Santiago Hills
Phase II Planned Community and
East Orange Planned Community
Area 1

Runoff Management Plan

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SECTION 1: INTRODUCTION

1.1 PROJECT DESCRIPTION

The planning and design of the Santiago Hills Phase II and East Orange Area 1 project has incorporated the preparation of this comprehensive ***Runoff Management Plan (ROMP).*** The ROMP addresses pre-development and post-development surface water runoff, drainage systems, and water quality management. The project encompasses the watershed for the Irvine Community Development Company's (ICDC) Santiago Hills Phase II and the East Orange Area 1 planned development generally located as shown in Figure 1.1. The existing terrain encompassed by the proposed Santiago Hills Phase II development can be generally characterized as undeveloped space surrounded by Irvine Regional Park to the north, Jamboree Road to the west, and the Eastern Transportation Corridor to the south and east, Figure 1.1. East Orange Area I is generally bounded by the Eastern Transportation Corridor to the west and the Santiago Canyon landfill to the east. The Santiago Hills II project is comprised of Tentative Tract No’s. 16199 and 16201. The East Orange Area 1 project is depicted by Tentative Tract No. 16514. The order of development will proceed as Stage 1 (TT 16199), Stage 2 (TT 16201), and finally East Orange Planned Community, Area 1 (TT 16514), Figure 1.1. The existing watershed area is generally bounded by Jamboree Road, Irvine Regional Park, Santiago Canyon landfill and Loma Ridge, as illustrated on Figure 1.2. The proposed condition watershed is shown on Figure 1.3. The difference in watershed areas between Figures 1.2 and 1.3 is the result of diversions to satisfy the objectives of Mitigation Measure W-4 from the Santiago Hills II Supplemental EIR dated 2000, discussed in detail below. The defined watershed areas generally drain to Peters Canyon Reservoir, Irvine Lake or Santiago Creek downstream of Irvine Lake.

The ROMP is intended to document current pre-development watershed conditions and analyze and outline a plan to mitigate development runoff through appropriate backbone infrastructure to accommodate issues of urban drainage, flood protection, and storm water quality. The ROMP, Volume 1 (this document) and Volume 2, Surface Water Quality are also intended to serve as a preliminary Water Quality Management Plan (WQMP). The recommended drainage infrastructure is based on the most current information for the project watershed, including approved land use and preliminary engineering studies of the development area. The ROMP addresses environmental, regulatory, and regional community issues related to watershed runoff and downstream facility impacts. The ROMP also identifies the required and recommended backbone infrastructure that will reduce potential hydrologic impacts to the appropriate levels as described in this document.

WQMP and DAMP Requirements

The project’s proposed extended detention basins, swales and hydrodynamic separators satisfy structural-treatment requirements of the Model Water Quality Management Plan (WQMP) and Orange County’s Drainage Area Management Plan (DAMP) and the City of Orange’s Local Implementation Plan (LIP).

Figure 1.1 – Vicinity Map

Figure 1.2 – Existing Watershed Boundary

Figure 1.3 – Proposed Watershed Boundary

These structural treatment controls, and the corresponding regulatory requirements, are discussed in greater detail in Volume 2, Surface Water Quality (under separate cover).

EIR Areas of Concern

Table 1.1 list items of concern and project design features to be addressed in the SEIR/EIR currently being prepared. The items deal with the potential for increased flooding at key existing drainage facilities and degradation of habitat. In each case the proposed project design features will satisfy the concern.

Table 1.1 – Areas of Concern Identified by Mitigation Measure W-4

Item of Concern	Discussion of Item	Project Design Features
Potential flooding impacts to Handy Creek downstream of Peters Canyon Reservoir within Orange Park Acres, an item brought forward by County of Orange and Orange Park Acre residents	Handy Creek through Orange Park Acres is largely an unimproved natural channel. Upstream lies Santiago Hills (Phase 1), Peters Canyon Reservoir, and portions of the proposed project, which are currently undisturbed existing terrain. As mitigation for potential flooding associated with development of existing Santiago Hills (Phase 1), a storm water detention basin was incorporated into the park site within that project as well as modifications to Peters Canyon Reservoir. Peters Canyon Reservoir and the park site serve to detain peak flows up to a 100-year storm event. With full build-out, as defined in the previous drainage master plan, storm water would be released at a rate equal to or less than the pre-developed flow rates. The performance of these facilities assumed that the tributary areas within the currently proposed project were developed.	The proposed project incorporates diversion, and minor improvements to Peters Canyon Reservoir to achieve peak runoff rates that are equal to or lower than pre-development peak flow rates.
Potential flooding and sheet flow in improved Irvine Regional Park, a concern raised by Orange County Harbors, Beaches and Parks	Irvine Regional Park currently experiences sheet flow flooding when the capacities of the existing conveyance systems are exceeded.	The size of the watershed tributary to Irvine Regional Park will be reduced through phased grading and rerouting of flows to the east and west around the improved areas of the park, thereby reducing flows through the park for all storm frequencies.
Potential degradation of existing habitat upstream of Jamboree Road, a concern raised by City of Orange	Increased storm water flows from development may increase potential for erosion and degradation of habitat areas in the North and South tributaries, Figure 2.2.	The habitat within both the North and South tributaries will be protected from storm flow erosion by construction of parallel storm drains within the adjacent roadways that will carry major storm flows, Figure 5.1. Low flows will be routed to the North and South tributaries. The habitat in the South tributary will be protected in-place and enhanced through strategic placement of

Table 1.1 – Areas of Concern Identified by Mitigation Measure W-4		
Item of Concern	**Discussion of Item**	**Project Design Features**
		emergent marsh areas consistent with HMMP. The North tributary will be graded and an expanded habitat area created as detailed in the HMMP.
Potential releases to Peters Canyon Wash, a concern raised by local citizens	Storm water exits the reservoir through an outlet pipe on the northerly side of Peters Canyon Reservoir that ultimately drains to Handy Creek. An emergency spillway in the same general location also is tributary to Handy Creek. At the southerly end of the reservoir are a dam and an emergency outlet pipe and valve system that allows discharges to Peters Canyon Wash. This outlet system must remain functional to lower the reservoir water level in case of emergency related to the integrity of the dam, and is also used by the County as a means of vector control. These discharges are unrelated to the proposed project. The valve is tested periodically as required by the State Division of Dam Safety.	Proper operation of Peters Canyon Reservoir for flood protection requires releases of storm water to Handy Creek only. Releases to Peters Canyon Wash are at the direction of Orange County Vector Control and State Division of Dam Safety. Post project flows to the reservoir will not affect existing releases to Peters Canyon Wash.
Potential impassibility of Jamboree Road during 100-yr storm event, a concern raised by the City of Orange	Currently, the culverts at Jamboree Road are designed for 10-year storm events and may overtop and flood the road in any larger storm event, including a 100-year storm event.	The size of the tributary area to the culverts will be decreased through rerouting of flows to Santiago Creek and to Irvine Lake. In addition, the proposed project includes new drainage improvements, which will route portions of the storm water south around the existing facilities to points downstream of Jamboree Road. Proposed drainage improvements will keep Jamboree Road in passable condition during a 100-year storm event.

HMMP Requirements (per MM W-4)

The Final Conceptual Mitigation and Monitoring Plan for Impacts to Areas within the Jurisdiction of the U.S. Army Corps of Engineers and the California Department of Fish and Game, dated November 2003, is included under separate cover (HMMP). The HMMP addresses the habitat mitigation area within the project. Specifically, the HMMP includes measures to mitigate impacts to riparian and wetland resources within Santiago Hills II, focusing on the North and South tributaries upstream of the Jamboree Road culverts, Figure 5.1.

The following key elements and objectives of the project have been identified for evaluation in the *Runoff Management Plan (ROMP)*. Items which are addressed in Mitigation Measure W-4 from the 2000 Final Supplemental Environmental Impact Report to Final Environmental Impact Report No. 1278 for the East Orange General Plan, Volume 4, Mitigation Monitoring Program are addressed in greater detail in *Section 18 – Satisfaction of Mitigation Measure W-4.*

Hydrology/Flood Protection – Goals of the ROMP:

- Confirm that post-development storm flows from the proposed project to Peters Canyon Reservoir are consistent with available detention capacity and will not exceed existing condition peak discharges to Handy Creek. (MM W-4)

- Analyze the hydrology and hydraulics associated with the previous design of the existing Transportation Corridor drainage facilities and Peters Canyon Reservoir.

- Compare the current watershed hydrology analysis to local watershed master plans or hydrology studies which have been prepared for the Peters Canyon Reservoir and Irvine Lake watersheds or municipal drainage master plans for the adjacent cities.

- Establish and quantify baseline watershed hydrologic conditions extending to the project boundary limits and including the off-site tributary areas. The baseline hydrologic characteristics include surface drainage patterns, drainage area delineations, flowrates, and volumes for various return periods. (CEQA)

- Incorporate diversion of storm flows to either be routed northerly of the existing Irvine Regional Park improvements to Santiago Creek or westerly to the area of impoundment behind Villa Park dam. This will alleviate problems of storm runoff from undeveloped tributaries to the improved portions of Irvine Regional Park that exceed capacities of existing facilities. (MM W-4)

- Provide inventory and describe existing public storm drain systems within the project development watershed and those drainage facilities immediately downstream of the development, which are influenced by the project watershed surface hydrology. (CEQA)

- Analyze the available hydraulic capacities of the drainage facilities within the development area or immediately downstream based upon available record improvement drawings, including identification of hydraulic deficiencies or limitations. (MM W-4 and CEQA)

- Develop a recommended drainage infrastructure program for the primary backbone drainage facilities within the project development area.

- Prepare preliminary construction cost estimates for the recommended backbone drainage infrastructure facilities to serve the development area.

- Prepare a comprehensive document that summarizes the pre- and post-development hydrologic conditions for the watershed, and outlines the recommended infrastructure drainage program and anticipated operation of the watershed. (MM W-4 and CEQA)

Erosion and Sediment Transport – Goals of the ROMP:

- Stabilize natural drainage courses between Chapman Avenue and Jamboree Road to inhibit scour and lateral bank erosion within these natural drainage courses. (MM W-4)

- Evaluate the historical and potential effect of development on stability of existing natural receiving waters, which will be avoided and/or preserved as part of the development program, as well as proposed wetlands and restored creeks. Analyze the stream mechanics of these systems, including geomorphology and long-term streambed/bank variations.

- Prepare a qualitative assessment of the project watershed sediment yield to evaluate required debris/sediment storage. (MM W-4)

- Protect against adverse scour and lateral bank erosion resulting from project flows to Peters Canyon Regional Park, Irvine Regional Park, and Irvine Lake.

- Maintain free flow of storm water to Peters Canyon Reservoir for runoff exiting existing drainage facilities in Jamboree Road. (MM W-4 and CEQA)

Water Quality Goals of the ROMP (discussed in detail in ROMP Volume 2, Surface Water Quality (March 2005) and FlowScience's Peters Canyon Reservoir Report, (September 2004), under separate cover):

- Determine with the County, water quality conditions in Peters Canyon Reservoir, Santiago Creek, and Irvine Lake. (MM W-4 and CEQA)

- Establish specific requirements for non-structural and structural Best Management Practices (BMPs). (MM W-4 and CEQA))

- Develop a recommended program to implement storm water BMPs appropriate for the proposed development, which meet current standards or requirements for storm water quality control based upon state and local jurisdictional requirements.

- Evaluate dry season low flows qualitatively, and, in accordance with the County DAMP and NPDES requirements, storm water flows originating from the project watershed. Consider flow routing to structural BMPs such as extended detention basins, grass swales and emergent marsh areas prior to entering Peters Canyon Reservoir, Santiago Creek, and Irvine Lake. Selected BMPs are those most suitable for achieving applicable water quality standards. (MM W-4 and CEQA)

- Develop a quantitative assessment of the storm water quality for the baseline conditions and anticipated storm water pollutants to be targeted or of concern with the development. (CEQA)

- Evaluate the potential water pollution, sedimentation, and adverse impacts of storm water runoff to the receiving waters from the proposed development while comparing to documented information concerning current characteristics. (CEQA)

- Examine potential operational alternatives for Peters Canyon Reservoir that would enhance water quality over existing conditions. (MM W-4)

Habitat Protection – Goals of the ROMP (discussed in detail in the HMMP):

- Protect against any significant long-term impacts to habitat of endangered species and create or enhance wetlands and riparian habitat within the natural drainage course between Jamboree Road and Chapman Avenue for (endangered species) habitat and water quality purposes. (MMs W-4 and B-1)

1.2 GENERAL OVERVIEW – RUNOFF MANAGEMENT PLAN

The *Runoff Management Plan* (ROMP) is being developed pursuant to Mitigation Measure W-4 specified by the City of Orange in the Final Supplemental Environmental Impact Report to Final Environmental Impact Report No. 1278 for the East Orange General Plan, Volume 4, Mitigation Monitoring Program for the Santiago Hills II, which states that:

W-4 RUNOFF MANAGEMENT PLAN

A Runoff Management Plan (ROMP) shall be submitted to appropriate City and County departments for review. The document will be approved by the City of Orange and the Manager of Watershed and Coastal Resources for the County of Orange prior to approval of any tentative tract map, other than for financing purposes, or issuance of any grading permit. The ROMP shall detail how the proposed project achieves the most appropriate balance between flood protection, water quality and preservation of sensitive habitats, given the project's grading plans. To ensure that *the ROMP is processed in a timely manner, the document shall be circulated for an initial 30-day review period. Objectives addressed by the ROMP are detailed in Attachment A. (Attachment A is included in the Technical Appendix A of this report)*

The ROMP will not be finalized until the least Bell's vireo/southwestern willow flycatcher surveys are completed.

The ROMP will be subject to a review process wherein the appropriate agencies (including ACOE, USFWS, and CDFG) and concerned members of the public who have provided a written or oral testimony on the project are provided an opportunity to review and provide input on the plan. The ROMP shall be considered a discretionary project for purposes of CEQA, and shall be subject to review and approval by the Planning Commission, subject to appeal to City Council.

The objective of the ROMP is to establish a framework for implementation of the project drainage facilities which: (1) satisfies current standards for flood protection, (2) minimizes impacts from potential surface runoff water quality effects, (3) evaluates estimates for runoff rates with development and mitigation requirements, (4) evaluates stability of natural streambeds avoided and/or preserved as part of the development, (5) evaluates the effect of development hydrology to downstream drainage features, (6) identifies impacts and appropriate project design features to mitigate potential adverse impacts of the staged development, and (7) protects the created and preserved habitat areas established in the HMMP. The ROMP, Volume I, is intended to identify potential changes to the watershed from the pre-development condition to the proposed development and identify project design features for the post-development hydrology. The ROMP, Volume I, will present backbone drainage infrastructure to provide the necessary level of flood protection while ensuring the baseline watershed hydrology is maintained to the extent possible. Volume II of this ROMP will present an urban runoff water quality control program, which will address the storm water NPDES requirements and water quality standards.

SECTION 2: EXISTING WATERSHED AND FLOOD PROTECTION ASSESSMENT

2.1 BACKGROUND

The project limits of the proposed planned community development of Santiago Hills Phase II and East Orange Area 1, as defined by Tentative Tract Maps 16199, 16201 and 16514 encompass approximately 904 acres of undeveloped land within an unincorporated portion of Orange County, proposed for annexation to the City of Orange. The Eastern Transportation Corridor (ETC), comprised of the SR 241 and SR 261, was completed in October 1998. The ETC bisects the Santiago Hills II and East Orange Area 1 developments. Drainage from the ETC is conveyed in culverts to natural conveyances and then to either Santiago Creek, Irvine Lake, or to Peters Canyon Reservoir. The HMMP defines the character of the watercourses within the project area. Evidence of erosion within some natural conveyances can be observed. In particular, the North Tributary between SR 261 and Jamboree Road is incised 25 feet in some areas. Sediment from the channel has deposited at the culvert under Jamboree Road. Some of the sediment has been conveyed to Peters Canyon Reservoir.

There are three watersheds and five distinct sub-watersheds (Figure 1.2) associated with the Santiago Hills Phase II and East Orange Area 1 development areas. The largest watershed (Area A) encompasses most of the southern portions of the proposed development area. This watershed is tributary to the Peters Canyon Reservoir watershed, which under certain circumstances is tributary to Handy Creek when water levels in the reservoir exceed the invert elevation of the improved 42-inch outlet pipe. The northern watershed is tributary to Santiago Creek (Areas B, C and D). The third watershed is tributary to Woody’s Cove in Irvine Lake (Area E).

2.2 FLOODPLAIN MAPPING

According to the Federal Emergency Management Agency (FEMA), Panel 23 of 81 dated September 15, 1989, the Santiago Hills Phase II and East Orange Area 1 Development Areas for Orange County, California and incorporated areas are not located in a Flood Hazard Zone. Peters Canyon Reservoir is designated as Zone “A” and the area within the Development Areas are designated as Zone “C”. However, it should not be concluded that there are no flood hazards or 100-year floodplains within the project, since the minor tributaries were not mapped by FEMA at that time. Figure 2.1 shows the FEMA mapping and the Zone designations.

Flood Hazard Zone “A” has been identified in the community flood insurance study as an area subject to inundation by the 100-year flood event. Base flood elevations and flood hazard factors have not been determined by FEMA for this area. Flood insurance within Zone “A” is mandatory. No Zone “A” flooding areas have been identified within the proposed developed area of the project.

Figure 2.1 – Flood Zone Map

Flood Hazard Zone "C" has been identified in the community flood insurance study as an area of moderate or minimal hazard from the principal source of flooding in the area. However, buildings in this zone could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Local storm water drainage systems are not normally considered in the community's Flood Insurance Study. The failure of a local drainage system creates areas of elevated flood risk within this zone. As will be discussed, the project's proposed drainage system mitigates this risk to an insignificant level. Flood insurance is available in participating communities but is not required by regulation in this zone.

2.3 WATERSHED DESCRIPTION

The existing condition of the watersheds encompassing Santiago Hills Phase II and East Orange Area 1 is undeveloped rangeland comprised of moderately steep upper canyons with reduced gradients towards the lower elevations. Natural vegetative growth is limited primarily to annual and scrub grasses with generally poor cover. The primary hydrologic soil group classification is type "D," with relatively minor areas of Types "C" and "B". Type "A" soils are most pervious and Type "D" soils are least pervious, Exhibit B. Due to the generally high relief over the site, storm water runoff to the natural drainage courses would be expected to increase rapidly in response to rainfall excess. The character of existing streams and watercourses within the project site are detailed in the HMMP and the biological technical report *East Orange Planned Community, Area 1*, dated May 31, 2004.

The study area tributary watershed can be divided into five subwatersheds areas "A" through "E" in Figure 2.2. Four of the watersheds include existing major culvert crossings of the ETC.

The first watershed is tributary to Peters Canyon Reservoir and is shown as Area "A" in Figure 2.2. This area includes two subwatersheds, the North Tributary and South Tributary, to the west of the ETC. The portion of Area "A" west of Peters Canyon Reservoir has been previously developed as single-family residential.

The Area "B" watershed in the northern portion of the project site is tributary to Santiago Creek. It drains across SR 241 through two culverts: a 66-inch CSP (ETC-6) and a 54-inch RCP (ETC-7), Exhibit A. After crossing SR 241, these flows are conveyed to Irvine Regional Park in natural valley channels. At the Park, the flows are conveyed by a series of small open channels and culvert crossings to Santiago Creek to the north. Flows that exceed the capacity of the existing drainage facilities sheet flow across the Park to Santiago Creek.

The Area "C" watershed drains across SR 241 through an 84-inch CSP pipe culvert, ETC-9. After crossing SR 241, the flows are conveyed by a natural stream channel to the northeastern portion of Irvine Regional Park where the flows are conveyed to Santiago Creek.

The Area "D" watershed is located at the northwestern most portion of the project site and is tributary to Santiago Creek.

The Area "E" watershed consists of Woody's Cove, which is tributary to Irvine Lake. In the ultimate developed condition a portion (approximately 60 acres) of Area "A" will be diverted to this watershed. See Figure 5.1 and the hydrology analysis in Chapter 5.

The County of Orange Resource & Development Management Department (RDMD) has prepared a Natural Community Conservation Plan (NCCP) for the Orange County Central and Coastal Subregion of the Southern California NCCP Coastal sage Scrub (CSS) program. The purpose of the program is to provide long-term, large-scale protection of natural vegetation and wildlife diversity while allowing compatible land uses and appropriate development and growth. Figure 2.3 shows the NCCP boundary in the vicinity of the proposed Santiago Hills Phase II and East Orange Area 1 development. A review of the figure shows that the proposed development does not encroach into the area established for the NCCP, except as permitted by the terms and conditions of the NCCP to accommodate project-related storm drainage infrastructure. The biological impacts of this permitted infrastructure, including consistency with NCCP requirements, are addressed in the following reports, which are included in the appendices to the EIR/DEIR for the proposed project:

- Santiago Hills II Planned Community supplement to Final EIR 1278. Technical Appendix E – Biology Report

- *Biological Resources Report: SHII Supplemental Assessment of Water Quality Basin/Habitat Restoration*, Irvine Regional Park

- *Biological Resources Report: SHII Supplemental Assessment, Peters Canyon Storm Drain Outlet*, *Peters Canyon*.

