TABLES



FIGURES

# SECTION 4.8

## Hydrology and Water Quality

This section of the EIR addresses the potential impacts on hydrology and water quality from the development of the UC Santa Cruz campus under the 2005 LRDP. It includes an assessment of on-site and off-site effects of UC Santa Cruz growth on groundwater resources, surface water resources, campus drainage patterns, erosion and sedimentation. Information was obtained from numerous geologic, hydrogeologic and drainage plans and studies of the UC Santa Cruz campus[1] and nearby areas.

Public comments related to hydrology and water quality received during the scoping period of this EIR requested that the EIR address the following issues:

- Effect of increased impervious surfaces and trail use (especially in the north campus area) on existing drainage problems, including erosion and sedimentation
- Cumulative impacts of development on water quality and hydrology
- Effect of the proposed campus growth on seeps, springs, and caves on and off campus
- Effect of storm water pollutants on the quality of runoff and the effect of the use of sinkholes for storm water management on receiving water quality
- Effect of increased runoff in Moore Creek drainage and the Arboretum Dam, and potential flooding and erosion effects in the Moore Creek drainage and city area to the southwest of the campus
- Effect of the campus's northward expansion, including new impervious surfaces or well drilling, on the water table on Ben Lomond Mountain, especially as it affects the Cave Gulch neighborhood, and Bonny Doon
- Off-campus hydrological impact on the areas to the west of the campus, including Cave Gulch neighborhood groundwater and wells; impacts on Cave Gulch Creek and Wilder Creek; effect of the development of the corporation yard, new road and bridge on storm water drainage and erosion in Cave Gulch
- Impact of campus growth on streams and creeks on and below the east side of the campus, including erosion in the Pogonip City Park
- Effect of filling karst voids on flows to springs and creeks in the city
- Applicable requirements of the NPDES regulations and other water quality standards promulgated by the Regional Water Quality Control Board
- Use of non-impervious surfaces, clustering of development, use of landscaping to dissipate roof runoff, encouraging water retention, and other storm water best management practices.
- All of these issues are addressed in the analysis in this section.

[1] Throughout this section, "campus" refers to the UC Santa Cruz main campus, unless noted otherwise.

## 4.8.1 Environmental Setting

### 4.8.1.1 Study Area

The study area for the evaluation of impacts on hydrology and water quality consists of all watersheds that originate on the campus. (See Table 4.8-1 below for a list of campus watersheds.) For groundwater impacts, the study area includes the campus and portions of the city of Santa Cruz between the campus and the coastline (see Figure 4.8-1, *Watersheds and Sub-Basins on UC Santa Cruz Campus*). Because of its distance from the campus, the Bonny Doon area is not included in the study area, except for the purpose of evaluating the effects of campus growth under the 2005 LRDP on groundwater wells.

### 4.8.1.2 Overview

The UC Santa Cruz campus slopes upward in a series of marine terraces from an elevation of 300 feet at its southern boundary on High Street to an elevation of about 1,200 feet at its northwestern boundary. The average north-south gradient is slightly greater than 5 percent. Along the eastern and western flanks of the campus and along the numerous stream drainages that cross the campus, gradients generally range from about 25 to about 70 percent.

The geology of the northern one-third of the campus (defined in this EIR to include the upper and north campus) consists of weathered schist and granitic rocks, which are overlain in some areas by thin (5- to 30-feet thick) eroded remnants of Santa Margarita sandstone and marine terrace deposits. The hydrologic system of this portion of the campus is dominated by the broad, gently sloping topographic surfaces that form most of the area. Surface drainage from these areas occurs as overland flow and rills. Drainage divides are poorly defined, but surface flow eventually collects in a few well-defined drainages along the margins of the flats. The dispersed surface flow encourages percolation of rainwater, recharging a shallow groundwater system, which in turn feeds springs and seeps located along the southern and eastern edge of the north campus.

The southern two-thirds of the campus consists of marble and schist bedrock overlain by deposits of residual soils and colluvium, where karst topography has developed as a result of the dissolution of marble. This portion of the campus is cut by several steep-walled north-south flowing streams, but an integrated drainage system is not present because of sporadic stream capture by sinkholes and swallow holes. As a result, very little storm water is conveyed by surface streams to channels downstream of the campus. Instead, storm water is captured by the karst aquifer, stored and transmitted via solution channels and caves, and discharged in springs at lower elevations to the east, south and west of the campus.

