.41	4.42	721.16	140.36

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Operational Mitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Mitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	11.63	12.71	127.70	0.26	41.45	8.07
Apartments low rise	19.43	19.90	199.89	0.40	64.88	12.63
Condo/townhouse general	57.28	60.45	607.24	1.21	197.08	38.36
Retirement community	5.49	4.60	46.21	0.09	15.00	2.92
Congregate care (Assisted Living)	3.26	2.34	23.48	0.05	7.62	1.48
Elementary school	8.05	4.09	39.81	0.08	12.86	2.50
Library	7.57	7.93	75.76	0.15	24.13	4.70
City park	0.50	0.36	3.40	0.01	1.13	0.22
Regnl shop. center	21.94	23.63	224.67	0.45	73.30	14.26
General office building	26.14	28.39	279.47	0.56	91.97	17.89
Office park	27.30	29.91	297.24	0.60	97.75	19.02
Firestation	0.40	0.44	4.32	0.01	1.45	0.28
TOTALS (lbs/day, mitigated)	188.99	194.75	1,929.19	3.87	628.62	122.33

Operational Settings:

Includes correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2020 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	102.00	9.90	dwelling units	306.00	3,029.40	26,795.05
Apartments low rise	45.25	6.90	dwelling units	724.00	4,995.60	44,186.09
Condo/townhouse general	115.75	8.00	dwelling units	1,852.00	14,816.00	131,047.54
Retirement community	73.40	3.71	dwelling units	367.00	1,361.57	12,043.09
Congregate care (Assisted Living) Facility	17.56	2.81	dwelling units	281.00	789.61	6,984.10
Elementary school		1.45	students	900.00	1,305.00	8,344.59
Library		84.98	1000 sq ft	36.00	3,059.28	15,657.36
City park		2.60	acres	40.90	106.34	736.93
Regnl shop. center		37.06	1000 sq ft	224.10	8,305.15	47,582.35
General office building		11.56	1000 sq ft	634.00	7,329.04	59,710.34
Office park		10.20	1000 sq ft	697.00	7,109.40	63,461.18
Firestation		7.41	1000 sq ft	13.50	100.03	941.75
					52,306.42	417,490.37

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	50.6	0.0	100.0	0.0
Light Truck < 3750 lbs	7.2	0.0	98.6	1.4
Light Truck 3751-5750 lbs	23.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	11.0	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.7	0.0	82.4	17.6
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.6	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.9	41.4	58.6	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	12.7	7.0	9.5	13.3	7.4	8.9
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
Library				5.0	2.5	92.5
City park				5.0	2.5	92.5
Regnl shop. center				2.0	1.0	97.0
General office building				35.0	17.5	47.5
Office park				48.0	24.0	28.0
Firestation				35.0	17.5	47.5

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\032.223 Mission Village\Alternatives\Alt 4 Mission Village Operational.urb924
Project Name: Mission Village - Alternative 4 Operational
Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	170.95	83.44	40.52	0.14	1.85	1.83
TOTALS (lbs/day, mitigated)	170.95	83.44	40.52	0.14	1.85	1.83
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	224.67	268.23	2,099.16	3.70	721.16	140.36
TOTALS (lbs/day, mitigated)	197.92	233.84	1,829.79	3.22	628.62	122.33
Percent Reduction	11.91	12.82	12.83	12.97	12.83	12.85

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5
TOTALS (lbs/day, unmitigated)	395.62	351.67	2,139.68	3.84	723.01	142.19
TOTALS (lbs/day, mitigated)	368.87	317.28	1,870.31	3.36	630.47	124.16
Percent Reduction	6.76	9.78	12.59	12.50	12.80	12.68

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	4.74	62.06	31.42	0.00	0.12	0.12
Hearth	1.25	21.38	9.10	0.14	1.73	1.71
Landscaping - No Winter Emissions						
Consumer Products	147.89					
Architectural Coatings	17.07					
TOTALS (lbs/day, unmitigated)	170.95	83.44	40.52	0.14	1.85	1.83