- *Amendment to Biological Resources Report: SHII Supplemental Assessment of Peters Canyon Stormdrain Outlet, Peters Canyon Regional Park.*

Figure 2.2 – Existing Drainage Boundary Exhibit

Figure 2.3 – NCCP Boundary Exhibit

SECTION 3: REGULATORY REQUIREMENTS AND DESIGN CRITERIA

3.1 FLOOD PROTECTION REQUIREMENTS

The drainage systems for the project can be divided into two categories (1) backbone and (2) local. The backbone system consists of the major facilities required to drain the development and will be maintained by the City of Orange. The local drainage facilities on the project will collect and convey runoff generated from the project site and are generally smaller diameter facilities.

All storm drain facilities shall be designed in accordance with the City of Orange storm drain design criteria and specifications. Final facility design and locations will be reviewed as part of the final storm drain improvement plans and grading plans. The proposed storm drain systems will also be designed for High Confidence storm events per the Orange County Flood Control Design Manual.

3.1.1 BACKBONE SYSTEM

The backbone flood control systems within the Santiago Hills Phase II and East Orange Area 1 development will be designed following City of Orange standards and criteria so that, as appropriate, they can be owned and maintained by the City of Orange through an agreement with the developer. Plans for facilities within either Irvine or Peters Canyon Regional Parks will be reviewed and approved by Orange County Harbors Beaches and Parks. The major backbone system will be designed for a 100-year level of flood protection between SR 241/SR 261 and Jamboree Road. Other backbone systems will likely be designed for 25-year discharges. The exact parameters of the storm drain system will be finalized during the final engineering design phase.

3.1.2 LOCAL SYSTEM

The local system will meet or exceed City criteria, which require all on-site storm drain facilities to be designed to convey flows expected from a 10-year storm with additional design factors of safety and freeboard to provide a 100-year level of flood protection to all inhabited structures. Local drainage facilities will be designed for 10- or 25-year storm events depending on whether or not the systems contain sump areas. Where there are no sump areas, systems should be designed at a minimum for 10-year storm events. Systems that drain sump areas with secondary outlets should be designed at a minimum for 25-year storm events. Systems that drain sump areas with no secondary outlets should be designed at a minimum for 100-year storm events. During storms of intensity greater than the 10-year design, additional flood protection is provided by utilizing the local storm drain systems capacity and conveying excess runoff above the storm drain capacity within the streets or drainage channels. The exact parameters of the storm drain system will be finalized during the final engineering design phase.

The smaller local storm drain facilities will be maintained by the Santiago Hills Phase II and East Orange Area 1 Homeowners' Associations. Section 17 – Facilities Maintenance of this report provides additional discussion on suggested typical maintenance responsibilities for the flood control infrastructure. See the Master O&M Table in the GeoSyntec Report for a summary of maintenance responsibilities for water quality features.

3.2 HYDRAULIC DESIGN

To provide the required level of flood protection and reduce potential public safety hazards, an underground drainage system will be provided to intercept and convey the storm water flow generated within the site and off-site tributary flow through the site. The conceptual drainage system illustrated in this ROMP indicates preliminary pipe size requirements and proposed facility alignments, Figures 7.3 and 7.4. A more detailed engineering analysis will be performed during the final engineering design phase to refine the drainage system and confirm it is consistent with the ROMP criteria.

SECTION 4: DESCRIPTION OF EXISTING DRAINAGE FACILITIES

4.1 EXISTING CULVERTS AND STORM DRAIN FACILITIES

4.1.1 ETC FACILITIES

The construction of the Eastern Transportation Corridor (ETC), SR 241 and SR 261, started in 1995 and was completed in October 1998. ETC includes drainage facilities to convey storm water from one side of the road to the other, as well as drain the roadway itself. Exhibit A shows the existing ETC drainage facilities in the vicinity of the project area, ranging in size from 24-inch pipes for local road drainage to 108-inch pipe culverts which serve as both drainage conduits and wildlife crossings. The ETC drainage crossings have been designed to convey a 10-year discharge flowing full, and with available head plus freeboard, pass the 100-year event. ETC crossings within Area “A” (See Figure 2.2) include a 108-inch pipe (ETC-15) and a 48-inch pipe (ETC-4). (Plans for ETC-4 crossing show a 54-inch CSP, but measurements in the field show the culvert to be 48-inch.) The 108-inch culvert also serves as a wildlife crossing. A rock riprap channel conveys flows from ETC-4 to a 60-inch culvert under Chapman Avenue. Also within Area “A” is a culvert that varies in diameter from 60 to 78 inches (ETC 3), conveying flows across Santiago Canyon Road and SR 241 to the 108-inch culvert. ETC crossings in Area “B” include 66-inch (ETC-6) and 54-inch (ETC-7) culverts. ETC crossings in Area “C” include an 84-inch (ETC-9) pipe culvert that also serves as a wildlife crossing. The datum used for the ETC facilities was NGVD 29. This datum is approximately 2.4' lower than the NAVD 88 datum, which is used for the proposed development.

4.1.2 IRVINE REGIONAL PARK

In general, the drainage facilities that exist in Irvine Regional Park are sized to convey nuisance flows across roads and across the park landscaping, with discharge to Santiago Creek. Exhibit A shows the drainage facilities in the park. Typically the pipe sizes are 18 and 24-inch culverts with two culverts, which are 30 and 48-inch. When flows exceed the flow capacity of the culverts and open channels, the flows spread out and follow an overland sheet flow path across the park. This overland flow leaves behind debris, silt and saturated turf that can inhibit immediate use of these areas.

4.1.3 JAMBOREE ROAD

Jamboree Road is a major arterial road and the road section is generally 102 feet wide curb to curb and 129 feet wide right-of-way to right-of-way. Three culvert crossings exist in Jamboree Road that are tributary to Peters Canyon Reservoir, see Exhibit A. The culverts were constructed with the road in 1989. The northern culvert, located at the intersection of Canyon View Avenue, is a 4-foot high by 9.5-foot wide (4'H x 9.5'W) reinforced concrete box (RCB) which transitions to a double 3.5'H x 7'w RCB with a 10-year design capacity of 415 cubic feet per second (cfs) above the transition and 646 cfs below the transition based on as-built plans. The transition is due to a storm drain confluence in the middle of the structure. A storm drain pipeline exists in Jamboree Road from the intersection of Chapman Avenue to its confluence with the northern culvert. The culvert varies from a 30-inch RCP to 3'Hx 7'W RCB at the confluence. The 10-year design capacity of the 3'x7' RCB Section is 238 cfs. Storm flows from larger, lower frequency storms may sheet flow across the road and into Peters Canyon Reservoir.

The southern culvert is a double 3' H X 9' W RCB. The improvement plans state that this facility has a 10-year design capacity of 515 cfs. The middle culvert is a 1.25' H X 3.5'W RCB that transitions to a 27" RCP at the outlet. The 25-year design capacity of the culvert is 31cfs. The culvert crossings within Jamboree Road are constrained vertically by the existence of the 84-inch Allen-McCallugh water transmission main, the 54" Baker Aqueduct and the 54-inch Irvine Lake Pipeline.

A silt fence and debris basin has recently been installed immediately upstream of the north culvert at Jamboree Road to capture existing condition sediments which may have otherwise obstructed the culvert. The silt fence and debris basin will be removed during the Stage 1 development and replaced with a developed storm drain system.

4.1.4 CHAPMAN AVENUE / SANTIAGO CANYON ROAD

The Chapman Avenue/Santiago Canyon Road extension, designated County Highway S18, was realigned with the construction of the ETC in 1998. Drainage facilities within Chapman Avenue between Jamboree Road and SR 241 consist of four cross culverts ranging in diameter from 18 to 60-inch and two local drainage systems, which drain the road (see Exhibit A). The culverts and drainage system closest to SR 261 convey flows from the west side of Chapman Avenue to the east side. The flows are conveyed to the Jamboree Road crossing and then to Peters Canyon Reservoir via natural earthen channels. The drainage system at the intersection of Chapman Avenue and Jamboree Road conveys flows from the road surface south along Jamboree Road to the northern culvert crossing Jamboree Road. The flows are then conveyed to Peters Canyon Reservoir in a natural earthen channel.

4.2 EXISTING CHANNEL FACILITIES

4.2.1 HANDY CREEK

A portion of the development is tributary to Peters Canyon Reservoir, which in turn is tributary to Handy Creek (OC/RDMD Facility E08S06). The existing drainage facilities downstream of Peters Canyon Reservoir along Handy Creek were designed based upon previous watershed studies (Rivertech, 1985). The channel downstream of Peters Canyon Reservoir is improved through Santiago Hills Phase I and concrete-lined west of Chapman Avenue for approximately 1000 feet to Broadmoor Trail. Handy Creek west of Broadmoor Trail is generally unimproved and undersized with respect to the 100-year discharge. A majority of the unimproved earthen trapezoidal channel through this reach is privately owned. The level of flood protection is not consistent with current design standards and some downstream drainages have had reports of chronic flooding. Hydraulic constraints within these existing drainage systems limit the available flow capacity for conveying runoff generated from the upper watershed.

4.2.2 SANTIAGO CREEK

Santiago Creek (OC/RDMD Facility E08) downstream of Irvine Lake is a wide unimproved natural stream or regional floodplain, which generally flows to the north of the proposed project to the impoundment behind Villa Park Flood Control Dam. The total watershed area of Santiago Creek at Villa Park Flood Control Dam is approximately 84 square miles.

4.3 EXISTING RESERVOIRS AND FLOOD CONTROL FACILITIES

4.3.1 PETERS CANYON RESERVOIR

A critical element in the flood control system for the watershed that encompasses the proposed project is the Peters Canyon Reservoir (Figure 4.1), constructed in 1934, and owned and operated by Orange County Harbors, Beaches and Parks. The reservoir's previous owner, The Irvine Company, dedicated it to the County with the requirement that it be maintained as a flood control facility.

Peters Canyon Reservoir was constructed by The Irvine Company for use as an irrigation water storage and distribution lake as part of former commercial agriculture and ranching operations. An earthen dam across Peters Canyon Wash at the southern end of the reservoir has a crest elevation of 552.3 feet (NAVD 1988) and a crest length of 580 feet. An emergency outlet works system, including an outlet tower, trashrack, a 42-inch RCP and floodgates, connects the reservoir to Peters Canyon Wash downstream. The emergency outlet works are operated by the County of Orange and would be used to reduce reservoir water levels to protect the integrity of the dam. The outlet works are occasionally used by the County to release water to Peters Canyon Wash. The total storage volume of the reservoir has decreased from approximately 1070 acre-feet to approximately 500 acre-feet (570 acre feet) because of sedimentation since original construction. However, the flood control related storage has only decreased by approximately 20 acre-feet.

The earthen dam is under the jurisdiction of the State Division of Safety of Dams because of the height of the embankment and the storage volume, and is designated as Dam No. 793-2. The dam is inspected and certified for safety semi-annually by the State Division of Safety of Dams, and is considered structurally sound at this time.

In the late 1980's a concrete spillway and 42-inch outlet pipe were constructed at the northern end of the reservoir. Flows that enter the northerly 42-inch outlet pipe or overtop the northerly spillway are ultimately conveyed to Handy Creek. The northerly 42-inch pipe follows along Canyon View Road and then passes through Santiago Hills I in a combined channel/pipe system before outletting to Handy Creek. Runoff over the northerly spillway flows northwesterly through the Santiago Hills I improvements and then to Handy Creek.

Prior to its dedication to the County, The Irvine Company had directed approximately 20,000 to 25,000 acre-feet of water annually through the reservoir for crop irrigation, using it more as a regulating device than a storage facility. End–of-month water surface elevations varied, for example fluctuating over a range of fourteen feet during the period from May 1975 to June 1977. By the early 1980's, The Irvine Company no longer utilized the reservoir for its original intent and eliminated external water deliveries to it. The spillway and 42-inch outlet pipe at the northern end of the reservoir were installed to mitigate anticipated increases in storm water runoff from the development of the project known as Santiago Hills Phase I and as an allowance for the area now known as Santiago Hills Phase II and East Orange Area 1. Figure 4.2 shows water surface elevations for Peters Canyon Reservoir taken from County records in the 1990's.

Figure 4.1 – Peters Canyon Reservoir – Aerial Topography Map

The outlet works from the reservoir to the downstream improved sections of Handy Creek consist of an improved 42-inch culvert with an invert elevation of 539.58 and a 100-foot wide spillway with a crest elevation of 545.12 (NAVD 88). These facilities were constructed in 1986. The outflow rating curve for the reservoir is included in *Technical Appendix F-I.* The reservoir had been designed per County of Orange design criteria. Per the criteria, High Confidence discharges are required for design purposes and Expected Value discharges are used for evaluating protection levels provided by existing facilities. The Peters Canyon Reservoir is a major impoundment, which receives tributary drainage from the proposed development watershed. The stage vs. storage volume for the reservoir is shown in Table 4.1 and illustrated in Figure 4.3. A previous stage vs. storage volume rating which was developed by the dam operator for the County and the rating curve used in the 1985 Rivertech report are also shown in Figure 4.3, adjusted to current datum of NAVD 88. The storage volume was taken from the invert elevation of the 42-inch outlet pipe. One contributing factor for the difference between the storage curves is the result of sedimentation in the reservoir. The source and reliability of the County's information is uncertain. From a comparison of the curves for March 2000 and the County data, it appears that the flood control storage volume has been reduced by approximately 20 acre-feet at elevation 547.

From a comparison of the curves for March 2000 and the 1985 Rivertech data, it appears that the storage volume has been reduced over this interval by approximately 45 acre-feet at elevation 545, which is approximately the spillway crest elevation.4.3.2

4.3.2 VILLA PARK FLOOD CONTROL DAM

Villa Park Flood Control Dam is an existing flood control facility located downstream of portions of the project. The proposed runoff quantities and quality from the development are evaluated and discussed in later sections to determine the potential impacts to this facility and opportunities for project design features to mitigate potential impacts to be implemented with the development. Discharge from the dam is conveyed in Santiago Creek to the Santa Ana River.

4.3.3 CALTRANS BASIN (ETC-1)

A debris/detention basin called ETC-1 was constructed at the eastern side of the SR 241/SR 261 confluence to address a relatively small diversion of runoff. ETC-1 represents an existing constraint, which must be integrated into the overall functioning of the future drainage system for the watershed, without impairing ETC-1's original capacity or function.

4.3.4 SANTIAGO RESERVOIR (IRVINE LAKE); SANTIAGO DAM

The runoff from the drainage area tributary to Santiago Creek is partially controlled by the Santiago Reservoir (also known as Irvine Lake, a water supply reservoir built by the Serrano and Carpenter Irrigation Districts and Irvine Company in 1933) and the Santiago Dam, Exhibit K, which are currently maintained and operated jointly by the Serrano Water District and the Irvine Ranch Water District.

The Santiago Dam is located at the westerly side of the reservoir and controls outflows from the reservoir, with a spillway elevation of 790 feet and a dam crest elevation of 810 feet.

Figure 4.2 – Peters Canyon Reservoir – Historic Water Surface Elevations

Table 4.1 – Peters Canyon Reservoir Stage vs. Volume Rating Curve

CONTOUR ID.	AREA (Acres)	VOLUME DIFFERENTIAL AC-FT	STORAGE VOLUME Based on exist dtm (AC-FT)
522*	6	4	4
525*	14	31	33
528*	23	55	89
531*	30	80	169
Water surface (531.4)	30.99	0.2	169.2
532	33.12	19.9	189.1
533	35.30	34.86	223.9
534	37.01	36.1	260.1
535	38.66	37.8	297.9
536	40.42	39.5	337.4
537	42.77	41.5	378.9
538	46.36	44.6	423.5
539	50.16	49.4	472.9
540	53.10	51.8	524.8
541	55.59	54.7	579.5
542	57.47	57.5	637.0
543	59.30	60.6	697.6
544	61.26	61.3	758.9
545	63.75	64.5	823.4
546	70.59	74.3	897.6
547	73.33	72.3	969.9
548	75.87	73.1	1043.0
549	78.18	79.3	1122.3
550	80.98	82.3	1204.6
551	83.03	92.8	1297.3

Date of Topography: March 2000

* From reservoir topography dated April 2004

Figure 4.3 – Peters Canyon Reservoir – Stage vs. Storage Volume

4.4 NATURAL DRAINAGES

4.4.1 NORTH TRIBUTARY

The North Tributary is characterized by a relatively steep profile with a narrow floodplain and little vegetation in the stream beds. The stream is deeply incised (25') in the upper reaches with the narrow floodplain somewhat spreading in the lower reaches. The floodplain shows evidence of gully erosion during significant storm events. The North Tributary receives flows that cross Chapman Avenue (ETC-5) and flows from culvert ETC-101 which drains a portion of SR 261. Approximately 100-feet of the incised channel downstream of ETC-5 has been filled and lined with rock riprap as part of the road construction. The flows from ETC-5, ETC-101, and ETC-102 outlet into the incised natural channel, which conveys the flows to an existing culvert in Jamboree Road. The flows then outlet to Peters Canyon Regional Park and Reservoir.

4.4.2 SOUTH TRIBUTARY

The South Tributary receives flows crossing SR 261 in culvert ETC-15, conveying them in a natural stream to a double RCB culvert under Jamboree Road and discharging into Peters Canyon Regional Park and Reservoir. The stream is generally a wide floodplain with little evidence of incisement and follows a mild gradient. The floodplain shows some evidence of gully erosion during significant storm events.

4.4.3 NATURAL DRAINAGE IN THE ETC-9 WATERSHED

The construction of SR 241 bisected a well defined, hydraulically steep natural drainage lined with vegetation. The bisected watershed is connected by ETC-9 and flows downstream until it intersects Santiago Creek.

4.4.4 WOODY'S COVE

Woody's Cove is a canyon drainage area tributary to the southern portion of Irvine Lake, extending south across SR-241, with a total area of 1088 acres. Four major culverts convey flows across SR-241 to Irvine Lake, ranging in size from 54 inch to 96 inch, see Figure 7.4. The conveyance to Irvine Lake is a natural canyon channel crossing Santiago Canyon Road in a culvert.

SECTION 5: WATERSHED HYDROLOGY

5.1 SURFACE HYDROLOGY CHARACTERISTICS

5.1.1 PRECIPITATION

Precipitation data for the various hypothetical storm frequencies utilized in the watershed hydrologic analysis for this study were determined based on methodologies in the Orange County Hydrology Manual. Because the watershed is below 2000 feet in elevation, the area is considered to be "non-mountainous". The precipitation intensities (in/hr) were obtained from Figure B-3 in the Orange County Hydrology Manual for determining the peak discharges using the Rational Method. The Orange County design storm S-graph and rainfall distribution was used per the methodology in the Orange County Hydrology Manual for the unit hydrograph method calculations.

Assumptions made in the calculation of storm water runoff for flood control purposes such as comparing storm water discharges at a given concentration point, or to be used in the design of flood control facilities, are different than those made in the calculation of storm water runoff for the purpose of water quality comparisons. Flood control hydrology is concerned with peak flows from a storm of a particular frequency for comparison or design, whereas water quality hydrology is concerned with average storm water runoff or "first flush" runoff to provide realistic pollutant loads and concentrations. First flush runoff is typically generated by storms less than a 1-year frequency or by the early stages of larger storms. First flush runoff conveys the majority concentrations of pollutants. For these reasons, the assumptions used for an analysis of hydrology are different from those used in a water quality analysis. Volume 2, Surface Water Quality, discusses these issues in greater detail.

5.1.2 SURFACE FLOODING AND FLOW PATHS

The project proponent has been requested to incorporate into the design of the drainage system (Attachment A – Mitigation Measure W-4, see Technical Appendix A) features to mitigate potential existing drainage inadequacies or hydraulic deficiencies of the drainage facilities in the project area.

One area of concern identified in Mitigation Measure W-4 is Handy Creek downstream of Peters Canyon Reservoir. Residences within the Orange Park Acres development adjacent to Handy Creek report localized flooding. In an effort to avoid post-development runoff contribution to downstream flooding, the ROMP concept for this development proposes to divert some of the tributary watershed away from the Peters Canyon Reservoir. . As each Stage of the development (Stage 1, Stage 2 and Ultimate) is implemented, the increase in runoff due to development is offset by diversion of flows away from the Peters Canyon Reservoir watershed. A second area of concern is the drainage of the two natural tributary areas upstream of Jamboree Road and bounded by Chapman Avenue and the Eastern Transportation Corridor (Concentration Point 2, Figure 5.1). The North Tributary extends from approximately the intersection of the ETC and Chapman Avenue to Jamboree Road at the intersection of Canyon View Avenue. An existing detention / desilting basin is located immediately to the east of the SR 241/SR

261 interchange   Flows from the basin are conveyed at SR 261 and Chapman Avenue in a pipe system and are currently discharged into the north tributary. The South Tributary extends from the ETC south of its intersection with Chapman Avenue, to Jamboree Road. These tributaries were previously described in Section 4.4 of this report. Deposition is evident at both of the tributary crossings of Jamboree Road, although these deposits may be displaced to a certain extent during large storm events. The entrance pools for the culverts under Jamboree Road act as desilting basins, capturing some silt. However, evidence shows that much of the bedload continues to Peters Canyon Reservoir. A silt fence and debris basin has been installed as discussed in Section 4.1.3. The construction of an additional culvert under Jamboree Road will reduce flows and improve routing of flows at Concentration Point 2, as discussed further in Section 6.2.

Another area of concern are the overland flows to Santiago Creek within Irvine Regional Park (Concentration Point 5). The drainage concept of this ROMP proposes that portions of the tributary watershed be diverted around the Park, thereby reducing flows through the park for all storm frequencies. Figure 5.1 shows a schematic of the proposed diversions in the Ultimate Condition. Comparing the proposed condition to the existing condition shown in Figure 2.2, it can be seen that the area tributary to the Park (Area B) has been reduced by diverting flows to Areas C and D. By implementing this diversion scheme, the area tributary to the Park has been reduced from 250 acres to 63 acres, a reduction of 75%. All flows are still tributary to Santiago Creek, but will enter the creek at different locations to the east (Concentration Point 3) and west (Concentration Point 4) of the park.