On account of steep gradients and the presence of fractured rocks and soils highly susceptible to erosion, the potential for erosion by storm water runoff is generally high on the central and north campus. Historical uses including logging, quarrying, and grazing that occurred prior to development of the UC Santa Cruz campus would have disturbed the natural vegetation and landscape, thereby increasing erosion and sedimentation rates within the campus watersheds. The potential for erosion on the central and lower campus has been exacerbated by the addition of impervious surfaces as the central campus has developed over the years. Natural drainages are the primary means used to manage storm water on the campus.

Within the developed portions of the campus, storm drains have been installed to capture and convey storm water. These are generally small systems that locally capture runoff, and convey it to detention basins from which the water is then discharged into the nearest creek or sinkhole. In some areas the collected water is discharged without detention. The discharge of storm water from impervious surfaces on the campus has resulted in stream flow changes (i.e., channel configuration, surface water volume and flow velocities) in several of the creeks, which has increased the naturally-occurring erosion on the campus. The sections that follow discuss the surface water resources and the groundwater hydrology of the campus in more detail.

### 4.8.1.3 Campus Surface Water Resources

Rainfall averages approximately 38 inches per year for the entire campus (Gilchrist & Associates 1990). Rainfall levels vary considerably on campus with elevation; the lower campus[2] receives an average of 30 inches of rainfall annually, while the upper campus receives 40 to 45 inches or more (Johnson and Weber & Associates 1989). Review of the Western Regional Climate Center (WRCC) website database indicates that the average annual precipitation for the Santa Cruz station (approximately representative of the lower campus) was 30.56 inches from 1948 through 2005. WRCC data indicates that the average annual precipitation for the Ben Lomond station (considered representative of the upper campus) was 49.17 inches from 1972 through 2005. Over the past 25 years, annual precipitation has ranged from 15 inches in 1989 to 59.8 inches in 1983. Average evapotranspiration[3] is estimated to be 19.7 inches per year (Johnson and Weber & Associates 1989).

#### Watersheds on the UC Santa Cruz Campus

The campus is located within the Big Basin Hydrologic Unit, as defined by the Central Coast Regional Water Quality Control Board (CCRWQCB). The campus is drained through both surface and subsurface drainages by watersheds that originate within the campus boundaries. The assignment of surface water runoff to a particular watershed is based on topographic features of the campus; however, flows captured by the natural subsurface karst aquifer drainage system or by the campus storm water drainage system may be transferred from one watershed to another in some cases.

Three watersheds, Cave Gulch, Moore Creek and Jordan Gulch, drain approximately 1,100 acres in the central portion of the approximately 2,020-acre campus. All three stream channels are aligned north-south and controlled by the major geologic fracture systems on the campus. Cave Gulch, which drains most of the northwestern portions of the campus, joins Wilder Creek immediately west of the campus. Moore Creek, which drains the central portions of the campus, flows in a southwesterly direction and discharges into Antonelli Pond near the coast. Jordan Gulch drains the central and eastern portions of the campus and continues as a spring-fed channel down Bay Street (Figure 4.8-1).

As noted above, as a result of the karst geomorphology of the central and lower campus, several of the tributaries of the main campus drainages do not discharge into the main channels but instead discharge into in-stream swallow holes. Flow in the two main drainages on the campus, Moore Creek and Jordan

[2] For definitions of upper, north, central and lower campus, see Section 3.2 in Chapter 3.
[3] Evapotranspiration refers to the loss of water by evaporation from soil and transpiration from plants.

Gulch, is captured by swallow holes in the lower campus. The karst features intercept most of the surface flow, even during extreme rainfall events. As a result, surface runoff from the campus is usually low overall compared to other areas with similar rainfall (Johnson and Weber Associates 1989).