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Area Source Mitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Mitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5
Natural Gas	4.74	62.06	31.42	0.00	0.12	0.12
Hearth	1.25	21.38	9.10	0.14	1.73	1.71
Landscaping - No Winter Emissions						
Consumer Products	147.89					
Architectural Coatings	17.07					
TOTALS (lbs/day, mitigated)	170.95	83.44	40.52	0.14	1.85	1.83

Area Source Changes to Defaults

Percent residential using natural gas changed from 78% to 100%

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 100%

The number of persons per household for consumer product use changed from 3 persons to 2.45 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	13.67	17.06	134.64	0.24	46.29	9.01
Apartments low rise	23.08	28.13	222.03	0.39	76.33	14.86
Condo/townhouse general	67.74	83.43	658.49	1.16	226.38	44.07
Retirement community	6.70	7.67	60.51	0.11	20.80	4.05
Congregate care (Assisted Living)	4.05	4.45	35.09	0.06	12.06	2.35
Elementary school	6.87	5.50	42.86	0.07	14.42	2.81
Library	9.88	10.65	82.99	0.14	27.05	5.27
City park	0.48	0.48	3.65	0.01	1.27	0.25
Regnl shop. center	27.90	31.74	244.37	0.42	82.19	15.99
General office building	31.33	38.23	296.44	0.53	103.13	20.06
Office park	32.51	40.30	313.54	0.56	109.61	21.32
Firestation	0.46	0.59	4.55	0.01	1.63	0.32
TOTALS (lbs/day, unmitigated)	224.67	268.23	2,099.16	3.70	721.16	140.36

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Operational Mitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Mitigated

Source	ROG	NOX	CO	SO2	PM10	PM25
Single family housing	12.32	15.27	120.56	0.21	41.45	8.07
Apartments low rise	19.88	23.91	188.71	0.33	64.88	12.63
Condo/townhouse general	59.56	72.63	573.27	1.01	197.08	38.36
Retirement community	5.08	5.53	43.63	0.08	15.00	2.92
Congregate care (Assisted Living)	2.81	2.81	22.16	0.04	7.62	1.48
Elementary school	6.36	4.90	38.22	0.07	12.86	2.50
Library	8.82	9.49	74.01	0.12	24.13	4.70
City park	0.44	0.43	3.25	0.01	1.13	0.22
Regnl shop. center	24.94	28.30	217.93	0.37	73.30	14.26
General office building	28.11	34.10	264.37	0.47	91.97	17.89
Office park	29.18	35.94	279.62	0.50	97.75	19.02
Firestation	0.42	0.53	4.06	0.01	1.45	0.28
TOTALS (lbs/day, mitigated)	197.92	233.84	1,829.79	3.22	628.62	122.33

Operational Settings:

Includes correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2020 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	102.00	9.90	dwelling units	306.00	3,029.40	26,795.05
Apartments low rise	45.25	6.90	dwelling units	724.00	4,995.60	44,186.09
Condo/townhouse general	115.75	8.00	dwelling units	1,852.00	14,816.00	131,047.54
Retirement community	73.40	3.71	dwelling units	367.00	1,361.57	12,043.09
Congregate care (Assisted Living) Facility	17.56	2.81	dwelling units	281.00	789.61	6,984.10
Elementary school		1.45	students	900.00	1,305.00	8,344.59
Library		84.98	1000 sq ft	36.00	3,059.28	15,657.36
City park		2.60	acres	40.90	106.34	736.93
Regnl shop. center		37.06	1000 sq ft	224.10	8,305.15	47,582.35
General office building		11.56	1000 sq ft	634.00	7,329.04	59,710.34
Office park		10.20	1000 sq ft	697.00	7,109.40	63,461.18
Firestation		7.41	1000 sq ft	13.50	100.03	941.75
					52,306.42	417,490.37

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	50.6	0.0	100.0	0.0
Light Truck < 3750 lbs	7.2	0.0	98.6	1.4
Light Truck 3751-5750 lbs	23.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	11.0	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.7	0.0	82.4	17.6
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.6	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.9	41.4	58.6	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	12.7	7.0	9.5	13.3	7.4	8.9
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
Library				5.0	2.5	92.5
City park				5.0	2.5	92.5
Regnl shop. center				2.0	1.0	97.0
General office building				35.0	17.5	47.5
Office park				48.0	24.0	28.0
Firestation				35.0	17.5	47.5