To abide by Caltrans request to treat runoff from the ETC within the ETC right-of-way, a portion of the flows that are currently conveyed through the improved area of Irvine Regional Park directly to Santiago Creek will be rerouted to allow the first flush flows to pass through proposed extended detention basins prior to discharge into the creek. This rerouting of flows will allow the runoff to be conveyed and discharged into an unimproved area of Irvine Regional Park and is discussed in further detail in Section 5.4.

Flows routed to Santiago Creek through Concentration Points 3 and 4 (Figure 5.1) are not attenuated or diverted to reduce the increase in peak flow rates due to development. Water is diverted to these Points during Phases 1 and 2 and Ultimate Condition in order to accomplish other goals such as the reduction in flows through the developed portion of Irvine Regional Park. The inherent increases in peak flow rates that accompany the development are insignificant compared with the peak flow rates in the receiving waters of Santiago Creek at the confluence points. The times of concentration of the peak discharges in the receiving waters are also much longer than the times of concentration of flows from the project site, also resulting in a lesser impact of the increased flows due to development. Riprap and other velocity-reducing devices are proposed as necessary at Points 3 and 4 to reduce impacts from increased flows. See Sections 5.6 and 6.3 for a detailed discussion of potential impacts to Santiago Creek as a result of the proposed development.

Similarly, increased flows routed to Woody's Cove/Irvine Lake (Concentration Point 6) are not attenuated or diverted to reduce the increase in peak flow rate due to development. Water from a portion of the East Orange 1 development that currently drains to Peters Canyon Reservoir is intentionally diverted to Woody's Cove to reduce flows to the Jamboree Culverts and Peters Canyon Reservoir. This intentional increase in peak flow rates due to development is insignificant compared with the overall volume of the receiving waters in Irvine Lake. Riprap and other velocity reducing devices are proposed as necessary at Point 6 to reduce impacts from increased flows. See Section 6.4 for a detailed discussion of potential impacts to Woody's Cove/Irvine Lake as a result of the proposed development.

5.1.3 WATERSHED CHARACTERISTICS

Figure 5.2 shows the proposed land use plan for Santiago Hills Phase II and East Orange Area 1 Project. Generally, the proposed development plan consists mostly of dedicated open space and residential densities ranging from 4 to 20 dwelling units per area (du/ac). Area F shown on Figure 5.2 is not included in this project because it has been sold to Rancho Santiago Community College and will not be developed per the proposed tentative maps.

Figure 5.3 shows the land use assumptions that were used in the 1985 Hydrology & Hydraulic Analysis prepared by Rivertech. This figure is included for reference only. The overall imperviousness of the previous land use assumptions (45.7%) compared to the currently proposed project (31.6%) has decreased significantly. The reduced imperviousness is the result of an increase in proposed open space. This decrease in imperviousness results in a reduction of the expected runoff tributary to Peters Canyon Reservoir from that computed in the 1985 study. Section 7.3 provides a detailed comparison of the reservoir routing analyses taken from the 1985 analysis and routing analysis prepared for this ROMP.

5.2 WATERSHED MODEL DEVELOPMENT

Hydrologic calculations to evaluate surface runoff associated with various expected values (EV) and high confidence (HC) hypothetical design storm frequencies from the project watershed were performed. Typically, EV discharges are used for comparison of flows for mitigation purposes and evaluating protection levels for existing facilities. HC discharges are generally used for design of new flood control facilities. See Table 5.1 and Section 5.2.2 below for an explanation of which hypothetical storm frequencies were used to size drainage devices and which were applied to Points 1 through 6 in the project area.

The Rational Method is a surface hydrology procedure that allows evaluation of the peak discharge generated from a watershed area, but does not analyze runoff volumes or the time variation of runoff. Unit hydrographs are the other procedure utilized to evaluate the runoff volume for the inflows to the detention facilities such as the watershed tributary to Peters Canyon Reservoir (Area A, Figure 5.1). These two methodologies are described in greater detail in Sections 5.2.3 and 5.2.4 of this report. Sections 5.2.5 and 5.2.6 explain which methodology was applied to each point in the project area.

5.2.1 WATERSHED PARAMETERS/CHARACTERISTICS

The watershed parameters used in the hydrologic calculations include soil type, infiltration rates, and rainfall intensity-duration curves as specified by the Orange County Hydrology Manual. The following paragraphs discuss each of the watershed parameters.

Figure 5.1 – Proposed Drainage Boundary Diversion Map

Figure 5.2 – Land Use Exhibit

Figure 5.3 – 1985 Land Use Exhibit for Peters Canyon Reservoir

Soils maps from the Orange County Hydrology Manual indicate the soil types “B”, “C”, and “D” are representative of the project location, Exhibit B. The prominent soil type in the Santiago Hills Phase II watershed is “D”. In East Orange Area 1 the predominant soil types are B and D. Soil type “C” is also found in Santiago Hills Phase II and East Orange Area 1, but in lesser quantities such that it is of less effect relative to the more prevalent soil types B and D. Hydrologic soil ratings are based on a scale of “A” through “D,” where “D” is the least pervious, providing greatest storm runoff. Hydrologic Soil Groups differ from Soil Type classifications in that the Hydrologic Soil Groups refer to a soil’s infiltration capabilities. “Soil types” refer to a particular soil classification, i.e. sandy loam or clay. Therefore, an area with the same soil type may have varying Hydrologic Soil Groups due to factors such as topographic relief. Increasing the slope of the terrain can result in the soil being less pervious and therefore, different Hydrologic Soil Groups even for the same soil type.

In addition to the soil type, the infiltration rate is affected by the type of vegetation or ground cover and percentage of impervious surfaces. The runoff coefficients used were based on the proposed residential layout. Figure 5.2 shows the proposed land use plan for the Santiago Hills Phase II and East Orange Area 1 Project. A majority of the area that drains into Peters Canyon Reservoir, Santiago Creek, or Santiago Canyon Reservoir is proposed to be undeveloped open space or emergent marsh. The remainder of the land use is dominated by residential land uses. A portion of the site consists of park and school land uses.

Standard rainfall intensity-duration curve data were taken from the *Orange County Hydrology Manual* dated October 1986.

5.2.2 DESIGN RAINFALL

The storm frequencies investigated at each of the discharge points are shown in Table 5.1 (discharge points are shown on Figure 5.1), and reflect special requirements of the County of Orange under Mitigation Measure W-4, and direction from the Orange County Flood Control District. EV Discharges are used for comparison of flows for mitigation purposes and evaluating protection levels for existing facilities. HC Discharges are generally used for design of new flood control facilities.

Expected value analyses for the 2, 5, 10, 25 and 100-year storm events were performed at Points 1 and 2 to provide a sufficient range for comparison between developed condition peak discharges, and the Existing Condition discharges. 100-year high confidence analyses were also performed at points 1 and 2 to verify that the existing design parameters of Peters Canyon Reservoir and Jamboree drainage system, respectively, are being met. The 100-year, HC storm event was conducted at Peters Canyon Reservoir (Point 1) to analyze whether the existing Northern outlet works would detain a 100-year HC event. The 100-year high confidence discharge was calculated to analyze whether the existing culverts in Jamboree Road (that are currently designed to convey the 10- HC storm event) could convey a 100-year HC event.

Only high confidence analyses were performed for discharges to Santiago Creek, Villa Park Dam, Irvine Lake and Irvine Regional Park (Points 3, 4, 5 and 6) because it was not necessary to meet specific thresholds for developed condition discharges at these

Concentration Points. Therefore no expected value analyses were performed. Instead, the 25 and 100-year HC analyses were performed since they provide useful information for preliminary design of the proposed pipe system.

The major backbone infrastructure that conveys flows between SR 241/SR 261 and Jamboree Road will be designed for a 100-year, high-confidence storm event because the culverts crossing SR 261 and Chapman Avenue have been designed to convey the 10-year discharge under open flow conditions and the 100-year discharges under pressure flow conditions. Therefore these culverts have the capacity to convey the 100-yr storm event. Other lateral backbone systems will be designed to convey, at a minimum, the 25-year storm event with the difference in discharges between the 25 and 100-year storm events being conveyed in the streets or drainage channels according to City and County design criteria. The 100-year expected value discharges per Addendum No. 1 of the Orange County Hydrology Manual were used for the floodplain analysis.

Table 5.1 – Analyzed Storm Frequencies

Discharge Point	**25-Yr HC**	**100-Yr HC**	**2-Yr EV**	**5-Yr EV**	**10-Yr EV**	**25-Yr EV**	**100-Yr EV**
1. Peters Canyon Reservoir		X	X	X	X	X	X
2. Jamboree Road		X	X	X	X	X	X
3. Santiago Creek	X	X					
4. Villa Park Reservoir	X	X					
5. Irvine Regional Park	X	X					
6. Irvine Lake (Woody's Cove)	X	X					

5.2.3 RATIONAL METHOD

The hydrologic calculations to determine the design discharges were performed using the County of Orange Rational Method from the *Orange County Hydrology Manual* dated October 1986. The Rational Method is an empirical computation procedure for developing a peak runoff rate (discharge) for watersheds less than 640 acres and storms of a given recurrence interval. The Rational Method hydrology is only applicable where the rainfall intensity can be assumed to be uniformly distributed over the drainage area at a uniform rate throughout the duration of the storm. This assumption generally applies for drainage areas less than 640 acres. This procedure is the most common method for small area urban drainage design since the peak discharge is generally the only required parameter for hydraulic design of drainage facilities. The Rational Method equation is based on the assumption that the peak flowrate is directly proportional to the drainage area, rainfall intensity, and a loss coefficient related to land use and soil type. The peak discharge from a drainage area using the Rational Method occurs at a critical time when the entire drainage area is contributing runoff known as the "time of concentration" for the watershed area. The design discharges were computed by generating a hydrologic "link-node" model that divides the analysis area into drainage subareas, each tributary to a concentration point or hydrologic "node" point determined by existing terrain.

The results of the watershed analysis for the proposed development generated the resulting peak discharges at the discharge points. The Rational Method time of concentration results were also used to compute the lag times used in the Unit Hydrograph analysis.

5.2.4 UNIT HYDROGRAPH (UH)

Unit Hydrograph analyses are generally used for large watersheds (greater that 640 acres) and when hydrographs are required for analyzing flow through water impoundments such as detention basins or reservoirs. For large drainage areas, where more flow is subject to natural storage and infiltration, and where the rainfall distribution can vary considerably, the absence of depth-area adjustments in the Rational Method can result in significant differences in the estimate of the average depth of catchment point rainfalls. These differences generally result in overestimating the peak discharges from large drainage areas when using the Rational Method, since natural storage and infiltration becomes significant over larger areas. The UH method is a statistically based model which assumes that watershed discharge is related to the total volume of runoff, and that the time factors which affect the unit hydrograph shape are invariant, and that watershed discharge storm rainfall runoff relationships are characterized by watershed area, slope and shape factors. The UH method is used to estimate the time distribution of watershed runoff in drainage basins where stream gage information is unavailable. Furthermore, while the Rational Method provides only peak discharges, the UH method provides a time distribution of watershed runoff. For these reasons, the unit hydrograph is more suitable to large watershed analyses.

For the study area, discharge at Concentration Points 1, and 6, Figure 5.1, were computed by generating a "single area unit hydrograph" for the watershed tributary to the concentration point. The following assumptions/guidelines were applied for use of the Unit Hydrograph Method:

1. Lag time was set equal to 80 percent of the Time of Concentration (TC) determined from the Rational Method analysis.

2. The Orange County Valley S-graphs were selected to represent watershed runoff response to unit rainfall.

3. Base flow was assumed to be zero. All streams in the study area are ephemeral with the exception of the South Tributary upstream of ETC 261, which is designated as intermittent. Though flows in this intermittent stream are negligible and have not been precisely charted, flows are estimated to be less than 1/20 cfs. Because this flow would have no appreciable effect on calculations, it was considered zero base flow for purposes of the unit hydrograph model.

4. Standard Intensity-Duration Curve data were taken from the Orange County Hydrology Manual (October, 1986).

5. The UH Method includes the effects of infiltration caused by soil surface characteristics. The soils map from the Orange County Hydrology Manual indicates that the study area consists of soil types "B, C and D," See Exhibit B. The dominant soil types at the project site are "B" and "D." Hydrologic soil ratings are based on a scale of A through D, where D is the least pervious, providing greatest storm runoff.

6. The infiltration rate of a given soil type is also affected by the type of vegetation or ground cover and percentage of impervious surfaces. Loss rates were determined from the SCS Curve Number corresponding to each land use category.

5.2.5 CONCENTRATION POINTS USED FOR COMPARISON

Several key concentration points were used for comparison of the computed discharges between the existing baseline condition and the intermediate staged conditions and the Ultimate Condition. Figure 2.2 shows the concentration points used for the Existing Condition analyses. Figure 5.1 shows the concentration points used for the Proposed and Ultimate Condition analyses. These locations are as follows:

- Point 1 – Peters Canyon Reservoir
- Point 2 – Jamboree Road-The confluence of all flows just before they enter Peters Canyon Reservoir.
- Point 3 – Santiago Creek upstream of the improved portion of Irvine Regional Park
- Point 4 – Santiago Creek downstream of the improved portion of Irvine Regional Park and upstream of Villa Park Reservoir
- Point 5 – Improved Irvine Regional Park
- Point 6 – Woody's Cove at Irvine Lake

5.2.6 DESIGN DISCHARGE METHODS APPLIED TO POINTS 1 THROUGH 6

Discharges at Point 1 were determined using the Unit Hydrograph methodology because it was necessary to analyze flow through Peters Canyon Reservoir, and because the tributary area for Point 1 is greater than 640 acres. The Rational Method analysis was also used at Point 1 in order to determine the Times of Concentration and Lag Times used as input in the Unit Hydrograph analysis.

Discharges at Point 2 were determined using the Unit Hydrograph methodology because the tributary area for Point 2 is greater than 640 acres. The Rational Method analysis was also used at Point 2 in order to determine the Times of Concentration and Lag Times used as input in the Unit Hydrograph analysis.

Discharges at Points 3, 4 and 5 were determined using the Rational Method methodology because the tributary areas are less than 640 acres and there are no storm water detention basins proposed within the drainage areas. See Section 5.3 below for a discussion how existing Caltrans Basin ETC-1 was treated in the models.

Discharges to Point 6 were determined using the Unit Hydrograph methodology because the tributary area is greater than 640 acres. The Rational Method analysis was also used at Point 6 in order to determine the Times of Concentration and Lag Times used as input in the Unit Hydrograph analysis.

5.3 EXISTING BASELINE WATERSHED ANALYSIS

The baseline hydrology allows quantifying the “pre-development” watershed runoff values where “pre-development” represents the watershed with existing conditions prior to development of the proposed Santiago Hills Phase II and East Orange Area 1 project.

Pre-development hydrology calculations were performed using the guidelines established in the Orange County Hydrology Manual, 1986 Edition. The Unit Hydrograph method was used to model attenuation in the watershed due to Peters Canyon Reservoir. The Rational Method was used to estimate watershed lag times for the Unit Hydrograph procedure and to tabulate the maximum watershed loss rate. Rational Method and Unit Hydrograph calculations were performed as described in Section 5.2.6. The Rational Method hydrology map for Points 2, 3, 4, and 5 is included as Exhibit C. Off-site single area Rational Method hydrology maps such as Exhibit C-1 were generated to provide correct flowpaths for specification as inputs to the computer model when determining the critical time of concentration (TC). The Rational Method Map for (Peters Canyon Reservoir) Hydrology Point 1 is shown on Exhibit D. The Rational Method hydrology map for Point 6 is included as Exhibit K. The results of the Rational Method analyses are included in *Technical Appendix B.*

For the purposes of developing the Unit Hydrograph analysis at Peters Canyon Reservoir, no credit was taken for the attenuation of peak flows from the existing ETC-1 detention basin. The flows tributary to the basin were assumed to pass directly through the basin without attenuation. This methodology provides a conservative approach in analyzing the effects of the development. Flows in both the existing and developed conditions are attenuated to some degree by the ETC-1 detention basin.

The results of the Existing Condition Rational Method hydrology are shown in Table 5.2. The results of the Existing Condition Unit Hydrograph hydrology are shown in Table 5.3. The flow rates shown in these two tables are not for comparison purposes since Table 5.3 reflects the influence of on-site detention. The results of the Unit Hydrograph analyses are included in *Technical Appendix B.*

Table 5.2 – Existing Condition Hydrology Summary Rational Method										
				High Confidence (cfs)		Expected Value (cfs)				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
1*	3000	Outlet of Peter's Canyon Reservoir	1135.2	NA	2640	154	562	1153	1547	1938
2*	441/1435/269	Jamboree Road	815.3	NA	1840	80	353	792	1067	1341
3	1030	Santiago Creek	197.6	390	521	NA	NA	NA	NA	NA
4	1510	Villa Park Dam	32.2	67	88	NA	NA	NA	NA	NA
5	935	Irvine Regional Park	249.6	470	625	NA	NA	NA	NA	NA
6*	2024	Irvine Lake	1088.3	1836	2471	NA	NA	NA	NA	NA

* Rational method analysis for Points 1, 2 and 6 were used for time of concentration purposes only.

Table 5.3 – Existing Condition Hydrology Summary Unit Hydrograph										
				High Confidence (cfs)		Expected Value (cfs)				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
1*	3000	Outlet of Peter's Canyon Reservoir	1135.2	NA	117	6	12	26	41	60
2*	3000	Jamboree Road	815.3		1805	253	418	822	1097	1322
6*	2024	Irvine Lake	1088.3	1671	2266	NA	NA	NA	NA	NA

* Nodes apply to Existing Condition Hydrology Map (Exhibit C, C-1 and Exhibit K)

5.3.1 JAMBOREE ROAD ANALYSIS (POINT 2)

The drainage facilities along Jamboree Road were originally designed in 1989, for a 10-year design discharge of 515 cfs (assuming ultimate developed conditions) for the southern culvert based on as-built plans for Jamboree Road. The 10-year design discharge for the northern culvert varies from 415 cfs at the inlet to 646 cfs after the confluence with a 3.5' x7' RCB in Jamboree Road. A smaller culvert exists between the two culverts mentioned above. This culvert drains local drainage from Jamboree Road. The culvert transitions from a 1.25' H x 3.5' W RCB to a 27-inch pipe at its outlet into Peters Canyon Reservoir with a 25-year design discharge of 31 cfs. The computed 100-year flows at the southern crossing of Jamboree Road are 871 cfs, which is more than the capacity of the culvert. The computed 100-year flow at the northern crossing of Jamboree road is 978 cfs, which is more than the capacity of the culvert. The difference in design and predicted flows in the existing condition is addressed by the re-routing of flows and the extension of storm drain improvements under Jamboree Road to be constructed with the Stage 1 improvements. See Section 6.2. Table 5.4, lists the design discharge for the culverts under Jamboree Road and the corresponding computed 100-year high confidence discharges for the pre-development condition.

Table 5.4 – Summary of Pre-development Conditions Selected Discharges (H.C.)			
Concentration Point	**Watershed Area (Ac)**	**Q_{10} Design Discharge (cfs)**	**Q_{100} Computed Discharge (cfs)**
Southern Culvert – dbl 3'H x 9'W Jamboree Road	401.0	515	869
Middle Cross Culvert	8	Q25 =31	23*
Northern Culvert – 4'H x 9.5'W/dbl 3.5'H x 7'H Jamboree Road	406.3	646	978

* Rational Method discharge

5.3.2 PETERS CANYON RESERVOIR ANALYSIS (POINT 1)

A separate existing condition off-site Rational Method map (Exhibit D), Rational Method model and Unit Hydrograph model were developed for the tributary area. See Table 5.3 for a summary of the results.

5.3.3 SANTIAGO RESERVOIR ANALYSIS (POINT 6)

A separate existing condition analysis for Woody's Cove at Irvine Lake is included in the ROMP. A separate hydrology map for this area of the project can be found in Exhibit K. The hydrologic models can be found in Appendix G. Table 5.3 shows the Existing Condition discharges at Point 6.

5.3.4 IRVINE REGIONAL PARK AREA (POINTS 3, 4, and 5)

Existing condition analyses were performed for Points 3, 4, and 5 to provide a benchmark for proposed condition analyses. The results of the analysis are included in Technical Appendix B.

5.4 PROJECT WATERSHED ANALYSIS

The proposed development will be implemented in stages. Each construction stage must be independently evaluated to determine the new flow quantities and ensure that project design features achieve the desired peak storm flows for each stage. Stages must also be evaluated cumulatively to evaluate overall effects as each new phase of construction is completed.

The Santiago Hills Phase II project consists of two primary stages. Stage I will be the area bounded by SR 261, Jamboree Road and existing Santiago Canyon Road (future Chapman Avenue). Stage II will be the area bounded by SR 241 to the east, Chapman Avenue to the south, Irvine Regional Park to the north and Jamboree Road to the west. As each stage is constructed, the storm drain system associated with that stage will be constructed as well as those facilities necessary to convey off-site flows and project condition discharges. Figure 5.4shows the backbone storm drain system to be constructed during each development stage. Because the staging will proceed from the lower portion of the watershed, those areas upstream of each stage will remain in their existing condition. The hydrology for each stage was prepared so that the interim conditions could be assessed. The results of the staged hydrology are shown in Tables 5.5 and 5.6.