Areas of the campus not drained by the three major watersheds are drained by a number of creeks and gullies that originate along the campus boundary. Much of the western boundary of the campus, including portions of the upper and north campus, is drained by Wilder Creek. Four small drainages occur along the southern campus boundary. From west to east these are: a western tributary of Moore Creek that discharges to Moore Creek downstream from the UC Santa Cruz campus boundary, the headwaters of Arroyo Seco, hillslope drainage onto High Street, and drainage into Kalkar Quarry Pond (a spring-fed pond occupying a former marble quarry). The northeastern and eastern boundary of the campus is drained mainly by a series of hillslope drainages within the San Lorenzo River watershed.

The drainage areas of campus watersheds are shown in Table 4.8-1. Each of the major watersheds is described below. Sinkholes and swallow holes break up the campus drainages into more than 50 sub-watersheds. Based on the locations of known sinkholes and swallow holes, campus watersheds have been divided into portions having partial or complete subsurface drainage as shown in Figure 4.8-1.

**Table 4.8-1**
**Watersheds on the UC Santa Cruz Main Campus**

| Watershed | Total Area[a] (acres) | On-Campus (acres) | Area On-Campus as Percent of Total | Subsurface (acres) | Partial Subsurface (acres) | Surface Drainage (acres) | Number of Subsurface-drained Subwatersheds |
|---|---|---|---|---|---|---|---|
| Wilder Creek | 3,000 | 192 | 6% | 0 | 192 | 0 | 1 |
| Cave Gulch | 460 | 336 | 73% | 42 | 294 | 0 | 4 |
| Moore Creek | 920 | 321 | 35% | 103 | 201 | 16 | 15 |
| Moore Creek Western Tributary | 320 | 98 | 31% | 12 | 0 | 86 | 1 |
| Jordan Gulch | 1,380 | 440 | 32% | 373 | 9 | 58 | 20+ |
| Arroyo Seco | 260 | 44 | 17% | 7 | 0 | 38 | 0 |
| High Street | 60 | 24 | 39% | 0 | 0 | 24 | 3 |
| Kalkar Quarry | 60 | 56 | 94% | 10 | 0 | 46 | 0 |
| San Lorenzo River | 74,000 | 509 | 0.7% | 66 | 2 | 441 | 6 |
| **Total** | | **2,020** | | **612** | **699** | **708** | **50** |

**Source:** Johnson 1988; URS 2005

Wilder Creek Watershed. Wilder Creek has a watershed of approximately 3,000 acres. About 192 acres of Wilder Creek watershed are located in the northern and western portions of the campus. A large spring, Wilder Creek Spring, is present in the creek west of the campus immediately upstream of the Cave Gulch confluence. This spring likely discharges water originating from the subsurface drainage underlying the campus. Upstream from the Wilder Creek Spring, much of the stream flow drains underground through swallow holes in the streambed (Johnson and Weber & Associates 1989). Campus development within this watershed is limited to service roads.

Cave Gulch Watershed. The western and northwestern portions of the Santa Cruz campus drain to the Cave Gulch watershed, a tributary basin to the Wilder Creek watershed. The on-campus drainage area of Cave Gulch is about 336 acres, which is about 73 percent of the total watershed of this drainage. The on-campus portions of the Cave Gulch system are steep to moderately steep with channel gradients ranging from roughly 1 to 10 percent (Kennedy/Jenks Consultants 2004).

There are two main tributaries to Cave Gulch on the campus. The Porter Tributary is located to the west of the Porter Infill Apartments and Family Student Housing complex, and drains about 30 acres. Two sinkholes located near Family Student Housing capture runoff from the Porter Tributary. The Pump Station Tributary is located approximately 1 mile north of the west entrance to the campus on Empire Grade Road. This tributary drains runoff from a roadside ditch along Empire Grade Road (Kennedy/Jenks Consultants 2004).

In general, campus lands that presently discharge into the Cave Gulch drainage system are largely undeveloped and contain only a few service roads used for recreation and emergency vehicles access and a 1-million gallon water tank. The few developed areas within the watershed are a portion of the Campus Trailer Park, the western half of Kresge and Porter Colleges, and a portion of Family Student Housing complex. There are some existing erosion conditions within the watershed, associated mainly with the Pump Station Tributary and the Porter Tributary. These erosion conditions are addressed by the Infrastructure Improvements Project, the environmental impacts of which are addressed in Chapter 2 *Infrastructure Improvements Project,* (Volume III).