Stage I storm water flows from west of the ETC and north of Chapman Avenue will be conveyed in pipe systems along Chapman Avenue, north along Jamboree Road and discharged to the west of the improved portion of Irvine Regional Park (Point 4). Flows to Point 4 will increase as a result of rerouting flows north of Chapman Avenue that are currently tributary to Peters Canyon Reservoir. Flows to Irvine Regional Park (Points 3 and 5) will remain relatively unchanged. Runoff generated in the Stage I area tributary to the Jamboree Road area (Point 2) will not increase as a result of the development except for an increase of 44 cfs for the 2-year storm event. Flows leaving Peters Canyon Reservoir (Point I) do not increase for any storm events during Stage I. During Stage I, it is proposed that a small sill be built atop the crest of the spillway at the north outlet works of Peters Canyon Reservoir. The design depth from the invert of the 60/42-inch pipe entrance to the spillway crest was 6.0 feet according to construction plans. Through survey, it has been determined that the current available depth is 5.54 feet. Because of this 0.46-foot as-built deviation from the design height, a concrete sill will be constructed across the length of the spillway to provide the original design depth from the invert of the 60/42-inch pipe entrance to the spillway crest. The sill is further described in Section 7.3.

Constructing the concrete sill along the spillway to Handy Creek to re-establish the original design depth of 6.0' above the outlet pipe invert will add additional depth to Peters Canyon Reservoir. Assuming a 2:1 embankment slope around the reservoir this translates to approximately an additional 0.3 acres of flooded area within the 100-year floodplain. This is the area that would be flooded if the spillway was at the original design depth of 6.0 feet. It should be noted that the sill will only affect storm flows on the order of the 100-year, High Confidence, single day storm event. Higher frequency flows will remain below the current spillway crest elevation.

This sill is not being constructed to mitigate peak flows. Mitigation is only required for impacts under EV analysis, and none of the EV flow calculations in Existing, Stage 1, Stage 2 or Ultimate condition, show flows that would implicate the as-built height deficiency of the spillway. Only a 100-yr HC storm event could implicate the as-built deficiency. The applicant has agreed to construct the small sill during Stage I of the project in order to bring the height of the spillway into conformity with the original design, thereby restoring the reservoir's design capacity to handle a 100-yr HC storm event. See Section 7.3 for a detailed discussion of the sill.

Figure 5.4 – Recommended Drainage Facilities by Stages

Table 5.5 – Stage I Condition Hydrology Summary										
				High Confidence (cfs)		Expected Value (cfs)				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
1	3000	Outlet of Peter's Canyon Reservoir	1027.0	NA	108	6	12	25	39	56
2	441/1435/269	Jamboree Road	707.1	NA	1756	297	415	800	1056	1323
3**	1030	Santiago Creek	SAME AS EXISTING							
4**	1510	Villa Park Dam	144.4	253	335	NA	NA	NA	NA	NA
5**+	935	Irvine Regional Park	251.3	473	629	NA	NA	NA	NA	NA
6	2024	Irvine Lake	SAME AS EXISTING							

* Node applies to Stage I Condition Hydrology Map (Exhibit E)
** Rational method only, all other analyses are unit hydrograph.
*+ The flow provided for Point 5 is the sum of flows tributary to Nodes 1320 and 935, (see Exhibit E).

During Stage II, a large portion of the Stage II area, north of Chapman Road and west of SR 241 tributary in the Existing Condition to either the Stage 1 area or the Irvine Regional Park, will be rerouted to the west of the improved portion of Irvine Regional Park, within the Santiago Creek watershed (Point 4). This diversion, which is proposed in response to Mitigation Measure W-4, will lessen flooding impacts in the park and minimize flows leaving Peters Canyon Reservoir.

As part of Stage II, drainage patterns east of SR 241 and SR 261 within tentative tract 16201 will also be diverted to Point 4. A benefit of the Stage II development is the reduction of the area that drains to the improved portions of Irvine Regional Park, reducing flows and potential flooding within the park for the storm frequencies analyzed. Post development flows will be directed around the improved areas of the park. Flows from existing culverts ETC-6 and ETC-7 will be redirected north to ETC-9 as a result of the Stage II development. The culvert system within Irvine Regional Park that currently serves the drainage from ETC-6 and ETC-7 will continue to convey flows from the reduced tributary area adjacent to the park.

In order to fulfill a Caltrans request to treat runoff from the ETC within the Caltrans right-of-way, a portion of the flows that are currently conveyed through the improved area of Irvine Regional Park directly to Santiago Creek will be rerouted to allow the first flush flows to pass through proposed extended detention basins prior to discharge into the creek. Another area within the ETC right-of-way is currently tributary to Peters Canyon Reservoir. These flows will also be rerouted to allow the first flush flows to pass through proposed extended detention basins prior to discharge into Santiago Creek. The flows rerouted from these two areas within the ETC right-of-way will be conveyed in the proposed storm drain within Chapman Avenue to an area west of the improved portion of Irvine Regional Park. A comparison of the hydrology maps for the Existing Condition (Exhibit C) and the Stage 2 condition (Exhibit G) shows how flows from these areas are rerouted.

A portion East Orange Area 1 (approximately 60 acres) will be diverted from the Peters Canyon Reservoir watershed to Irvine Lake. An additional area previously tributary to existing Detention Basin ETC-1 will be diverted to Point 3. These diversions will help to reduce flows to Peters Canyon Reservoir. The diversion away from the ETC-1 Basin will also allow for a greater reserve storage capacity for both storm water and sediment. Flows from the ETC-1 basin will continue to be conveyed to Peters Canyon Reservoir. The existing 48-inch culvert (ETC-4) under the ETC and the 60-inch culvert under Chapman will convey the flows to a proposed pipe system that will route the flows directly to the north culvert at Jamboree Road.

Table 5.8 shows the computed peak discharges at Jamboree Road (Point 2) for the combined hydrographs from the North and South Tributaries and the new storm drain 2C for various frequency storms. For the Peters Canyon Reservoir Analysis (Point 1) a separate single area Rational Method map and model were run for each stage and the Ultimate Condition. The off-site maps are included in Exhibits C-1, D, F, H, and J. Results of staged hydrology, Rational Method and unit hydrograph analysis are located in *Technical Appendices C and D* for Stage I and II, respectively.

In some cases, discharges will increase or decrease between stages for a particular storm frequency at a particular concentration point. A comparison of Table 5.2 (Points 3, 4, and 5) and Table 5.3 (Points 1, 2 and 6) (Existing) to Table 5.5 (Stage 1), Table 5.6 (Stage 2) and Table 5.7 (Ultimate) shows how development discharges compare with existing condition baseline discharges. Changes in flows to each of the concentration points are discussed in Section 6 of this report.

Table 5.6 – Stage II Condition Hydrology Summary

				High Confidence (cfs)		**Expected Value (cfs)**				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
1	3000	Outlet of Peter's Canyon Reservoir	993.8	NA	105	6	12	24	37	54
2	441/1435/ 269	Jamboree Road	673.9	NA	1661	268	392	756	962	1206

Table 5.6 – Stage II Condition Hydrology Summary										
				High Confidence (cfs)		Expected Value (cfs)				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
3**	1030	Santiago Creek	277.9	497	669	NA	NA	NA	NA	NA
4**	1510	Villa Park Dam	286.9	600	789	NA	NA	NA	NA	NA
5**	935	Irvine Regional Park	62.8	173	229	NA	NA	NA	NA	NA
6	2024	Irvine Lake	SAME AS EXISTING							

* Node applies to Stage II Condition Hydrology Map (Exhibit G)
** Rational method only, all other analyses are unit hydrograph.

5.5 ULTIMATE CONDITION WATERSHED ANALYSIS

The Ultimate Condition watershed consists of Stages 1 and 2 of Santiago Hills Phase II and East Orange Area 1, and their tributary areas. See, Exhibit I hydrology map for Points 1-5; and Exhibit L, Irvine Lake hydrology map.

Method and Unit Hydrograph procedure and represent peak discharges. The Ultimate Condition hydrology analysis for the Rational Method and Unit Hydrograph for Points 1-5 are included in *Technical Appendix E.* The Ultimate Condition Rational Method and Unit Hydrograph for Irvine Lake (Point 6) are included in *Appendix H*. Table 5.8 presents peak discharges at each concentration point for each storm frequency. The results of the Ultimate Condition hydrology are summarized in Table 5.7.

Table 5.7– Ultimate Condition Hydrology Summary										
				High Confidence (cfs)		Expected Value (cfs)				
Point	**Node***	**Location**	**Area**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
1	3000	Outlet of Peter's Canyon Reservoir	881.9	NA	93	6	11	21	33	48
2	441/1435/269	Jamboree Road	562	NA	1457	242	364	649	859	1063
3**	1030	Santiago Creek	324.2	635	843	NA	NA	NA	NA	NA
4**	1510	Villa Park Dam	293.3	612	804	NA	NA	NA	NA	NA
5**	935	Irvine Regional Park	SAME AS STAGE II							
6	2024	Irvine Lake	1148.07	1761	2387	NA	NA	NA	NA	NA

* Node applies to Ultimate Condition Hydrology Map (Exhibit I and L)

** Rational method only, all other analyses are unit hydrograph.

Table 5.8 – Peak Discharge Comparison Table					
Location**	**Frequency**	**Existing Condition Peak Discharge (cfs)**	**Stage 1 Peak Discharge (cfs)**	**Stage 2 Peak Discharge (cfs)**	**Ultimate Condition Peak Discharge (cfs)**
Point 1	2-yr EV	6	6	6	6
	5-yr EV	12	12	12	11
	10-yr EV	26	25	24	21
	25-yr EV	41	39	37	33
	100-yr EV	60	56	54	48
	100-yr HC	117	108	105	93
Point 2	2-yr EV	253	297	268	242
	5-yr EV	418	415	392	364
	10-yr EV	822	800	756	649
	25-yr EV	1097	1056	962	859
	100-yr EV	1322	1323	1206	1063
	100-yr HC	1805	1756	1661	1457
Point 3***	25-yr HC	390	390	497	635
	100-yr HC	521	521	669	843
Point 4***	25-yr HC	67	253	600	612
	100-yr HC	88	335	789	804

Table 5.8 – Peak Discharge Comparison Table					
Location**	**Frequency**	**Existing Condition Peak Discharge (cfs)**	**Stage 1 Peak Discharge (cfs)**	**Stage 2 Peak Discharge (cfs)**	**Ultimate Condition Peak Discharge (cfs)**
Point 5***+	25-yr HC	470	473	173	173
	100-yr HC	625	629	229	229
Point 6	25-yr HC	1671	1671	1671	1761
	100-yr HC	2266	2266	2266	2387

* Project Design Feature includes construction of sill; the pdf will provide the original design depth n and contain the 100-year storm below the spillway crest elevation.

** Total acreage varies at each location depending on construction stage

*** Rational Method used to determine Peak Flow

+ The values shown for Existing and Stage 1 are the sum of flows tributary to Nodes 1320 and 935. See Exhibits C and E

The design of the Peters Canyon Reservoir north outlet works consists of a 60-inch improved inlet to a 42-inch outlet pipe and spillway, designed for a 100-year, HC, single-day storm event with the maximum flood stage at the spillway crest elevation. This design flow to Handy Creek is reported as 120 cfs. See "Hydrologic & Hydraulic Analysis of Peters Canyon Reservoir and Handy Creek Drainage Plan," September 1985 (Figure 3-2 of report). Table 5.9 shows the 100-year, 1-day HC discharges at the Peters Canyon Reservoir northerly outlet works, all of which are less than the original design outflow of 120 cfs.

Table 5.9 – 100-year, 1-day HC Summary Peters Canyon Reservoir		
Condition	**Tributary Area to Peters Canyon Reservoir (ac)**	**Discharge (cfs)**
Existing	1135.2	117
Stage 1 (TT16199)	1027.0	108
Stage 2 (TT 16201)	993.8	105
Ultimate (EO Area1)	881.9	93

5.6 SANTIAGO CREEK / VILLA PARK DAM IMPACTS

Table 5.10 shows the tributary areas to Santiago Creek and Irvine Lake for the existing condition and each stage of development. The changes in tributary area are due to the diversion of flows from the watersheds currently tributary to Peters Canyon Reservoir and the improved portion of Irvine Regional Park, to the Santiago Creek watershed. These diversions are intended to prevent any increase in flows from the project in Handy Creek, and reduce existing flooding in Irvine Regional Park. Figures 2.2 and 5.1 list the tributary areas at points 3, 4, 5 and 6 for the Existing Condition and of the Ultimate Condition development. Due to the diversion of storm water flows from one watershed to another, the tributary areas increase at some concentration points and decrease at others. Table 5.10 indicates that the net increase in tributary area from the Existing Condition to the Ultimate Condition at Points 3, 4, 5 and 6 is 260.7 acres, 0.5% increase above the existing tributary area of 50,549 acres, for this section of Santiago Creek (ref: OCEMA Hydrology Report, Santiago Creek, dated 1995). This minor increase will have an insignificant effect on the hydraulics in Santiago Creek and the Villa Park Dam.

Table 5.10 – Tributary Areas to Santiago Creek

Point	Existing Area (ac)	Stage 1 Area (ac)	Stage 2 Area (ac)	Ultimate Area (ac)
3	197.6	197.6	277.9	324.2
4	32.2	144.4	286.9	293.3
5	249.6	251.3	62.8	62.8
6	1088.3	1088.3	1088.3	1148.1
Total	1567.7	1681.6	1715.9	1828.4
	Net Change*	113.9	148.2	260.7
% of Total Tributary Area to Santiago Creek**		0.2%	0.3%	0.5%

* Net changes are with respect to the Existing Condition
** Tributary Area Santiago Creek Upstream of Villa Park Reservoir (per Hydrology Report, Santiago Creek, Facility No. E08 from Villa Park Dam to Santiago Peak prepared by OCEMA dated September 1995). Area = 50,549 ac

The 100-year Expected Value discharge in Santiago Creek adjacent to Tract 16201 is projected to be 14,600 cfs (Ref: Hydrology Report for Santiago Creek prepared by OCEMA dated August 14, 1995). This 1995 study presents a conservative estimate of peak flows because much of the upper watershed has since been dedicated as permanent open space, whereas the zoning at the time of the study in 1995 was for residential development. To determine the Existing Condition and Ultimate Condition peak flows in Santiago Creek adjacent to the Santiago Hills II development unit hydrograph analyses were prepared. The development of landuse maps and loss rate calculations are detailed in the analyses included in Technical Appendix M. The unit hydrograph analyses were developed using parameters taken from the "Outflow from Villa Park Dam (E08D01)" unit hydrograph analysis in the Hydrology Report for Santiago Creek prepared by OCEMA dated August 14, 1995. It was assumed that the parameters for lag time, S-curve distribution, peak rainfall values and depth-area reduction factors from the existing study would be applicable to the current study due to the size of the watershed (84 sq. mi.) and the relatively small changes in the watershed characteristics The same assumed watershed parameters were used for the existing and ultimate condition analyses. In the ultimate condition analysis, only the Santiago Hills II and East Orange

Areas 1, 2 and 3 proposed land uses were included in the model since it was the objective to determine the impacts of the proposed developments on Santiago Creek and Villa Park Dam. The impacts of the diverted drainage areas (59.8 acres to Irvine Lake and 200.9 acres to Santiago Creek; total 260.7 acres) were modeled in the ultimate condition analysis. The unit hydrograph analyses are included in Technical Appendix M. The analyses were prepared for the 100-year Expected Value storm to correspond with the County's 1995 Santiago Creek Facility No. E08 study. Because the intent of the analyses was to determine the relative change in peak discharge as a result of the proposed development a 1-day storm was analyzed instead of a 2-day storm as was prepared in the County study. A comparison of the unit hydrograph analyses shows that the peak flows in Santiago Creek at Concentration Points 3, 4, and 5 for the Existing and Ultimate are approximately 11,731 cfs and 12,077 cfs, respectively. These values include discharges from East Orange Areas 2 and 3. The net increase of flows due to the development would be 346 cfs. This is a 3 % increase above the existing 100-year Expected Value discharge. Table 5.11 compares the results of the Existing Condition and Ultimate Condition at key concentration points along the watershed. During Stage 2 of development, a large portion of the discharge tributary to the improved portion of Irvine Regional Park (Point 5) will be diverted to the west and discharged into an unimproved portion of Irvine Regional Park (Point 4), reducing the 100-year peak discharge at Point 5 from approximately 626 cfs to 229 cfs.

Table 5.11 – Comparison of Unit Hydrograph Flows Within Villa Park Dam Watershed 100-year Expected Value

Concentration Point	Existing Condition cfs	Proposed Condition cfs
Irvine Lake (Node 308)	15,615	15,677
Irvine Lake – Just below Spillway	9,149	9,198
Area Between Spillway and Villa Park Dam	4,485	4,576
Combined Hydrographs at Villa Park Dam	11,731	12,077

In the Ultimate Condition, approximately 261 acres of storm flow will be diverted to the Santiago Creek/Villa Park Dam watershed downstream of Irvine Lake. The effect of the increased runoff peak flow and volume to the Villa Park Dam was analyzed. The analysis is included in Technical Appendix M. A comparison of the results of the hydrology analysis is summarized in Table 5.12.

Table 5.12 – Villa Park Dam Comparison Table				
	100-Year Storm Event			
	Peak Inflow	**Peak Outflow**	**Max W.S. Elevation**	**Peak Storm Volume**
Existing Condition	17,000 cfs	5,825 cfs	569.90 ft	17,969 ac-ft
Project Condition (from Step 5)	17,103 cfs	5,868 cfs	569.92 ft	17,982 ac-ft
Project Condition (from Step 6)	17,083 cfs	5,890 cfs	569.94 ft	17,988 ac-ft

The impacts to the Villa Park Dam as a result of the project diversion were assessed using similar modeling procedures as the COE had developed in the Santiago Creek Study The 100-year HC runoff volume to Santiago Creek / Villa Park Dam will increase approximately 13 acre-feet (from 17,969 acre-feet to 17,982 acre-feet) as a result of the development resulting in a increased discharge over the spillway of approximately 63 cfs (5,825 cfs to 5,868 cfs). The approved 100-year outflow from the reservoir is 6,000 cfs. This is an increase of approximately 1.1%, which is negligible. The spillway is designed for a maximum spillway flow of 29,000 cfs. It should be noted that the existing and ultimate peak discharges out of Villa Park Dam are less than the 6,000 cfs approved by the U.S Corps of Engineers for studies in Santiago Creek below Villa Park Dam. The development will have an insignificant impact on Villa Park Dam and on Santiago Creek both upstream and downstream of Villa Park Dam. The diverted area is tributary to Handy Creek, which confluences with Santiago Creek below the dam. Since flows that were once tributary to Handy Creek downstream of the dam are now being conveyed to Santiago Creek upstream of the dam and attenuated by the dam, the peak flow rate in Santiago Creek below the confluence with Handy Creek may actually decrease with the proposed project.

The analysis also concluded that the COE used realistic land use assumptions (percent impervious) for the development of the inflow hydrograph to the Villa Park Dam.
Due to landscaping, non-erosive surfaces and drainage improvements associated with development, the sediment source tributary to Point 4 will be greatly reduced. Flows exiting the proposed pipe at Point 4 will be dissipated to non-erosive velocities. Prior to discharging into Santiago Creek, the first flush flows at Point 4 will either pass through a CDS unit for removing coarse sediments and debris, or through extended detention basins 6A1 and 6A2 (Figure 11.3). The effect that this diversion will have on Villa Park Dam is a net reduction in sediment delivered, thereby resulting in a negligible effect on the capacity, operation and hydraulics of the Villa Park Dam. See Technical Appendix M. Any sediment generated from East Orange Areas 2 and 3 are assumed to be removed from downstream flows through natural processes in Irvine Lake.

Diversion to Point 3 (Figure 5.1) will occur during construction of Stage 2 of Santiago Hills II and East Orange Area 1 (Stage 3). Again, due to the development, the sediment source will be reduced. Also, prior to discharging into Santiago Creek the first flush flows will have passed through extended detention basins (Figure 11.5) where course sediment will be captured. Discharges, except for low flows required to provide water for the habitat between ETC-9 and Irvine Regional Park, will be conveyed in a pipe directly to Santiago

Creek. Flows exiting the pipe will be dissipated to non-erosive velocities as they enter Santiago Creek. The effect that this diversion will have on Villa Park Dam is a net reduction in sediment delivered. The effect on the sediment delivered to Villa Park Dam as a result of the diverted area was analyzed. The analysis is included in Technical Appendix M. The results of the analysis show that the average annual sediment yield to Santiago Creek / Villa Park Dam will be reduced from approximately 1129 tons to 1098 tons as a result of the development. Although the tributary area will increase, the sediment source will be decreased due to reduced erodible surface area as a result of development and also proposed landscaping. The Universal Soil Loss Equation (USLE) was used to determine the sediment yields from the tributary areas for the Existing and Ultimate Conditions. Values for the variables used in USLE were based on information from the Drainage Report, Estimation of Bulking Factors, for the Eastern Transportation Corridor dated November 21, 1995. A copy of the relevant portions of the report is included in Technical Appendix M.

SECTION 6: HYDROLOGIC IMPACTS AND PROJECT DESIGN FEATURES

A comprehensive storm water program incorporating several project design features (PDFs) has been developed herein to address the potential impacts of increased peak flows associated with the Santiago Hills Phase II and East Orange Area 1 development. The ROMP proposes to use a series of diversions and other Project Design Features (PDFs) to alter flow rates due to development, as discussed below for each of the discharge points analyzed.

6.1 POINT 1 (NORTH OUTLET FROM PETERS CANYON RESERVOIR TO HANDY CREEK PIPE)

The outflows from Peters Canyon Reservoir at the north outlet works (Point 1) have been analyzed for the 2, 5, 10, 25 and 100-year Expected Value (EV) for the Existing Condition and development Stages 1, 2 and Ultimate Condition. See Table 6.1. Per the Orange County Hydrology Manual (addendum No. 1), the EV analysis is used for calculating mitigation requirements for development.

The 100-year High Confidence (HC), single-day analysis was performed at Point 1 for the Existing Condition and the development stages because the outlet works were designed to detain flow from a 100-year HC, single-day event with no discharge over the spillway. The HC analysis is more conservative than the EV analysis, and is used to design and size storm drainage facilities. The HC analysis shows that the design criteria for the existing Peters Canyon Reservoir outlet works (60-inch improved inlet to a 42-inch RCP with a 100-foot spillway) function such that there would be no flow over the spillway, with construction of a 0.46’ concrete sill along the spillway crest, for a 100-year HC, single-day storm event for all stages of development. The sill is discussed in greater detail in Section 7.3.

Table 6.1 – Peak Discharges at Peters Canyon Reservoir Outlet to Handy Creek*

Location	Frequency	Existing Condition Peak Discharge (cfs)	Stage 1 Peak Discharge (cfs)	Stage 2 Peak Discharge (cfs)	Ultimate Condition Peak Discharge (cfs)
Point 1	2-yr EV	6	6	6	6
	5-yr EV	12	12	12	11
	10-yr EV	26	25	24	21
	25-yr EV	41	39	37	33
	100-yr EV	60	56	54	48
	100-yr HC	117	108	105	93

Assumes construction of 0.46’ concrete sill along top of spillway crest.

The total tributary areas are 1135.2 acres, 1027.0 acres, 993.8 acres, and 881.9 acres for the Existing, Stage 1, Stage 2, and Ultimate conditions respectively.

6.1.1 PEAK FLOWS AT THE NORTH OUTLET AFTER DEVELOPMENT

As can be seen from Table 6.1, peak outflows from the north outlet works to the Handy Creek pipe system are predicted to be equal to or lower than peak flows under the Existing Condition for all development stages for all the storm frequencies analyzed. Therefore, the proposed project will not have a significant impact on Peters Canyon Reservoir or Handy Creek. It should be noted that the County's prescribed assumptions produce conservative results (i.e. predict greater peak outflows from the reservoir) for at least two reasons. First, the design standards for detention facilities require the assumption that, at the beginning of each storm, the reservoir is filled to the invert of the 42-inch outlet pipe in the northern outlet works. As the data in Figure 4.2 show, the historical water surface elevation of Peters Canyon Reservoir is 1.5 to 3.5 feet below the invert of the outlet pipe. Since in reality the reservoir is only very rarely full to the outlet invert at the outset of any rain event, this assumption produces conservative results at Point 1.

Additionally, the model does not take into account any of the infiltration, evaporation, and water retardation that will be introduced into the Santiago Hills II/East Orange Area 1 (SHII/EO1) hydrologic system by the numerous water quality features that will be constructed as part of the project. For example, the proposed SHII/EO1 development will include extended detention basins, Hydrodynamic Separator Systems, treatment swales, bioretention areas, and connecting vegetated swales. The effect of these water quality features is significant since the response to storm flows in Peters Canyon Reservoir is driven by the volume of water entering the system, and the volume of water captured by these features and the Caltrans basin ETC-1 is not taken into account in the design standards for County detention facilities, producing conservative results.

6.1.2 ADDITIONAL PROJECT DESIGN ALTERNATIVES

Because of the diversion of flows away from the areas currently tributary to Peters Canyon Reservoir, no additional project design features are necessary. As previously indicated, a concrete sill will be constructed atop the north spillway to bring the spillway height to conformance with its original design parameters, as discussed in Section 7.3.

6.2 POINT 2 (JAMBOREE ROAD—THE CONFLUENCE OF ALL FLOWS BEFORE THEY ENTER PETERS CANYON RESERVOIR)

The outflows from Point 2 have been analyzed for the 2, 5, 10, 25 and 100-year EV for the Existing Condition and development Stages 1, 2 and Ultimate Condition (See Table 6.3).

The 100-year HC, single-day analysis also was performed at Point 2 for the Existing Condition and the development stages so that design features for the project could be developed that will allow 100-year HC discharges to pass safely under Jamboree Road. There are currently three conveyances under Jamboree Road (two major culverts, one system for local street drainage). Table 6.2 below summarizes the 100-year HC discharges for each culvert.

Table 6.2 – 100-year HC Peak Discharges for Conveyances under Jamboree Road

Location	Existing Condition Peak Discharge (cfs)	Stage 1 Peak Discharge (cfs)	Stage 2 Peak Discharge (cfs)	Ultimate Condition Peak Discharge (cfs)
North Culvert (2A)	978	706	609	542
Local Street System	23	23	23	23
South Culvert (2B)	869	155	155	155
Proposed Culvert (2C)	NA	867	867	758

Flows represent peak discharges to each of the culverts. For a comparison of combined discharges at Point 2 (timing of peaks accounted) see Tables 5.8 or 6.3.

6.2.1 PEAK FLOWS DOWNSTREAM FROM THE JAMBOREE CULVERTS

As can be seen from Table 6.3, for each storm frequency and in each stage of development, combined peak outflows at Point 2 are expected to be less than peak flows under the Existing Condition. This is a result of diversion of existing flows to Santiago Creek and Irvine Lake,

Currently, there are two main culverts and a smaller culvert under Jamboree Road that comprise Point 2. The capacity of the existing culverts at Point 2 is less than the computed 100-year HC flow. Proposed as part of the project are an additional drain/culvert and a graded secondary outlet or bypass that will allow the 100-year HC discharges to pass safely under Jamboree Road. Therefore the project will decrease peak flows at Point 2 to Peters Canyon Reservoir, and will result in flood control facilities at Point 2 being able to safely accommodate 100-year HC discharges. Flows from proposed culvert 2C will be outletted to the mean high water of Peters Canyon Reservoir in order to minimize potential impacts to habitat in this area, Outlet 2C is discussed further in Section 7.2.

6.2.2 PROJECT DESIGN FEATURES

Peak flows at Point 2 are expected to be less than peak flows for the Existing Condition. For each stage of development with the exception of the 2-yr EV storm for Stage I and Stage II of the development, no additional project design features are required to reduce peak flows. An additional drain/culvert under Jamboree (Outlet 2C) and the existing culverts working in combination allow 100-year HC discharges to pass safely under Jamboree Road.

There is an increase in flows at Point 2 during Stage I for the 2-yr and 100-yr EV storm and during Stage II for the 2-yr EV study. During Stage 2 the flows are for the 100-yr are below those calculated for the Existing Condition. In the Ultimate Condition, the combined flows at Point 2 are below those calculated for the Existing Condition for all storm frequencies analyzed. Nonetheless, an increase is not significant, and will be readily handled by the increased culvert capacity under Jamboree Road with the construction of proposed Culvert 2C under Jamboree Road during Stage I. It should be noted that due to the time of concentration, flows do not increase at the north outlet of Peters Canyon Reservoir (Point I) during the 2-yr EV storm event, despite the small increase at Jamboree Road. Other than the construction of proposed Culvert 2C, no additional project features are required.

Table 6.3 – Peak Discharge Comparison Table

Location	Frequency	Existing Condition Peak Discharge (cfs)	Stage 1 Peak Discharge (cfs)	Stage 2 Peak Discharge (cfs)	Ultimate Condition Peak Discharge (cfs)
Point 2	2-yr EV	253	297	268	242
	5-yr EV	418	415	392	364
	10-yr EV	822	800	756	649
	25-yr EV	1097	1056	962	859
	100-yr EV	1322	1323	1206	1063
	100-yr HC	1805	1756	1661	1457

* Flows based on Unit Hydrograph results. For a comparison of peak flows to each of the four culverts that comprise Point 2 see Table 6.2.

6.3 POINTS 3 (SANTIAGO CREEK UPSTREAM OF THE IMPROVED IRVINE REGIONAL PARK), 4 (SANTIAGO CREEK DOWNSTREAM OF THE IMPROVED IRVINE REGIONAL PARK AND UPSTREAM OF VILLA PARK RESERVOIR), AND 5 (IMPROVED IRVINE REGIONAL PARK)

The 100-year and 25-year HC, single-day analyses were performed at Points 3, 4, and 5 for the Existing Condition, development Stages 1 and 2, and the Ultimate Condition. See Table 6.4. HC analysis is more conservative than EV analyses (*i.e.*, HC analysis usually predicts a greater flows) and is also the analysis used in calculations to size and construct flood control improvements. The project includes the re-routing of tributary area from the

Peters Canyon Reservoir watershed (Points 1 and 2) to the Santiago Creek Watershed (Points 3 and 4,) therefore, post-development flows will increase at these outlet points. Expected Value analyses were not necessary for points 3, 4, and 5 because there were no threshold facility requirements to meet at Santiago Creek.

6.3.1 PEAK FLOWS AT POINTS 3, 4, AND 5 AFTER DEVELOPMENT

As can be seen in Table 6.4, Ultimate Condition peak flows at Point 3 and Point 4 are generally expected to increase with development, while peak flows at Point 5 are expected to decrease with development. A small increase in peak flow at Point 5 in Stage 1 is the result of minor grading. The grading is at the top of a canyon (subarea E on Exhibit E) that drains to the west of the improved portion of Irvine Regional Park in the vicinity of Point 4. Therefore, the slight increase in flow will have no effect on the improved area of the Park and the peak flows will be below the Existing Condition for Stage 2 and the Ultimate Condition. Discharges at Point 5 represent the combined flow from the slope area tributary to Irvine Regional Park. Point 5 currently is collected in a pipe system of unknown capacity and excess flows would sheet flow over the Irvine Regional Park and can result in flooding at the park. The proposed development is designed to divert flow at Point 5 to Points 3 and 4, reducing existing drainage impacts at the park.

The flow diverted from Point 5 to Santiago Creek will result in a negligible increase in the total flow in Santiago Creek at Points 3 and 4. The increased flows at Points 3 and 4 will have an insignificant effect on the hydraulics in Santiago Creek relative to overall flows through the segment of the creek and Villa Park Dam as discussed previously in Section 5.6. The proposed development will have an insignificant impact on Santiago Creek and Villa Park Dam. Additionally, flows from Points 3 and 4 will be dissipated to non-erosive velocities as they enter Santiago Creek.

6.3.2 PROJECT DESIGN FEATURES

Since flows will be significantly reduced at Point 5, no additional project design features are required. This reduction also serves to eliminate the impacts currently caused by overland flow described in Section 4.1.2. Although the increased flows at Points 3 and 4 are very small compared to the existing flows of Santiago Creek at those Points, project design features are proposed to reduce the potential for erosion. For Point 3, an energy dissipation structure combined with riprap at the outfall will render erosion potential negligible. For Point 4, an energy dissipation structure combined with riprap at the outfall and invert control structures or vegetated swales along the flow path will make erosion potential negligible. Also, flows will be released to proposed basins 6A1 and 6A2, as further described in Section 8.

Table 6.4– Peak Discharge Comparison Table (Points 3, 4, and 5)

Location	Frequency	Existing Condition Peak Discharge (cfs)	Stage 1 Peak Discharge (cfs)	Stage 2 Peak Discharge (cfs)	Ultimate Condition Peak Discharge (cfs)
Point 3	25-yr HC	390	390	497	635
	100-yr HC	521	521	669	843
Point 4	25-yr HC	67	253	600	612
	100-yr HC	88	335	789	804
Point 5*	25-yr HC	470	473	173	173
	100-yr HC	625	629	229	229

* The values shown for Existing and Stage 1 are the sum of flows tributary to Nodes 1320 and 935. See Exhibits C and E

6.4 POINT 6 (WOODY'S COVE AT IRVINE LAKE)

The 100-year and 25-year HC, single-day analysis was performed at Point 6 for the Existing Condition, development Stages 1 and 2, and the Ultimate Condition. See Table 6.5. As with Points 3, 4, and 5, flow is intentionally diverted to outlet Point 6 to reduce runoff into Peters Canyon Reservoir and Irvine Regional Park. Since flows increase at outlet Point 6 by design, EV analyses were not required because there were no threshold requirements to meet at Woody's Cove at Irvine Lake.

6.4.1 PEAK FLOWS AT POINT 6 AFTER DEVELOPMENT

As can be seen from Table 6.5, flows at Point 6 are projected to remain equal to the Existing Condition through Stages 1 and 2, and then increase at the Ultimate Condition. At the Ultimate Condition, flows that would have previously flowed into Peters Canyon Reservoir will flow into Woody's Cove, resulting in increased flows to Irvine Lake. This aspect of the project reduces flows from Peters Canyon Reservoir. When the water level of the lake is high, flows from Point 6 will outlet directly into the lake, with no potential for erosion. When the water level is low, flows conveyed between the pipe outlet at Point 6 and the lake could potentially cause some erosion unless mitigation or project design features are implemented.

Table 6.5 – Peak Discharge Comparison Table (Point 6)

Location	Frequency	Existing Condition Peak Discharge (cfs)	Stage 1 Peak Discharge (cfs)	Stage 2 Peak Discharge (cfs)	Ultimate Condition Peak Discharge (cfs)
Point 6	25-yr HC	1671	1671	1671	1761
	100-yr HC	2266	2266	2266	2387

6.4.2 ADDITIONAL PROJECT DESIGN FEATURES

The proposed project design feature of placing riprap or other velocity-reducing devices as necessary at the outfall for Point 6 will render erosion potential negligible.

6.5 POTENTIAL COMBINED IMPACTS

Potential combined impacts related to the development of Santiago Hills II (SHII) / East Orange Area 1 (EO1) and East Orange Areas 2 (EO2) and 3 (EO3) have been identified in their respective ROMPs. These impacts are associated with peak flows in Santiago Creek below Irvine Lake, and peak flows and discharge volumes at Villa Park Dam. For the purposes of identifying the impacts of the development, it was conservatively assumed that the water surface levels in Irvine Lake and Villa Park Dam are at the spillway crest elevation. It is assumed that the response to flows into the water bodies is immediate.

Peak Discharges

Peak discharges from EO1 at Woody's Cove (Irvine Lake; Point 6) will increase by approximately 62 cfs for the 100-year, Expected Value storm event. The computed increase in flow over the spillway was 49 cfs (9,149 cfs to 9,198 cfs) see Table 5.11. Therefore, this additional flow is negligible, 0.5 %. These values include the impacts of East Orange areas 2 and 3. The 100-year Expected Value discharge over the Irvine Lake spillway is 12,600 cfs based on the Hydrology Report for Santiago Creek prepared by OCEMA dated August 14, 1995 based on ultimate development in the Irvine Lake watershed. Therefore, the development will have an insignificant impact on Irvine Lake and the spillway. . See Section 5.6 for additional discussion of the Concentration Points 3, 4, and 5 contribution to Santiago Creek. The 100-year Expected Value storm event was used for comparison to allow the flows to be compared with values calculated in the Hydrology Report, Santiago Creek, Facility No. E08 dated September 1995. The 100-year Expected Value analysis for Point 6 is included in Technical Appendix M. The peak discharges generated from EO2 and EO3 drain to Limestone Creek and Santiago Creek before draining to Irvine Lake. . **Volume**

In the ultimate condition analysis, only the Santiago Hills II and East Orange Areas 1, 2 and 3 landuses were included in the model since it was the objective to determine the impacts of the proposed developments on Santiago Creek and Villa Park Dam. The impacts of the diverted drainage areas (59.8 acres to Irvine Lake and 200.9 acres to Santiago Creek; total 260.7 acres) were modeled in the ultimate condition analysis. The unit hydrograph analyses are included in Technical Appendix M. The analyses were prepared for the 100-year Expected Value storm to correspond with the County's 1995 Santiago Creek Facility No. E08 study. A comparison of the unit hydrograph analyses shows that the runoff volume to Irvine Lake at Concentration Point 6 for the Existing and Ultimate are approximately 4.359 acre-feet and 4375 acre-feet, respectively. These values include discharges from East Orange Areas 2 and 3. The net increase in runoff volume due to the development would be 16 acre-feet. This is a 0.4 % increase above the existing runoff volume. Therefore, the proposed development will have an insignificant impact on Irvine Lake.

The impacts to the Villa Park Dam as a result of the project diversion were assessed. The 100-year HC runoff volume to Santiago Creek / Villa Park Dam will increase approximately 13 acre-feet (from 17,969 acre-feet to 17,982 acre-feet) as a result of the development resulting in a increased discharge over the spillway of approximately 63 cfs (5,825 cfs to 5,868 cfs). The approved 100-year outflow from the reservoir is 6,000 cfs. This is an increase of approximately 1.1%, which is negligible. The spillway is designed for a maximum spillway flow of 29,000 cfs. It should be noted that the existing and ultimate peak discharges out of Villa Park Dam are less than the 6,000 cfs approved by the U.S Corps of Engineers for studies in Santiago Creek below Villa Park Dam. The development will have an insignificant impact on Villa Park Dam and on Santiago Creek both upstream and downstream of Villa Park Dam. The diverted area is tributary to Handy Creek, which confluences with Santiago Creek below the dam. Since flows that were once tributary to Handy Creek downstream of the dam are now being conveyed to Santiago Creek upstream of the dam and attenuated by the dam, the peak flow rate in Santiago Creek below the confluence with Handy Creek may actually decrease with the proposed project.

SECTION 7: HYDRAULICS

Hydraulic calculations for this study included preliminary storm drain sizing for the site and floodplain mapping for the two tributaries upstream of Jamboree Road. The hydraulic requirements for the systems are determined by the City, which include regulations set forth by FEMA.

7.1 FLOODPLAIN HYDRAULICS

Floodplain hydraulics for the two tributaries upstream of Jamboree Road were performed using the U.S. Army Corps of Engineers Hydraulic Profile Program HEC-RAS (River Analysis System). HEC-RAS is designed to perform one-dimensional hydraulic calculations for natural and constructed channels. HEC-RAS generates steady flow water surface profiles for steady gradually varied flow using one-dimensional energy equations. Energy losses are evaluated by friction (Manning's Equation) and a contraction/expansion (coefficient multiplied by the change in velocity head). Manning's values for friction loss were taken to be 0.07, due to the rugged natural stream including vegetation. The momentum equation is utilized in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e. hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions). The effects of various obstructions such as bridges, culverts, weirs, and structures in the floodplain may be considered in the computations. The steady flow system is designed for application in floodplain management and flood insurance studies to evaluate floodway encroachments.

The existing 100-year floodplain was computed for the major natural water courses within the Stage 1 project site. The analysis was prepared using the 100-year HC discharges. Two streams were included in the analysis, the first (North Tributary) extending from Jamboree Road at the intersection of Canyon View Avenue to approximately the intersection of the ETC and Chapman Avenue, the second to the south (South Tributary) extends from Jamboree Road to the ETC. Cross section data were taken for each profile at the sections designated on the topographic map generated from a flight dated March 2000. The sections were selected at locations where large tributaries entered the stream course. As a general rule, distance between the sections did not exceed 150 feet. The complete HEC-RAS output listing and representative cross sections is included in *Technical Appendix I.*

The North Tributary is characterized by a relatively steep profile with moderate vegetation in the streambeds. The stream is deeply incised (25') in the upper reaches with the floodplain spreading out in the lower reaches. The stream demonstrates a generally subcritical flow and a comparatively narrow floodplain. Velocities vary from 3 to 10 fps for the 100-year event. The stream bed shows some evidence of gully erosion during significant storm events.

The South Tributary is generally wide with little evidence of incisement. The velocities vary from 5 to 7 fps in the lower reach to 2 to 12 fps in the upper reach. The stream is generally a wide floodplain and follows a mild gradient, resulting in a flow regime, which fluctuates between critical and slightly subcritical flow. The floodplain hydraulics of North and South tributaries were evaluated using the high confidence discharges from the 100-year existing condition unit hydrograph analysis.

The average depths, velocities, and top widths are shown on Table 7.1. All other computed hydraulic parameters are provided in the summary printout in *Technical Appendix I.* The results of the hydraulic analysis were used to develop the floodplain maps for the study reaches under existing conditions (Figures 7.1 and 7.2). The cross-section locations used in the HEC-RAS file are also included in *Technical Appendix I*.

Table 7.1 – Tributaries – Exist. Condition Floodplain Hydraulic Analysis

Reach	Flow Rate (cfs) 100-year	Avg. Depth (ft)	Avg. Velocity (ft/s)	Avg. Top Width (ft)
North Tributary Upper Reach	730	6.8	7.1	32
North Tributary Lower Reach	730	3.4	5.3	112
South Tributary	869	2.2	5.4	226

Floodplain hydraulics were not performed for these tributary streams for the proposed conditions because it is proposed that the storm flows be routed around the tributaries in pipes. Only low flows and flows from a small portion of the Residential area (6.1 acre) tributary to the south are expected to reach the tributaries and with the construction of the emergent marsh areas, the tributaries will be stabilized. The natural drainages are therefore no longer instrumental in providing flood protection. The 100-year flood protection is provided to the proposed development through construction of the drainage improvements illustrated in Figure 7.3.