Moore Creek Watershed. Moore Creek has a drainage area of about 920 acres above Antonelli Pond, which is located in the city of Santa Cruz adjacent to 2300 Delaware Avenue property. Approximately 320 acres of the drainage area are located on the campus. On campus, the watershed extends from the northern portions of the campus, north of Science Hill, to the campus's southern boundary.

The Moore Creek drainage system consists of the main stem and several tributaries. The Baskin and Science Hill tributaries drain the northwestern portions of the Science Hill area of the campus, whereas Kresge Tributary drains the area between Kresge College and Heller Drive. Both the Kresge Tributary and the Baskin Tributary end in sinkholes (the Kresge Sinkhole and the Baskin Sinkhole respectively) and discharge into the Moore Creek main stem only when the sinkholes overflow. During water year 2004 (the period from October 2003 through September 2004), observations were made during two short-duration rainfall events (i.e., storms with a less than 2-year recurrence interval) (Kennedy/Jenks 2004). While the Baskin Sinkhole did not spill in water year 2004, evidence of spilling was observed from the Kresge Sinkhole into the downstream reach leading to the Main Stem of Moore Creek (Kennedy/Jenks 2004).

The head of Moore Creek Main Stem (also referred to as the East Fork) is located near University House. The creek flows south to the East Dam and then into the Arboretum Pond, as shown in Figure 4.8-1. A perennial spring discharges into the Main Stem east of Oakes College. A sinkhole is present within the impoundment of the East Dam. Moore Creek Middle Fork originates south of Oakes College and also flows into the Arboretum Pond. The lowest on-campus tributary is the West Entrance Fork that originates just south of the intersection of Koshland Way and Heller Drive and flows in a southerly direction down to the West Dam (see Figure 4.8-1). A sinkhole is present in this channel just upstream of the West Dam.

The Arboretum Dam was constructed on Moore Creek by the City between 1880 and 1890, and was used to impound water for the City's North Coast water supply. The East and West dams were constructed upstream of the Arboretum Dam, and were intended to serve as sediment catch basins above the reservoir and/or to provide additional storage capacity (Johnson 2000). The use of the Arboretum Pond for water supply was abandoned in 1948 after the City determined that up to 750,000 gallons of water per day were being lost to the subsurface due to the presence of sinkholes in the channel of Moore Creek and the West Entrance Fork (Hecht 1968). All three dams on Moore Creek are earthen embankment dams. The East and West dams do not have spillways, although a 30-inch pipe was installed in the West Dam to serve as a spillway for excess flows. Originally the Arboretum Dam did not have a spillway and the dam only released discharge through a 14-inch pipe installed through the base of the dam. In 2001, a 4-foot-diameter pipe was installed below the dam crest to act as a spillway (Hall 2005). Both the 4-foot spillway pipe and the 14-inch outlet pipe discharge to a culvert under Empire Grade Road that carries runoff to Moore Creek.

The total area of Moore Creek watershed above the Arboretum Dam is about 305 acres, but about 100 acres of this drainage area drains directly to the subsurface at locations upstream of the dam (Johnson 2000). The impounded water drains through the pipe at the base of the dam, via the subsurface, and via leakages through burrows in the dam faces. Typically, water remains in the Arboretum Pond well into the dry season (Hall 2005). The Arboretum Pond and the two basins created by the East and West Dams have a reported combined capacity of about 35 acre-feet below the elevation of the Arboretum Dam spillway pipe, the West Dam outlet, and the crest of the East Dam. This capacity is large enough to contain runoff from a 50-year storm if all existing sinkholes are plugged, or a 100-year storm if the existing sinkholes remain open (Rutherford & Chekene 1992).

Approximately 15 acres of the campus lands south of the Arboretum Dam drain directly into Moore Creek south of the campus. Developed areas within the Moore Creek watershed on campus include most of the Campus Trailer Park, the western two-thirds of the Science Hill area, Kresge East and Graduate Apartments, the eastern portion of Kresge College, the western portion of the Arts area, most of Porter College, all of Oakes College and College Eight, and most of the existing Family Student Housing complex and University House.