No floodplain hydraulics were performed for the natural valley channel between Irvine Regional Park / Santiago Creek and the 84-inch culvert crossing SR 241 (ETC-9). The storm discharges from ETC-9 will be conveyed in a pipe system directly to Santiago Creek. Only runoff generated within the watershed between Irvine Regional Park / Santiago Creek and the 84-inch culvert crossing SR 241 (ETC-9), and minor storm flows (no nuisance flows) from ETC-9 will be conveyed in the natural channel thereby greatly reducing the flows compared to the existing condition. The reduction of flows will also reduce the potential for erosion within the natural valley channel.

As stated in Section 5.6, the increases in drainage area and peak discharge to Santiago Creek due to the project are approximately 0.5% and 3.0%, respectively. These minor peak flow and tributary area increases are insignificant; therefore, no additional flood mapping of this area is required.

The drainage diversion at Point 4 as a result of development of Stage 2 (TT 16201) will convey flows in a pipe system (Figure 7.3) to within the 100-year flood boundary of Santiago Creek / Villa Park Dam (Figure 2.1). Therefore, no additional flood mapping of this area is required.

Figure 7.1 – Existing Condition Floodplain North Tributary

Figure 7.2 – Existing Condition Floodplain South Tributary

Figure 7.3 – Recommended Drainage Facilities Map

The Woody's Cove drainage diversion, as a result of development of East Orange Area 1, will convey flows in a pipe system (Figure 7. 4) to within the 100-year flood boundary of Irvine Lake (Figure 2.1). A significant portion of the Woody's Cove watershed will remain in its natural condition (area south of SR 241, see Figure 5.1 Area E). Flows generated from this natural area will continue to flow unaltered to Woody's Cove. Therefore, no additional flood mapping of this area is required.

No floodplain hydraulics were performed for the natural canyon channel adjacent to Santiago Canyon Road, which conveys flows to Woody's Cove. The discharges from the developed area will be conveyed to Irvine Lake in a storm drain. There is an increase in flows to Woody's Cove as a result of the East Orange Area 1 development and diverted area from the Peter's Canyon Reservoir watershed. The increased flows from the project will have a negligible effect on the water level in Irvine Lake. By conveying the storm flows in a stormdrain, the potential for erosion in the natural canyon channel is reduced compared to the existing condition. The velocities of flows discharged to Irvine Lake will be reduced to non-erosive conditions through the construction of an energy dissipation structure in combination with rip rap at the storm drain outlet as necessary. The design of the energy dissipation structure will be provided during the design phase of the project. Bedrock in the lake bottom between the storm drain outfall and the lake water surface will further reduce the potential for erosion in the dry lake bottom. The estimated size of the pipe system would vary from 30-inch to a 72-inch pipe assuming a pipe slope of 2%, Figure 7.4. Rainfall falling directly on the area below the Woody's Cove improvements and natural off-site area flows would sustain the vegetation growth in the canyon.

7.2 STORM DRAIN FACILITIES

The preliminary hydraulic sizing for the storm drain system was taken from the 25-year, and 100-year Rational Method Hydrology. The Rational Method estimates required pipe sizes using normal depth calculations. Manning's "n" values for RCP used in the analysis was 0.013. The proposed storm drain systems will be designed for high confidence storm events per the Orange County Flood Control Design Manual. It is recommended that the major backbone systems be designed for a 100-year level of protection between SR 241/SR261 and Jamboree Road. The other storm drain systems will be designed to convey the 25-year storm within the system. The 100-year storm will be contained using a combination of the storm drain capacity and street capacity. Prior to reaching the existing South culvert at Jamboree Road, which has a 10-year design capacity, a pipe alignment, Line 2C, Figure 5.1, will convey the flows directly into Peters Canyon Reservoir thereby bypassing the existing culvert. This will allow the south culvert to convey the 100-year discharge conveyed by the South Tributary.

Estimated pipe sizes ranged from 18" to 72" Reinforced Concrete Pipe (RCP). Figure 7.3 shows the approximate locations and sizes of the proposed back bone storm drain systems. The sizes shown on the Figure 7.3 are for master planning purposes only. Additional hydraulic calculations must be performed and submitted with final design of the storm drain system to confirm the pipe sizing.

Figure 7.4 – Woody's Cove Drainage Facilities

Storm water flows generated within area tributary to Woody's Cove (Irvine Lake) during the East Orange Area 1 development will be conveyed in a pipe to the lake, Figure 7.4. The first flush or low flows will be conveyed to an extended detention basin prior to being reintroduced back into the existing natural drainage course that is parallel to Santiago Canyon Road. Flows generated in the existing open space outside the development area will continue to be conveyed along existing drainage patterns in existing culverts under Santiago Road and SR 241.

7.3 PETERS CANYON RESERVOIR HYDRAULICS

A comparative technical analysis was performed as part of the current watershed investigation to evaluate or quantify changes from previous hydrologic studies for this area. The report entitled *Hydrologic and Hydraulic Analysis of Peters Canyon Reservoir and Handy Creek Drainage Plan,* dated September 1985 and prepared by RIVERTECH, Inc., provided the basis of design for the existing Peters Canyon Reservoir combination spillway structure, which consists of a 42-inch RCP outlet with an improved inlet (side-tapered from 60 inches) and a broad-crested weir with a 100-foot span along the crest and 5 to 3 side slopes extending to a height of 4.5 feet above the crest. The outlet is located at the northern portion of the reservoir and outlets to Handy Creek. The spillway crest was originally designed 6 feet above the invert of the 42-inch outlet pipe. The hydrograph development and flood routing analysis performed in the RIVERTECH report is based on the *Orange County Flood Control District Hydrology Manual* dated October 1973. This manual has since been replaced by the *Orange County Hydrology Manual* dated October 1986 (revised December 1995). The depth-outflow rating curve data in the RIVERTECH report was developed using Chart 18 (Throat Control Curves for Side-tapered Inlets to Pipe Culvert) from the Federal Highway Administration (FHWA) report entitled *Hydraulic Design of Improved Inlets for Culverts,* dated August 1972. This chart has since been succeeded by Chart 55 (Throat Control for Side-tapered Inlets to Pipe Culvert) from the FHWA report entitled *Hydraulic Design of Highway Culverts,* dated September 1985.

The improvement plans entitled *Upper Peters Canyon Tract No. 12417 Storm Drain Improvements,* dated September 1986 (County approved) were prepared by Wilsey and Ham for The Irvine Company. The plans indicate that the spillway crest is 6 feet above the invert of the 42-inch outlet pipe, which agrees with the RIVERTECH report. A field survey performed by RBF Consulting in August 2000 indicates the spillway crest to be 5.54 feet above the invert of the 42-inch outlet pipe, which is 0.46 feet below the 6 feet required by the improvement plans and the RIVERTECH report. It appears based on available data that the outlet structure was not constructed per the approved improvement plans.

Table 7.2 presents the Peters Canyon Reservoir outlet structure rating curve. Depth-volume data was based on March 2000 aerial topography. The depth-outflow rating curve data used in this report is based on current survey information and was developed using the FHWA Chart 55 identified above. For comparison purposes, the Expected Value outflow discharges from the reservoir were computed in Table 7.3. A headwater of 6 feet will generate a flow of 117 cfs through the outlet pipe, and a headwater of 5.54 feet will generate a flow of 107 cfs through the outlet pipe.

Table 7.2 – Peters Canyon Reservoir Outlet Structure Rating Curve Data			
HW (feet)	**Elevation (feet)**	**Outflow (cfs)**	**Storage (ac-ft)**
0[a]	539.58	0	0
1	540.58	9	54
2	541.58	20	110
3	542.58	42	169
4	543.58	65	230
5	544.58	95	293
5.54[b]	545.12	107	329
6[c]	545.58	117	363

Notes: [a]Invert of 42-inch RCP w/ side-tapered inlet
[b]Spillway crest/ RBF Consulting/ April 2001
[c]Spillway crest/ RIVERTECH/ September 1985

The proposed Ultimate Condition provides enough runoff diversion to preclude combination flow (flow through the 42-inch pipe and over the spillway). The net effect is a peak 100-year, 1-Day HC outflow of 93 cfs and a maximum stage of 4.94 feet (0.60 feet below the current spillway crest).

For Stages 1 and 2 the 100-year, 1-Day HC out was 108 cfs and 105 cfs, respectively and maximum stage of 5.59 feet and 5.44 feet, respectively. These outflows are less than the design 100-year outflow discharge of 120 cfs. These flood stages are above the current spillway crest elevation. The spillway crest is set at 5.54 feet (based on field survey) above the invert of the 42-inch outlet pipe. The original design was for a height of 6.0 feet above the spillway. The proposed project will include a project design feature (PDF) that will construct a 0.46 foot high concrete sill along the spillway crest that will establish the original design elevation of 6.0' above the outlet pipe invert and contain the outflows from the reservoir in accordance with the original design criteria. Once this enhancement feature is constructed, no flows over the spillway will occur for the 100-year, 1-day storm frequency for any of the construction stages.

The flood routing through Peters Canyon Reservoir was prepared for various storms. Table 7.3 presents the flood routing analysis summary for the 2, 5,10, 25, and 100-year single day storm events. The hydrograph development and flood routing analysis was performed for each case above in accordance with current Orange County standards for the Existing and Ultimate Condition. Flow over the spillway does not occur in either condition. Figure 7.5 shows the 100-year high confidence storm inundation for Peters Canyon Reservoir. The map indicates that the 100-year reservoir water surface will have no effect on the hydraulic functioning of the culverts in Jamboree Road.

Table 7.3 – Peters Canyon Reservoir Flood Routing Analysis Comparison						
Frequency	**Maximum Stage (feet)**		**Peak Outflow (cfs) 1-min, 1 day values**		**Storage at Peak (ac-ft)**	
	Existing	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**
2 EV	0.67	0.66	6	6	36.2	35.7
5 EV	1.29	1.19	12	11	70.2	65.0
10 EV	2.29	2.04	26	21.	127.2	112.3
25 EV	2.95	2.57	41	33	166.0	143.4
100 EV	3.78	3.24	60	48	216.4	183.9
100 HC	5.98	4.94	117	93	361.8	289.0

Depth-outflow rating curve based on Chart 55, Hydraulic Design of Highway Culverts, FHWA, September 1985, and the broad-crested weir (trapezoidal) equation. Volume-depth rating curve data was based on March 2000 aerial topography.

Figure 7.5 – Peters Canyon Reservoir 100-year Inundation Map

SECTION 8: DEBRIS AND SEDIMENT YIELD

8.1 GENERAL

Sedimentation is the result of erosive forces degrading earth materials and transporting them to new locations along a streambed. Erosion, a process differentiated from sedimentation, can occur in many forms including rill erosion, sheet erosion, and gully erosion. Erosion can occur as part of a natural process, or it can be induced or inhibited by altering land use. Sediment yield is a measure of the total sediment outflow (usually in tons) from a watershed basin at a certain reference point within a specified time period. Sediment yield is generally reduced for urbanized areas as erodible surfaces are replaced by structures, streets, and vegetative cover. Reducing sediment yield may not be damaging in all instances, particularly where downstream watercourses are largely improved. A reduction in sediment bedload may protect existing improved facilities from accelerated wear and protect water quality in waters with high sediment loads like those tributary to Peters Canyon Reservoir, Santiago Creek and Irvine Lake. The amount of sediment conveyed to Peters Canyon Reservoir will be reduced by development, landscaping, routing of storm flows around areas prone to scour, and the design of conveyances with non-scour velocities. Reducing the sediment yield due to the development of Santiago Hills II and East Orange Area 1 will not affect beach sand replenishment at the ultimate ocean terminus (Santa Ana River outlet) because currently, sand from the Santiago Hills II and East Orange Area 1 areas is dropped out in Peters Canyon Reservoir or Villa Park Dam or Irvine Lake. Where downstream watercourses are unimproved, however, lowering sediment yield within a particular watershed may upset channel equilibrium by increasing the capacity of storm water to carry sediment, resulting in potential degradation of the channel bed below the developed watershed. Retarding basins also have the effect of lowering the sediment discharge of a given stream by allowing sediment particles to settle out while runoff is in temporary storage.

The natural drainage courses between Chapman Avenue and Jamboree Road consist of two streams designated as the North Tributary and the South Tributary, Figure 2.2. A significant change in the sediment load (reduction) to the tributaries upstream of Jamboree Road would tend to increase the potential for streambed erosion, possibly altering in-stream habitat. Detention facilities generally capture coarse-grained sediments that are necessary to maintain channel stability for alluvial channels. The North Tributary will be regraded to incorporate an emergent marsh system, Figure 11.4. Larger storm flows will be conveyed in a pipe system around the emergent marsh. Therefore, only dry weather and first flush flows will drain to the stream, thereby reducing the potential for stream erosion. The proposed system of extended detention basins and hydrodynamic separators will also limit the sources of sediment, which may reach Jamboree Road. Reducing the sediment will reduce the maintenance at the Jamboree Road culverts.

The South Tributary will, for the most part, be preserved in its existing condition. The only enhancement proposed in this stream will be the addition of emergent marsh areas, Figure 11.4. The areas will polish dry weather flows and first flush flows from the proposed development and from the Eastern Transportation Corridor. Larger storm flows will be conveyed in a pipe system around the emergent marsh area. Therefore, only dry weather, low flows, and approximately 6.1 acres of residential area will drain to the stream thereby reducing the potential for stream erosion. The South Tributary is wide (~250 feet) therefore flows spread out across the floodplain. The velocities of the resulting shallow flows will be within the non-erosive range. The proposed and existing system of emergent marsh areas will also limit the sources of sediment, which may reach Jamboree Road. Reducing the sediment will reduce the maintenance at the Jamboree Road culverts.

Sediment yield calculations were performed for the collective area tributary to Points 3, 4, and 5 (Figure 5.1). The areas tributary to Points 3 and 4 will be developed and therefore, the source of the sediment will be reduced. There will be a net reduction in sediment production in the area tributary to Irvine Regional Park (Area B), Point 5, as a result of the reduction in tributary area due to the development of Stage 2 (Tentative Tract 16201). The reduction in sediment production to improved portions of Irvine Regional Park will be a benefit to the Park. A detailed discussion of the reduction of sediment delivered to Santiago Creek/Villa Park Dam is included in Section 5.6. The change in sediment yield that will occur as a result of the proposed project and its impact on the Santiago Creek watershed are insignificant.

There will be a net reduction in sediment production in the area tributary to Woody's Cove (Area E), Point 6, as a result of the improvements within the watershed. The reduction in sediment production to Irvine Lake will be a benefit to the reservoir. However, if the removal of sediment is sufficient to reduce the sediment load downstream of the proposed outlet pipe to a level below the carrying capacity of the natural lake bottom channel, there is a potential for scour in the channel. Since the majority of the sediment source for the natural channel will remain unchanged, it is likely that sufficient material will be available to offset sediment loss due to development and extended detention of low flows. In addition, a geotechnical reconnaissance of the outfall area noted exposed bedrock.

No sediment transport calculations were performed along the conveyances tributary to Points 3,4,5 and 6, Figure 5.1. The drainage tributary to Point 3 will be conveyed in a pipe from the Caltrans culvert (ETC-9) to Santiago Creek. Therefore, sediment transport as a result of stream erosion will not occur from the East Orange Area 1 drainage. The natural canyon drainage between ETC-9 and Point 3 will convey only storm water runoff generated in the tributary area between the two points and controlled storm flow releases during storm events. Due to the conveyance of development area storm flows in the pipe, the discharge in the natural channel will be reduced thereby reducing the potential for erosion in the channel.

The area tributary to Point 4 will be fully developed and the flows conveyed in a pipe system thereby eliminating the sediment source and the need to analyze sediment transport. Energy dissipation for the piped flows at Point 4 will be provided using rock riprap in combination with an energy dissipation structure as needed. Project low flows and dry weather flows to Point 4 will be routed through extended detention basins 6A1 and 6A2. Excess flows will be released to Santiago Creek through a series of meandering channels of minimal gradient to minimize erosion. Flows tributary to Irvine Regional Park (Area B, Point 5) will be reduced due to the reduction in tributary area, Figure 2.2 and Figure 5.1. It should be noted that Area B, Figure 5.1, consists of natural slope area, which will not be affected by this project. Existing improved channels and pipes in Irvine Regional Park will convey these flows through the park to Santiago Creek.

The area tributary to the existing detention basin along SR 241 (Basin ETC-1, Figure 5.1) will be reduced as a result of the development of East Orange Area 1 by approximately 26 acres. This reduction will be in the natural slope areas. The remaining natural slope area will remain in its existing condition. Therefore, there will be a net reduction in the flows to the detention basin for all frequencies of storm events and a net reduction in sediment delivered to the basin due to the reduction of discharges to carry the sediment and the reduction of the sediment source. As there will be a reduction of storm flow and sediment delivered to the basin due to reduction in the tributary area as a result of the development, no additional sediment yield or sediment transport analyses was performed for the basin .

The area tributary to the existing culvert at SR 261 (ETC-15, Exhibit A) will be reduced as a result of the development of East Orange Area 1 by approximately 87 acres. This reduction will be in the natural slope areas. The remaining natural slope area will remain in its existing condition. Therefore, there will be a net reduction in the flows to the culvert for all frequencies of storm events and a net reduction in sediment delivered to the culvert due to the reduction of discharges to carry the sediment and the reduction of the sediment source. Furthermore, larger storm flows will be diverted around the North and South Tributaries. This will minimize erosion in the tributaries and reduce sediment to the Jamboree Road Culverts and Peters Canyon Reservoir. Therefore, the project will reduce the sediment to the Jamboree Road culverts and Peters Canyon Reservoir.

8.2 SEDIMENT YIELD

The source of potential sediment for the North and South tributaries upstream of Jamboree Road was assumed to be bounded by Chapman Avenue to the north, SR 261 to the south, and Jamboree Road to the west (Stage 1, Tentative Tract 16199). Coarse sediment outside this area is assumed to largely drop out in the existing detention basin and upstream of the culvert crossings prior to reaching the subject tributaries. Fine sediments are assumed to pass through the system in typical concentrations. Flows outside the sediment source watershed were assumed to be routed in a pipe system around the tributaries in the developed condition. Therefore, only stormwater falling directly on the watershed or directly tributary to it would result in sediment yield.

The proposed development would reduce the volume of sediment produced in the watershed. The reduction in sediment yield between the Existing and Ultimate Condition is largely the result of the decreased discharges due to conveying the storm flows generated upstream of the tributary channels around the channels in a pipe system. Only flows generated within the undeveloped areas of the tributaries and low flows from the extended detention basin or emergent marsh areas will contribute to flows in the tributaries for the Stage1 through Ultimate Condition for storm frequencies 100-year and below. The sediment yield is an estimation of the material, which is eroded from the watershed per storm event for the various storm frequencies. A reduction in sediment yield from the watershed represents a proportional reduction in erosion within the watershed. A significant reduction in erosion within the North and South Tributaries can be expected as a result of development in the adjacent areas, the routing of flows around the tributaries, and the construction of extended detention basins and emergent marsh areas within the tributaries. The yielding of “clear water” discharge as a result of reduced sediment yield is not a concern since the overall amount of flows through this system will be reduced due to re-routing and the detention basins. Therefore, an overall reduction in erosion can be expected.

The sediment yield quantities represent the total sediment load, which range from fine materials (silt and clay) to coarse materials (sand and gravel). Generally speaking, the coarse materials usually move closely to the streambed and would easily deposit once the flow velocity decreased. The fine materials normally stay suspended in the water and seldom settle. The fine materials are expected to pass through the drainage systems.

8.3 SEDIMENT TRANSPORT

The fluvial sediment transport discharge for the Santiago Creek tributary downstream of the ETC-9 culvert (see Figure 5.1) within Irvine Regional Park and west of the Eastern Transportation Corridor was not computed. The major storm flow discharges from ETC-9 will be conveyed in a pipe system directly to Santiago Creek. Therefore, it is not anticipated that there would be an increase in the sediment transport due to the development generated increase in runoff volume tributary to Santiago Creek. A structure downstream of ETC-9 will allow controlled release of storm flows in the natural valley channel to maintain natural growth. The low flow diversion structure will divert low storm flows to the natural valley channel but pass nuisance flows to Santiago Creek. This can be accomplished by providing a small lateral with its invert set slightly higher than the invert of the mainline pipe. In this way the nature of the growth in natural channel will be maintained.

The fluvial sediment discharges were not computed for the North and South tributaries to Peters Canyon Reservoir because these watercourses will only be subject to local flows and off-site water quality diversion flows for developed conditions. These subject flows are considered non-erosive (velocities less than 3 fps).

SECTION 9: STORM WATER DETENTION

As was previously stated, there is one existing detention basin, ETC-1, related to the proposed project. However, for the purposes of analyzing the effects of the development on the culverts at Jamboree Road and at Peters Canyon Reservoir, no credit was taken for the attenuation of peak flows from the existing ETC-1 detention basin. The flows tributary to the basin were assumed to pass directly through the basin without attenuation. This methodology provides a conservative approach in analyzing the effects of the development. Remaining discussions in this section relate to detention taking place in Peters Canyon Reservoir.

A hydrologic routing analysis was performed using the Advanced Engineering Software (AES) Orange County Flood Routing Analysis computer program which utilizes a Modified Puls procedure to determine the effect of Peters Canyon Reservoir on the peak flow attenuation and develop an outflow hydrograph. The stage-volume relationship characteristics for the reservoir were determined from recent aerial topography, Table 4.1. The stage-outflow relationship for the reservoir is shown on Table 7.2. The computation time interval for the routing analysis was one minute. The stage-storage volume-outflow relationship for Peters Canyon Reservoir is summarized on Table 7.2 and the calculations shown in *Technical Appendix F.*

Link-node hydrograph routing models were generated to calculate the flow attenuation in Peters Canyon Reservoir. Hydrographs were developed using time of concentration and maximum watershed loss data from the Rational Method study. Lag times for Unit Hydrograph computations for 2-, 5-, 10-, 25-, and 100-year storms were calculated from the Rational Method Tc estimates. Calculations for the watershed low loss fraction were completed separately and are included in the *Technical Appendices B, C, D and E*, depending on the condition modeled, along with the hydrograph model output listing. The single area hydrograph model at Peters Canyon Reservoir was computed because the area is larger than 640 acres. Therefore, a Unit Hydrograph methodology is warranted. Through diversion of watershed away from Peters Canyon Reservoir the increased peak runoff rates can be reduced so that the future condition outflows from Peters Canyon Reservoir are equal to or less than the existing condition for the analyzed storm frequencies. Table 9.1 lists the required maximum storm water storage volume and depth at the reservoir for the ultimate condition. Routing analysis computations are provided for the 2-, 5-, 10-, 25-, and 100-year storm recurrence intervals in the *Technical Appendices B, C, D and E*, depending on the condition modeled. The storage volumes shown in Table 9.1 are based on 100-year high confidence analysis.

Basin depth-storage-outflow relationships were determined using basin surface areas, average depth, and assuming the outlet hydraulics would be governed by inlet control. Rating curves for the assumed outlet geometry for the reservoir are included in the *Technical Appendix F.*

Table 9.1 – Peters Canyon Reservoir Data			
Location	**Effective Storage (ac-ft)**	**Effective Depth (ft)**	**Tributary Area (ac)**
Peters Canyon Reservoir	289.0	4.94	881.9

SECTION 10: STREAM STABILIZATION

As part of the initial drainage feasibility studies, the existing stream stability of the North and South tributaries between Jamboree Road and the ETC was examined. The study revealed that there is a need for streambed stabilization within these tributaries. The results of the study show that portions of the study reach experience erosion under existing conditions. The potential for erosion can be minimized by either installation of grade control structures, routing of major flows in a pipe or a combination of the two.

Due to the selected BMPs (primarily extended detention basins) within each of the tributaries it was decided that routing the larger storm flows around the basins would be necessary to maintain the integrity of the extended detention basins and emergent marsh areas. Flows conveyed by the culverts under SR 261 and existing Chapman Avenue will be conveyed by pipe to the existing and proposed culverts under Jamboree Road. Low flow devices constructed in the pipe system will convey “first flush” discharges as well as dry weather discharges to the extended detention basins and emergent marsh areas. Storm flows that exceed the capacity of the low flow devices will continue in the pipe system.

When Stage 2 is developed and existing flows that are currently tributary to ETC-6 and ETC-7 are diverted to ETC-9, the discharges from the outlet of the 84-inch culvert (ETC-9) will be conveyed directly to Santiago Creek in a pipe. The natural drainage will receive controlled releases of storm flows that are non-erosive. A rock riprap blanket will be constructed, as necessary, at the proposed pipe outlet into Santiago Creek. A geotechnical reconnaissance showed that at the pipe outlet into Santiago Creek the channel material generally ranges from gravel to boulders, which would provide armoring against potential erosion in the creek. A copy of the geotechnical report is included in Technical Appendix K.

When East Orange Area 1 is developed and the proposed diversion of additional flows to ETC-9, Figure 5.1, is complete, new energy dissipation will not be necessary at the existing outlet of the 84-inch culvert (ETC-9). No additional erosion is expected since the increased discharges will be piped directly to Santiago Creek, and an energy dissipater will already have been installed during Stage 2.

Discharges to Woody’s Cove / Irvine Lake will increase as a result of development and diversion of watershed. Flows generated within the East Orange Area 1 project site, which are tributary to Woody's Cove, will be conveyed in a pipe system to the high water elevation of Irvine Lake. When the lake level is high, the flows will outlet directly into the lake. However, when the lake water level is down, flows conveyed between the pipe outlet and the lake level water surface can potentially cause erosion within the canyon. A geotechnical reconnaissance of the outfall area showed exposed bedrock. The geotechnical report is included in Technical Appendix K. Therefore, the proposed project will include, as a project design feature, placement of rip rap or other devices as necessary at the outfall for energy dissipation, which, combined with the exposed bedrock in the canyon, and will make the potential for erosion negligible.

SECTION 11: RUNOFF WATER QUALITY ASSESSMENT

11.1 GENERAL

Current requirements of the Regional Water Quality Control Board, the local Orange County Drainage Area Management Plan (DAMP) and the City of Orange Local Implementation Plan (LIP) require implementation of control measures to control runoff water quality. Recommendations regarding the selection of structural and non-structural control measures will be developed specific to the watershed and the proposed land uses to comply with these requirements. These recommendations will be implemented in the project WQMP that is required to be prepared prior to obtaining a grading permit. A detailed water quality assessment will accompany this report as Santiago Hills II Planned Community and East Orange Area 1 Planned Community, Runoff Management Plan, Volume 2: Surface Water Quality Report, under separate cover.

The water quality assessment describes structural BMPs including but not limited to, extended detention basins, biofiltration, and emergent marshes proposed as project design features. Figure 11.1 shows the locations of the proposed extended detention basins and emergent marsh areas within the Santiago Hills II and East Orange Area 1 Project. Figures 11.2 through 11.6 give detailed information for the basins such as basin size and proposed maintenance responsibilities. All storm water runoff generated from areas developed by this project will pass through hydrodynamic separators or upstream extended detention basins prior to entering an emergent marsh area. Hydrodynamic Separator Device (herein, "CDS unit") are primarily gross pollutant traps, which capture trash, debris, and floatables in storm water runoff. This pretreatment will help maintain the aesthetics and quality of the emergent marsh areas. The locations of the CDS units are shown on Figures 11.2 through 11.6.

Low-flow devices will be constructed in the proposed drainage system to route low flows and first flush flows to the extended detention basins and emergent marsh areas. Proposed extended detention basins are off-line from storm flow / flood control facilities. The devices will be similar to a typical manhole with a vault below the mainline invert that will divert the low flows. These low flows are conveyed in a lateral set at the bottom of the vault. The low-flow devices will provide the flows to the proposed extended detention basin and emergent marsh system. Storm flows that exceed the capacity of the low-flow devices will remain in the drainage system. A conceptual low-flow device is shown as Figure 11.7.

Figure 11.1 – INDEX – Ultimate Condition Extended Detention Basins

Figure 11.2 – Ultimate Condition Extended Detention Basins

Figure 11.3 – Ultimate Condition Extended Detention Basins

Figure 11.4 – Ultimate Condition Extended Detention Basins

Figure 11.5 – Ultimate Condition Extended Detention Basins

Figure 11.6 – Ultimate Condition Extended Detention Basin

Figure 11.7 – Conceptual Low Flow

SECTION 12: DESIGN CONSIDERATIONS

12.1 AGENCY AGREEMENTS, PERMITS, AND APPROVALS

This ROMP is subject to the review and approval of the City of Orange and the County of Orange as defined in Mitigation Measure W-4 of the SEIR. This ROMP meets the requirements of the Corps of Engineers (COE) 404, Department of Fish and Game 1603, the Habitat Mitigation and Monitoring Plan (HMMP), Regional Water Quality Control Board (RWQCB) 401, and the County of Orange Drainage Area Management Plan (DAMP).

12.2 GEOTECHNICAL

No geological constraints have been identified for the project.

12.3 ENVIRONMENTAL CONSTRAINTS

The City of Orange is currently in the process of preparing an Environmental Impact Report to address impacts and, if necessary, appropriate mitigation for implementation of this ROMP.

12.4 ULTIMATE DEVELOPMENT REQUIREMENTS

- The specific runoff mitigation techniques employed in the Runoff Management Plan are as follows:

- <u>Drainage Improvements</u>: A combination of stream courses and storm drain systems will be incorporated to eliminate channel erosion and accompanying downstream sediment deposition, Figure 7.3. The southerly tributary, upstream of Jamboree Road will generally remain natural to preserve natural habitat, while the northerly tributary will be regraded and enhanced with emergent marsh areas. The drainage from the improved areas of the Woody's Cove Watershed will be conveyed in a pipe from the improved areas to Irvine Lake, thus eliminating a cause of additional potential erosion in the natural canyon channel, Figure 7.4. Flows generated in the natural open space outside of the proposed improved areas will continue to be conveyed in the existing drainage pattern in the current drainage facilities.

- <u>Landscaping</u>: Hillside developments typically require cut and fill slopes, which are susceptible to erosion. All manufactured slopes will be landscaped and maintained by the Homeowners Association or Caltrans. Slopes will also be protected during construction with conventional erosion control measures.

- <u>Rerouting of Flows</u>: Flows will be rerouted in several of the watersheds in order to accomplish project objectives and reduce potential impacts.

12.5 LOCAL DRAINAGE CONSIDERATIONS

A backbone drainage system for the development is shown on Figure 7.3. The backbone system represents the major collector system required to drain the development. In addition, a local drainage system will need to be constructed based on the local street patterns and tract layouts. The design of the local drainage system will need to be consistent and supplementary to the backbone system proposed in this ROMP. The storm drain facilities shall be designed in accordance with the City of Orange policies and requirements. It is proposed that the local drainage system be designed to convey the 25-year storm. It is recommended that the major backbone systems be designed for a 100-year level of protection. The difference in discharges between the 25 and 100-year storm events will be conveyed in the streets or drainage channels. The local drainage system must also be in substantial conformance with the proposed Water Quality Control system proposed for the site. This would mean that low flows developed within the development must be conveyed through the Water Quality Controls prior to entering Peters Canyon Reservoir or outletting into Santiago Creek upstream of Villa Park Dam or outletting into Woody's Cove. First flush flows in improved areas of the Peters Canyon watershed are conveyed through a series of BMP's before entering the reservoir, Figures 11.2, 11.3 and 11.4. First flush flows in improved areas of the Santiago Creek watershed are conveyed through Basins 6D1, 6D2 and J before entering the creek, Figure 11.5.

First flush flows in improved areas of the Villa Park Dam watershed are conveyed through Basins 6A1 and 6A2 before entering the Dam impoundment, Figure 11.3. First flush flows generated in the improved areas of the Woody's Cove watershed will be conveyed through Extended Detention Basin 6G, Figure 11.6.

12.6 RIGHT-OF-WAY

Storm drain facilities constructed outside of the public street Right-of-Way will be contained in an easement with a minimum width of 10-feet. Determination of easement widths will be in accordance with the City of Orange policies and requirements. For systems with excessive cover (over 20 feet) the pipe system will be oversized (minimum 60-inches) so that it can be maintained from the inside.

SECTION 13: PROPOSED DRAINAGE FACILITIES

13.1 BACKBONE FACILITIES

The Staged implementation of the development will require construction of drainage facilities to ensure the drainage objectives are achieved. The priorities for specific facilities will be evaluated based upon construction timing of the development and may require specific interim facilities to be constructed.

Storm drain facilities shall be designed in accordance with the City of Orange policies and requirements unless the facility is owned and maintained by Caltrans, and then their requirements shall apply. Conceptual alignment and locations have been identified, however, final drainage facility design and locations will be reviewed as part of the final storm drain improvement plans and grading plans. All on-site storm drain facilities shall be designed to convey flows from the minimum City criteria design storm with additional design factors of safety and freeboard to provide a 100-year level of flood protection to all proposed structures. During storms of intensity greater than the minimum design storm, additional flood protection is provided by utilizing the local storm drain systems capacity and conveying excess runoff above the storm drain capacity within the streets or drainage channels. It is proposed that the backbone drainage systems, which convey flows to the existing and proposed culverts in Jamboree Road, be designed to convey the 100-year high confidence storm. Culverts crossing SR 261 and Chapman Avenue have been designed to convey the 10-year discharge under open flow conditions and the 100-year discharges under pressure flow conditions. Therefore, these culverts have the capacity to convey the 100-year storm event. Other lateral backbone systems will be designed to convey, at a minimum, the 25-year storm event with the difference in discharges between the 25 and 100-year storm events being conveyed in the streets or drainage channels.

The primary drainage features associated with the project are the storm drain systems, Peters Canyon Reservoir, and natural drainages. Preliminary hydraulic analysis of Peters Canyon Reservoir operation were conducted as part of this investigation for various storm frequencies, see *Section 9, Storm Water Detention*.

The proposed storm drain improvements for the Santiago Hills Phase II and East Orange Area 1 are all reinforced concrete pipe ranging in size from 18-inches in diameter to 72-inches in diameter. Irvine Regional Park and existing roads such as Chapman Avenue, Santiago Canyon Road and Jamboree Road will be protected from 100-year discharges from the proposed developed areas. The existing 54-inch (ETC-7) and the 66-inch (ETC-6) culverts under SR 241 will be abandoned when the Stage 2 site is graded. The flows normally tributary to these systems will be conveyed to drainage system ETC-9 that drains to Santiago Creek. The larger diameter (backbone system) pipes are annotated on Figure 7.3 . This figure shows both existing storm drains and proposed backbone storm drains. In addition to the backbone system, local drainage facilities will need to be constructed. These local systems will include catch basins and smaller lateral pipes required to drain the proposed tract layouts.

13.2 FACILITY ALIGNMENT

The alignment of the proposed backbone drainage system is based on a preliminary assessment of drainage requirements and flood protection goals associated with the site. Constraints for the site include location of existing drainage facilities, construction phasing issues, achievement of water quality goals within the site and aesthetic and biological concerns. The backbone alignments are shown on Figures 7.3 and 7.4 .

13.3 JAMBOREE ROAD CULVERTS

The culverts at Jamboree Road have been previously designed to convey the 10-year storm event. The 10-year design allows for approximately 6-inches of freeboard above the required headwater depth prior to overtopping Jamboree Road for the Existing Condition. The discharges shown on Table 6.2 reflect the flows tributary to the culverts on the west side (downstream) of Jamboree Road. These flows reflect the surface runoff from Jamboree Road and discharges that enter the culverts from laterals within Jamboree Road. These additional discharges are also reflected in the combined discharges shown in Tables 5.5, 5.6, 5.7 and 5.8. The proposed culvert/pipeline 2C , Figure 13.1, will divert flows away from the existing South culvert 2B and convey the flows directly to Peters Canyon Reservoir. Dry weather and first-flush flows will be conveyed to the South culvert but larger storm flows will by-pass the culvert. For the North culvert 2A (currently 10-year HC design) the 100-year HC flows exceed the existing design capacity of the culvert for all Stages including the Existing Condition. The 100-year HC flows, which exceed the culvert capacity, will flow overland outside of the street right-of-way through a graded secondary overflow, proposed with the project, in a southerly direction to the South culvert (currently 10-year HC design). With construction of the bypass pipe from the South culvert 2B to the new proposed culvert 2C, the flows to the South culvert are substantially reduced and are below the design capacity and now able to accept the excess flows from the North culvert 2A. The revised system will be designed to convey a 100-year HC storm event, Figure 13.1. A detailed hydrology/hydraulic analysis of the culverts will be prepared during the design phase of the project to confirm conclusions reached in this report.

The proposed storm drain pipe (Figure 5.1, Line 2C) that routes storm water flows around the South culvert (double 3’ X 9’ RCB) will cross Jamboree Road and outlet to Peters Canyon Reservoir, Figure 7.3. Proposed outlet 2C is the terminus of a storm drain that is proposed to extend past existing park trails, to energy dissipation/velocity reduction devices (including rip rap). The outlet, inclusive of energy dissipation velocity reduction devices, will terminate at approximately the mean high water mark of Peters Canyon Reservoir. This design and alignment is predicted to release flows directly to Peters Canyon Reservoir at non-erosive velocities. Temporary impacts to habitat west of Jamboree Road near the entrance to Peters Canyon Reservoir may include excavation for the pipe installation. These construction impacts will be addressed by the SWPPP prepared for the project. See Section 16.2. The biological study of this area discusses the construction and long term impacts to wetlands near the outfall, and concludes that they are largely avoided through appropriate mitigation. The report concludes that no jurisdictional wetlands are directly impacted and therefore no Army Corp permit is necessary. See LSA Associates, Santiago Hills II Supplemental Assessment of Peters Canyon Reservoir Outlets for a discussion of biological impacts at the Jamboree culverts.

Figure 13.1 – Jamboree Road Culverts

13.4 RIGHT-OF-WAY

Right-of way issues at the project interfaces with the surrounding areas such as the ETC, Santiago Canyon Road, Chapman Ave, Jamboree Road, Irvine Regional Park, and Peters Canyon Reservoir will be resolved as the project is formalized.

13.5 FLOOD PROTECTION ASSESSMENT

The attenuation of low frequency peak storm water flows from the site in the post development condition is desirable primarily to avoid surcharging inadequate downstream facilities. Drainage facilities immediately downstream of the Peters Canyon Reservoir were designed for the predicted 25-year event from a fully developed watershed. Portions of the drainage course downstream of Santiago Hills Phase I are unimproved and/or undersized. Therefore, it is important that the proposed project meet the previous approved design concept for Peters Canyon Reservoir. Table 5.8 is a comparison of peak flows for the Concentration Points shown on Figure 5.1. The Peters Canyon Reservoir outflow is Concentration Point 1. The post-development outflows, with proposed project design features (including construction of the sill at the outlet to correct an existing construction deficiency), will be equal to or less than the pre-development outflows. See Section 5.5 for details.

No improvements are proposed for this project for Handy Creek downstream of the reservoir because no increases in peak flows are predicted to occur post-development. As discussed in Section 5.6, a relatively small increase in discharges in Santiago Creek due to the development and the diverted areas is anticipated. The outlet facility at Point 4 will be located outside of improved areas of Irvine Regional Park within the Villa Park Dam inundation area. The outlet facility at Point 3 will be located outside of Irvine Regional Park and will terminate at approximately the edge of Santiago Creek. Both outlets for Points 3 and 4 will include energy dissipation/velocity reduction controls so as to release flows in a non-erosive manner.

13.6 DETENTION FACILITIES

No new detention basins are incorporated into the proposed drainage system for the Santiago Hills II and East Orange Area 1 project, Figure 7.3. Basin 1 is an existing basin (ETC-1) constructed as part of the SR 241/ SR261 road construction. It is proposed that the layout of this basin remain unchanged. Basin 1 was designed for the ETC project with a forebay for sediment and sufficient capacity to mitigate increased discharges as a result of the road construction. The tributary area to Basin 1 will not change until the East Orange Area 1 is developed. As a result of the development of East Orange Area 1 a portion of the existing watershed tributary to the basin will be diverted to the northeast, thereby reducing the discharge to the basin (comparison of Area A east of SR 241 on Figures 2.2 and 5.1 of the ROMP). The land use of the remaining area tributary to the basin after the diversion will not change as a result of the development. The decrease in runoff due to the diversion will not require additional storage or ponded depths for the storm frequencies analyzed. The sediment source will also be reduced as a result of the

diversion of tributary area. The net result of the project is a reduction of runoff and sediment to the basin for all storm frequencies.13.7 WATER QUALITY FEATURES
Water quality features are analyzed at length in this ROMP in Volume 2, Surface Water Quality Technical Report.

13.8 STREAM STABILIZATION

The South Tributary is stabilized by directing major stormflow to storm drains located in the adjacent streets. The South Tributary is a wide floodplain and flows are able to spread which reduces the flow velocities and is more conducive to the establishment of habitat which stabilizes the soil.

The North Tributary will be completely regraded consistent with the HMMP. The storm flows will be conveyed in pipes around the tributaries. Only direct local flows, first flush and dry weather flows will be conveyed in the tributaries with the exception of approximately 6.1 acres of residential area conveyed to the south tributary. By limiting the flows and providing drainlines, the tributaries will be stabilized against erosion. In each of the cases described above and in Section 10, the type of energy dissipation structure that may be required at the outfall will be determined on a case-by-case basis during the design phase of the project. Some examples of dissipation devices are concrete baffled impact structures or stilling basin. Below the energy dissipation structure, articulating material such as rock rip rap or concrete block would be placed as necessary to protect against headcutting below the outfall.

SECTION 14: ESTIMATED CONSTRUCTION COSTS

A preliminary estimate of cost has been prepared for this ROMP. A summary of the estimated cost is included as Table 14.1. As shown in Table 14.1 these costs include extended detention basins, emergent marsh areas, existing basin outlet structure improvements, backbone and local pipe drainage systems, and manholes. This estimate is preliminary and the full cost will be determined at the time of final storm drain system design.

The number of extended detention basins was based on current preliminary configurations. The sizes and configurations for the basins varies. Once the recommendations for water quality BMPs are completed for the site, the quantities, and detailed basin cost estimates will be determined. The pipe sizes for the backbone and local drainage systems were taken from the hydrology analyses. The pipe sizes in the hydrology analyses are calculated to determine travel times and times of concentration. Once the conceptual alignments and drainage concepts are approved the pipe sizes and associated cost can be refined.

The number of manholes assumed was based on the summation of pipe lengths divided by a typical manhole spacing (400 feet).