Existing channel conditions in the Moore Creek watershed vary from fair to bad. Moore Creek contains the most severe in-channel conditions on campus; the Main Stem and West Entrance Fork are in particularly poor condition. Erosion features within the Moore Creek watershed consist of actively migrating knickpoints, eroding channel banks, minor slope failures, loss of near-channel vegetation, and channel incision (Kennedy/Jenks Consultants 2004). Migrating knickpoints are locations along the channel bed where there is a nearly vertical drop or a sloping ramp-like change in gradient that is moving upstream as a result of erosion (Kennedy/Jenks Consultants 2004). These erosion conditions are a result of a number of factors including the natural erosion process, increased runoff due to impervious surfaces and partly as a result of pedestrian and bicycle use of trails along creek banks. The Baskin and Kresge sinkholes are at or close to capacity. The erosion conditions, such as those observed in the Moore Creek watershed, can result in increased sediment loads in the creeks, which negatively affect water quality. See Chapter 2, *Infrastructure Improvements Project* (Volume III), which discusses the erosion conditions and storm water drainage improvements proposed for this watershed under the Infrastructure Improvements Project.

Jordan Gulch Watershed. The Jordan Gulch watershed is the largest watershed on the campus with a drainage area of about 1,380 acres, of which 440 acres are on campus. The on-campus portion of the watershed extends from north of Colleges Nine and Ten, south to near the main campus entrance at the intersection of High and Bay Streets.

Similar to the Moore Creek watershed, several critical sinkholes break-up the Jordan Gulch watershed into sub-watersheds. These sinkholes, the McLaughlin Drive Sinkhole (also known as the Chinquapin Sinkhole), Middle Fork Sinkhole, Upper Quarry Sinkhole, McHenry Library Sinkhole, and the Lower Quarry Sinkhole, are critical in that they capture runoff from the upper campus core, and failure of these sinkholes to adequately capture runoff during storm events would result in increasing impacts in downstream reaches. As a result of these sinkholes, almost all the water in the Jordan Gulch watershed enters the subsurface drainage system. Surface runoff from only a limited area (about 60 acres) near the main entrance of the campus leaves the campus as overland flow and enters Jordan Gulch south of the campus. From this point, the creek, Bay Creek, continues down in the median of Bay Street as a spring-fed perennial (year-round), partially culverted stream to Neary Lagoon.

Jordan Gulch East Fork originates just east of College Nine, flows south between Crown College and College Nine, and terminates in McLaughlin Sinkhole. Jordan Gulch Middle Fork originates in the area west of College Nine near Spring Road, and flows south in a deep canyon dividing the campus core approximately in half to its confluence with the Jordan Gulch main stem just west of the East Field area. Both the East and the Middle Forks are fed by springs in the north campus. Jordan Gulch Main Stem originates south of the Quarry Plaza area, and then continues further south in a deep incised canyon to terminate in two sinkholes just north of the Lower Quarry. South of the Lower Quarry, it again flows as a surface stream down to the area just west of the Hagar Drive/Glenn Coolidge Drive intersection.

Developed areas within the Jordan Gulch watershed on campus include the eastern one-third of the Science Hill area, the eastern half of the Arts area, Colleges Nine and Ten, the Quarry Plaza area, the Hahn Student services area, small portions of Crown and Merrill Colleges, and Cowell College. Even though most of Crown and Merrill Colleges, and the entire East Field House complex, are outside the Jordan Gulch watershed, some of the storm water from these areas is collected and discharged into Jordan Gulch.

Channel conditions vary within the watershed but in general are better than the conditions in the Moore Creek watershed. However, the McLaughlin Drive and Middle Fork sinkholes are at or close to capacity. See Chapter 2, *Infrastructure Improvements Project* (Volume III), which discusses the erosion conditions and storm water drainage improvements proposed for this watershed under the Infrastructure Improvements Project.