Table 14.1 – Estimated Cost

Santiago Hills Phase II Runoff Management Plan
Storm Water Management Facilities
Estimated Engineering and Construction Costs

No.	Description	Quantity	Unit	Unit Cost	Cost
1	Extended Detention/Emergent Marsh	26	EA	$50,000	$1,300,000
2	CDS Units	7	EA	$50,000	$350,000
3	Basin Outlet Structure Improvements	2	EA	$150,000	$300,000
4	Stage I Storm Drain System				$2,128,275
	18-in RCP	1,640	LF	$54	$88,560
	24-in RCP	2,700	LF	$72	$194,400
	27-in RCP	6,715	LF	$81	$543,915
	36-in RCP	2,400	LF	$108	$259,200
	60-in RCP	1,150	LF	$180	$207,000
	66-in RCP	1,300	LF	$198	$257,400
	72-in RCP	1,925	LF	$216	$415,800
	Manhole	36	EA	$4,500	$162,000
5	Stage II Storm Drain System				$2,197,190
	18-in RCP	2,500	LF	$54	$135,000
	27-in RCP	1,160	LF	$81	$93,960
	42-in RCP	600	LF	$126	$75,600
	48-in RCP	4,700	LF	$144	$676,800
	54-in RCP	2,640	LF	$162	$427,680
	60-in RCP	2,500	LF	$180	$450,000
	66-in RCP	925	LF	$198	$183,150
	Energy Dissipater	1	Ea	$20,000	$20,000
	Manhole	30	EA	$4,500	$135,000
6	Ultimate Storm Drain System				$1,737,696
	18-in RCP	2,000	LF	$54	$108,000
	21-in RCP	920	LF	$63	$57,960
	24-in RCP	2,700	LF	$72	$194,400
	36-in RCP	1,630	LF	$81	$132,030
	42-in RCP	3,621	LF	$126	$456,246
	54-in RCP	2,680	LF	$162	$434,160
	72-in RCP	900	LF	$216	$194,400
	Energy Dissipater	1	EA	$30,000	$30,000
	Manhole	29	EA	$4,500	$130,500
7	Woody's Cove Storm Drain System				$1,116,460
	30-in RCP	40	LF	$90	$3,600
	42-in RCP	300	LF	$126	$37,800
	48-in RCP	1,200	LF	$144	$172,800
	54-in RCP	180	LF	$162	$29,160
	66-in RCP	1,600	LF	$198	$316,800
	72-in RCP	2,050	LF	$216	$442,800
	Energy Dissipater	1	EA	$55,000	$55,000
	Manhole	13	EA	$4,500	$58,500
8	Sill to Bring PCR Spillway to Design	1		$500	$500
				Subtotal	$9,130,121
				30% Contingency	$2,739,036
				Total	$11,869,157

*Estimate does not include catch basins/inlets

SECTION 15: DEVELOPMENT OF DRAINAGE DESIGN GUIDELINES

15.1 MINIMUM SUBMITTAL REQUIREMENTS

The minimum submittal requirements for this ROMP are outlined in Mitigation Measure W-4 shown in Section 1.2 and Attachment A included in Technical Appendix A.

15.2 LOCAL DRAINAGE FACILITIES

To provide the required level of flood protection and reduce potential public safety hazards, an underground drainage system shall be provided to intercept and convey the storm water flow generated by the project or off-site tributary flows to the project.

Storm Drains: The following is an outline of the storm drain criteria and the local flood protection requirements:

- Drainage facilities shall be designed in accordance with the City of Orange storm drain criteria and requirements and secondarily that flood routing is consistent with the *County of Orange Flood Control District Design Manual* and *County of Orange Local Drainage Manual*.

- Runoff generated from the project shall be directed to and intercepted by an underground storm drain facility. Flows that exceed the capacity of the underground storm drain facility shall be conveyed in the street section up to the 100-year event.

- Street interception inlets and those inlets in a sump condition with a secondary outlet will be designed for the appropriate frequency storm event based on local drainage criteria.

- Local area drains and the landscaping or common area drainage system will connect to the storm drain at street inlet locations or manholes to provide locations of adequate maintenance.

- Local surface inlets for the common area or the landscaped area will be sized with the appropriate clogging factors, minimum 50%, to account for debris.

- Dedicated emergency overflow paths will be provided along the drainage system at sump locations based upon an “extreme event analysis” (i.e., 100-year). The overflow paths will assist in assuring that during large rainfall events there is a dedicated flow path that overland flow can escape without causing flood damage to any of the facilities. The emergency overflow paths may consist of pedestrian walk paths, which can confine and direct the flow without causing erosion.

- Dedicated right-of-way must be provided for the public storm drain facilities that traverse the site. The horizontal alignment and right-of-way width must follow the minimum requirements outlined by the City of Orange. No structural encroachments are allowed in these easements.

- The finished floor elevations of the commercial and habitable structures should be elevated one-foot above the 100-year water surface in the street or one-foot above the top of curb, whichever is greater.

- The drainage system should be designed to provide a 100-year level of flood protection to all structures through a combined hydraulic conveyance of the underground storm drain section and the street section.

- The proposed underground drainage systems that connect to existing downstream drainage facilities should be designed so the proposed design discharge does not exceed the original hydraulic design capacity or the original tabled discharges to that system.

- Provisions for maintenance should be incorporated in the proposed drainage system, which includes providing manholes at the appropriate spacing and locations.

- Maximum velocities in standard wall reinforced concrete (RCP) storm drain pipe is limited to 20 fps and 45 fps in special wall RCP.

- Street inlets should be provided at a minimum for those locations where the street hydraulic capacity will be exceeded or locations where the product of velocity and flow depth exceeds six or locations to reduce pedestrian hazards.

- Flows generated from developed areas will pass through a hydrodynamic separator device prior to discharging into an emergent marsh area where maintenance is restricted. Hydrodynamic separator devices are primarily gross pollutant traps that capture trash, debris, and floatables in storm water runoff. The use of these devices will help maintain the aesthetics of the emergent marsh areas.

15.3 DESIGN STANDARDS

The design of the extended detention basins and additional BMPs will be required to conform to the Drainage Area Management Plan (DAMP) adopted for Orange County and the Local Implementation Plan (LIP) adopted by the City of Orange. Some tributary areas to Peters Canyon Reservoir will be diverted to Santiago Creek or to Woody's Cove (Irvine Lake) in an effort to reduce current flooding conditions in Peters Canyon Reservoir/ Handy Creek, at the Jamboree Road culverts and through Irvine Regional Park. The design of portions of the storm drain system will need to be coordinated with Caltrans where the proposed systems join the Caltrans culverts. In addition, BMPs designed for Santiago Hills Phase II and East Orange Area 1 will be required to be in substantial conformance to the recommendations set forth in the water quality section of this ROMP, Volume 2. The water quality recommendations are consistent with the provisions of the DAMP.

15.4 COMPLIANCE WITH MASTER PLAN

A formal Master Plan of Drainage has not been prepared for the subject area. A previous study "*Hydrologic & Hydraulic Analysis of Peters Canyon Reservoir and Handy Creek Drainage Plan"* prepared by Rivertech, Inc. in 1985 serves as the approved benchmark for drainage purposes. The 1985 report primarily addressed flows from Peters Canyon Reservoir under developed and undeveloped conditions and hydraulics downstream in Handy Creek. A detailed discussion of the comparison of these two studies is included in Section 7.3 *Peters Canyon Reservoir Hydraulics*. The results of the comparison show that the outflows from Peters Canyon Reservoir will be below the design outfall discharges for all project stages.

A comparison of the storm water flows to the Jamboree Road culverts for the existing condition and each of the development Stages is included in Section 6. The results show that the peak combined outflow discharge from the culverts does not exceed the existing condition for each of the development Stages.

SECTION 16: IMPLEMENTATION AND FACILITY PHASING

16.1 STAGED CONSTRUCTION

Construction build-out of the Santiago Hills Phase II and East Orange Area 1 development is currently targeted to occur over a 5-10 year period. The order of development will proceed as Stage 1 (TT 16199), Stage 2 (TT 16201) and East Orange Planned Community, Area 1 (see Figure 1.1). Construction of flood control improvements is being staged to complement the progress of grading and other infrastructure improvements. Consideration has been given in the design of the storm drain network to allow the system to function during the interim construction period, maintaining proper storm water mitigation. Construction will generally progress from downstream to upstream along most watercourses, simplifying the installation of storm drain infrastructure. Storm drain improvements will be constructed in sequence with the applicable stage of development. Each tentative tract map and the Hydrology Maps (Exhibits E-J and Exhibit L) show the facilities in each phase. Verification of compliance with the ROMP will ultimately occur during the tract approval process via agency approval of the storm drain improvement plans. Project design facilities related to storm flows and water quality will be required to ensure consistency with the ROMP recommendations during all stages of construction. The ROMP is intended principally as a master plan document to achieve ultimate design goals.

16.2 CONTROL OF EROSION AND SEDIMENTATION DURING CONSTRUCTION

To minimize the impacts of construction operation with respect to sedimentation, erosion control measures during and immediately following grading operations will be necessary and shall be incorporated into the SWPPP prepared for the project. Refer to Volume 2 for details.

SECTION 17: FACILITIES MAINTENANCE

Maintenance of the master planned and local storm drain facilities described in this report will be provided by either City of Orange, Caltrans, County of Orange, or the Santiago Hills Phase II and East Orange Area 1 Homeowners Associations (HOA). Generally, facilities characterized as “backbone” will be maintained by the City of Orange. Maintenance of all publicly owned master planned (MPD) or local storm drain systems will be assumed by the developer prior to acceptance of the facilities and thereafter maintenance will occur as specified through an agreement with the City of Orange. Maintenance responsibilities are illustrated in Figure 17.1. Maintenance will occur annually and following major storms. See also, Master Operations and Maintenance Tables 17.1 and 17.2 for a detailed listing of proposed flood control and water quality features and associated maintenance responsibilities.

A copy of the Operation and Maintenance Manual for Santiago Hills II and East Orange Area 1 is included in Technical Appendix N.

Figure 17.1 – Tentative Maintenance Responsibility Map

Table 17.1 – Water Quality, Mitigation, and Flood Control Operation and Maintenance Responsibility

Treatment Control BMP/ Feature Type	Function	Long-term Maintenance Required?	BMP/ Feature ID	Entity Responsible for Long-term Maintenance/ Funding
Extended Detention Basin	Water Quality Treatment Control	Yes	2A 2B HR1	• Caltrans will be responsible for the inspection and maintenance of these basins that will be within their right-of-way
			E	• City of Orange
			A1 B1 C1 C2 C8 F2 G1 G2 G3 6A1 6A2	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the BMPs if they are not being properly maintained by the HOA, at the expense of the HOA. • An amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain. those basins that are incorporated.

Treatment Control BMP/ Feature Type	Function	Long-term Maintenance Required?	BMP/ Feature ID	Entity Responsible for Long-term Maintenance/ Funding
			6D1 6D2 J 6G	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City and the Water Districts will have the right, but not the duty, to inspect and maintain the BMPs if they are not being properly maintained by the HOA, at the expense of the HOA. • These basins are outside of the current IRWD service area. If the service area is amended to incorporate East Orange Area 1, an amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain. those basins that are incorporated.
Hydrodynamic Separator Systems	Water Quality Treatment Control	Yes	CDS-A2 CDS-B3 CDS-C1 CDS-C3 CDS-F2 CDS-6A2	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.
Treatment Swales	Water Quality Treatment Control	Yes	VS-G1 VS-H1	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.
			VS-S1 VS-S2	• Caltrans will be responsible for the inspection and maintenance of these swales that will be within their right-of-way.

Treatment Control BMP/ Feature Type	Function	Long-term Maintenance Required?	BMP/ Feature ID	Entity Responsible for Long-term Maintenance/ Funding
Bioretention Areas	Water Quality Treatment Control	Yes	BR-A1 BR-C4a BR-C4b	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.
Emergent Marshes and connecting Vegetated Swales	Wetland and Riparian Mitigation	No	A2 B2 B3 B4 C3 C4 C5 C6 C7 VS-B3 VS-B4 VS-C4 VS-C5 VS-C6	No long term maintenance is required. Short term access for establishment and maintenance of the emergent marshes will be necessary consistent with the HMMP.
Flood Control Basins	Peak Flow Reduction	Yes	ETC Basin 1*	• Caltrans will be responsible for the inspection and maintenance of this existing basin that is currently within their right-of-way.

* No credit for peak flow reduction or water quality were taken for this existing basin in the hydrology or water quality calculations

Table 17.2 – Water Quality and Flood Control Operation and Maintenance Activities and Frequencies

Treatment Control BMP	Operation and Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
Extended Detention Basin	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal	• 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.	• Pickup Truck • Stakebed truck • Backhoe/ dump truck
	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/Thinning • Irrigation System Adjustment	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup Truck • Stakebed truck
	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.	• Pickup Truck • Backhoe/ dump truck • Crane/crew truck

Treatment Control BMP	Operation and Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
Hydrodynamic Separator System	Routine Facility Maintenance	• Facility inspection • Trash, debris, and sediment removal	• Inspect quarterly until accumulation of trash, debris, and sediment in unit is known. • Cleanout of solids within the unit's sump should occur at 75% of the sump capacity.	• Pickup Truck • Vactor truck
	Major Maintenance	• Structural repairs	• As needed (infrequent)	• Crane/crew truck
Treatment Swale	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.	• Pickup Truck
	Vegetation/Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/Thinning	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup Truck • Stakebed truck
	Major Maintenance	• Major vegetation removal/planting • Major sediment removal	• As required (annually or less frequently)	• Pickup Truck • Stakebed truck

Treatment Control BMP	Operation and Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
Bioretention Area	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 swales indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Pickup Truck
	Vegetation/Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/Thinning • Irrigation System Adjustment • Mulching	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup Truck • Stakebed truck
	Major Maintenance	• Major vegetation removal/planting	• As needed (infrequently)	• Pickup Truck • Stakebed truck

SECTION 18: SATISFACTION OF MITIGATION MEASURE W-4

The objectives of this ROMP, detailed in Attachment A, are restated below followed by a response describing how each objective will be satisfied. These objectives are as required by existing Mitigation Measure W-4, quoted above in Section 2.1, and specified in earlier environmental declarations for the project area.

Hydrology/Flood Protection

Objective: Confirm that post-development storm flows from the proposed project to Peters Canyon Reservoir are consistent with available detention capacity and will not exceed previously established limits for releases to Handy Creek and capacity of detention facilities in Santiago Hills 1.

Response: The routing of flows through Peters Canyon Reservoir was modeled for the Existing Condition, Stage I, Stage II and East Orange Area 1 (Ultimate Condition) development. The analyses were run for the 2, 5, 10, 25, and 100-year storm events. A discussion of the results is included in Sections 5, 6, and 7 of this ROMP. Combined storm water peak discharges for the storm events analyzed into Peters Canyon Reservoir at the Jamboree Road culverts do not exceed the existing condition discharges for all development Stages except the 2-year storm frequency in Stage I and Stage II which is approximately 44 cfs and 15 cfs higher, respectively and 1 cfs higher in the 100-year EV storm event, Table 5.8 (Point 2). Post-development peak flows at the outlet works from Peters Canyon Reservoir (Point 1) do not exceed the existing condition discharges for all development Stages, Table 5.8 (Point 1).

Objective: Storm runoff from undeveloped tributaries to the improved portions of Irvine Regional Park may exceed capacities of existing facilities, therefore the proposed project should incorporate diversion of storm flows to either be routed northerly of the existing park improvements to Santiago Creek or westerly to the area of impoundment behind Villa Park dam.

Response: The area tributary to improved areas of Irvine Regional Park will be reduced from 250 acres to 63 acres, Figures 2.2 and 5.1. This will be accomplished by diverting areas east of SR 241 to the north through an unimproved portion of the park and into Santiago Creek and diverting areas west of SR 241 to the west through an unincorporated area of the County of Orange to the west of the park boundary. It should also be noted that no flows from the proposed development will be tributary to the improved portion of Irvine Regional Park. Only existing natural slope areas, unaffected by the development, will remain tributary to the park.

Erosion and Sediment Transport

Objective: Stabilize natural drainage courses between Chapman Avenue and Jamboree Road to inhibit scour and lateral bank erosion within these natural drainage courses.

Response: The natural drainage courses between Chapman Avenue and Jamboree Road consist of two streams designated as the North Tributary and the South Tributary, Figure 2.2. The North Tributary will be regraded to incorporate extended detention and emergent marsh areas, Figure 11.4. Larger storm flows will be conveyed in a pipe system around the extended detention basins and emergent marsh areas. Therefore, only direct local, dry weather, first flush flows and approximately 6.1 acres of residential area will drain to the stream, thereby reducing the potential for stream erosion. The proposed system of extended detention basins will also limit the sources of sediment that may reach Jamboree Road. Reducing the sediment will reduce the maintenance at the Jamboree Road culverts.

The South Tributary will, for the most part, be preserved in its existing condition. The only enhancement proposed in this stream will be the addition of emergent marsh areas, Figure 11.4. The emergent marsh areas will polish dry weather flows and first flush flows from the proposed development. Larger storm flows will be conveyed in a pipe system around the emergent marsh areas. Therefore, only direct local, dry weather and low flows will drain to the stream thereby reducing the potential for stream erosion. The South Tributary is wide (~250 feet) therefore flows spread out across the floodplain. The velocities of the resulting shallow flows will be within the non-erosive range. The proposed system of extended detention basins and CDS units will also limit the sources of sediment that may reach Jamboree Road. Reducing the sediment will reduce the maintenance at the Jamboree Road culverts.

Objective: Storm flows entering Peters Canyon Reservoir or the improved portions of Irvine Regional Park shall be protected against adverse scour and lateral bank erosion resulting from project flows to Peters Canyon Regional Park and Irvine Regional Park.

Response: The reduction of flows to the reservoir will be accomplished through diversion of flows away from the Peters Canyon Reservoir to Irvine Lake and Santiago Creek. Table 5.8 shows a comparison of discharges at Jamboree Road for all construction stages and storm frequencies. After exiting the culverts in Jamboree Road the flows will spread out in a wide floodplain as they enter the reservoir. The floodplain is heavily vegetated which will serve to dissipate flow velocities and minimize scour. Proposed outlet 2C is proposed to terminate at the approximate mean high water mark of the reservoir and to include velocity reduction and energy dissipation devices, thereby eliminating potential scour or erosion issues.

The tributary area to the developed portion of Irvine Regional Park will not be changed for Stage I development. Stage II development of the tributary area will be reduced by diverting flows in a pipe system to the western park boundary. Therefore, the Stage II development will improve the drainage to the Regional Park by reducing the flows through the park. East Orange Area 1 (Ultimate Condition) will be diverted to an existing 84-inch culvert under the corridor. This diversion is necessary to comply with Mitigation Measure W-4. A proposed pipe system will convey flows from the existing ETC-9 pipe directly to Santiago Creek outside of park boundaries. This will help reduce the peak flows that are tributary to the northern most boundary of the park and therefore reduce the erosion potential. A structure downstream of ETC-9 will allow low flows but not nuisance flows into the natural valley channel to maintain natural growth.

Objective: Maintain free flow of storm waters to Peters Canyon Reservoir for runoff exiting existing drainage facilities in Jamboree Road.

Response: The existing culverts in Jamboree Road have experienced heavy sedimentation in the past. The project will lessen the impacts to the culverts. Recently, a silt fence was installed just upstream of the North culvert to minimize the sediments which would have reached the culvert in the existing condition. Upstream of the silt fence a sediment basin was also recently installed to trap existing sediment in the North tributary prior to reaching either the silt fence or the culvert. Both the silt fence and the sediment basin will be removed and replaced with project design features, which include construction of pipe systems, which will convey storm flows around the North and South tributaries. The pipe systems will allow the regulation of flows into the streams thereby reducing the erosion in the tributaries. The construction of emergent marsh areas and a drainline system will reduce erosion and sediment conveyance in the North tributary. No grading or enhancements are proposed between the Peters Canyon Reservoir and Jamboree Road for sediment control. The area and existing outlets in question are maintained by the County of Orange Harbors, Beaches and Parks. Therefore, maintaining free flow through this reach will be the responsibility of the County. Some grading will be required for the construction of the new storm drain and outlet 2C, shown on Figure 7.3, which will be constructed to re-route flows away from the existing South culvert across Jamboree Road.

Water Quality (Under separate cover as Volume 2 of this ROMP)

Objective: Determine with the County water quality concerns in Peters Canyon Reservoir.

Response: See Peters Canyon Reservoir Analysis prepared by FlowScience (September 2004) and Volume 2, Surface Water Quality (March 2005).

Objective: Establish specific requirements for non-structural and structural BMPs.

Response: See Volume 2, Surface Water Quality.

Objective: Majority of dry season low flows, and, in accordance with the County DAMP and NPDES requirements, storm water flows originating from the project watershed, to be routed to structural BMPs such as extended detention basins, grass swales and wetlands prior to entering Peters Canyon Reservoir and Santiago Creek. Selected BMPs are to be those most suitable for achieving applicable water quality standards.

Response: The proposed project contains a number of Project Design Features to address pollutants of concern including site design, source and treatment controls. Little, if any, dry weather discharges flow from the project area because of PDFs and Emergent Marsh Areas. See further Volume 2, Surface Water Quality.

Objective: In addition, selected BMPs should be those best suited to address TMDLs that are established by Santa Ana Regional Water Quality Control Board.

Response: No TMDLs have been identified for Peters Canyon Reservoir, Irvine Lake, or Santiago Creek.

Habitat Protection (Addressed in detail in HMMP)

Objective: Protect against any significant long-term impacts to habitat of endangered species and create or enhance wetlands and riparian habitat within the natural drainage course between Jamboree Road and Chapman Avenue for (endangered species) habitat and water quality purposes.

Response: See HMMP.

Objective: Examine potential operational alternatives and water flow regimes for Peters Canyon Reservoir that would enhance water quality over existing conditions.

Response: Analysis by FlowScience Peters Canyon Reservoir-Candidate Water Quality Enhancement Measure Aeration System, September 22, 2004.

SECTION 19: REFERENCES

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