San Lorenzo – Pogonip Watershed. The San Lorenzo – Pogonip watershed has a combined total on-campus drainage area of about 510 acres. In general, the San Lorenzo – Pogonip watershed drains most of the eastern portion of the campus east of Hagar Drive from north of the Crown-Merrill Apartments south to the southern boundary of the campus. The watershed is divided into eight sub-watersheds associated with a number of gullies (Gullies A through H) that drain to the east (see Figure 4.8-1). Some of the gullies in the northern portion of this watershed are fed by springs that discharge in the north campus. Several sinkholes are located on campus property within this area, including one primary sinkhole that collects runoff from the East Remote parking lot (Kennedy/Jenks Consultants 2004). Apart from runoff lost to the subsurface through sinkholes, runoff also percolates through the permeable hillslope soils. The percolated runoff as well as runoff that drains to the subsurface via sinkholes contributes to several springs located about ½ mile east of the campus's eastern boundary in the Pogonip City Park and in Harvey West Park.

Channel conditions in the San Lorenzo–Pogonip watershed, including the campus portion of the watershed, vary from location to location but are in general fair to poor. Steep channel gradients, erosive soils and burrowing animals are responsible for erosion conditions in Gullies F and B, and concentrated runoff contributes to erosion conditions in Gullies H and G. Gully B is located southeast of the East Remote parking lot and receives storm water from the west side of Glenn Coolidge Drive via a culvert under the roadway. About 7 to 10 acres of campus land drains into Gully B. Most of this land is undeveloped except for about ½ acre that is covered by Glenn Coolidge Drive, a County-owned and maintained roadway. The erosion sites in the gully are downstream of four wooden dams built by the City in the Pogonip. Gully F is located directly east of the East Field, and flows southeast before crossing under Glenn Coolidge Drive. The on-campus drainage area of Gully F is about 37 acres. This gully receives un-detained water from the southern portion of Stevenson College, the East Field, and some length of Glenn Coolidge Drive. Concentrated runoff is likely the source of erosion problems in this gully on campus lands. Gully G is at the north end of Glenn Coolidge Drive and its on-campus drainage area is about 19 acres. Portions of Stevenson, Crown and Merrill Colleges, Stevenson College parking lots and portions of Glenn Coolidge Drive contribute runoff to this gully. This gully is deeply incised and has experienced several channel bank failures. Concentrated runoff is likely the source of erosion conditions in this gully. Gully H is located in the northeastern corner of the campus and has an on-campus drainage area of about 40 acres. Campus development that contributes runoff to this gully includes Crown-Merrill Apartments, Crown College and three parking lots. The erosion conditions in this gully include actively migrating knickpoints, incised channel, and eroding slopes. Concentrated runoff is the primary cause of these conditions (Kennedy/Jenks Consultants 2004).

Other Local Drainages. The far southwestern corner of the campus west of Empire Grade Road has low relief and lacks a well-defined drainage pattern. The central and eastern portions of this area drain into a western tributary of Moore Creek.

Arroyo Seco is a canyon located south of Meder Street and east of Western Drive. The upper 40 acres of the Arroyo Seco watershed are located on campus between Jordan Gulch and Moore Creek.

Kalkar Quarry is an old quarry just east of the campus near the Hagar Drive/Glenn Coolidge Drive intersection area, which has developed a pond that is fed by an underlying spring and by a series of culverts that drain the south-eastern portion of the campus, including a portion of the Faculty Housing area.

### Existing Channel Erosion on Campus

As described earlier, on account of the steep gradients and the presence of fractured rocks and soils highly susceptible to erosion, the potential for erosion by storm water runoff is generally high on the central and lower campus. Erosion on campus has increased with the addition of impervious surfaces as the campus has developed over the years. The discharge of storm water from impervious surfaces on campus has resulted in changes to the flow hydrograph[4] of several of the creeks, which have worsened the naturally occurring erosion conditions of the campus site. Sedimentation from channel incision and other sources is affecting the capacity of campus sinkholes to accommodate storm water flows, resulting in increased discharge to downstream channels from sinkhole overflows. Other contributing factors include repeated disturbance of channel beds and banks by bicycles and foot traffic on undesignated trails along the drainages, roadway runoff, activities that disturb banks and increase runoff, burrowing animals, and naturally-occurring erosive soils.

The existing campus drainage system mainly involves: (1) conveyance of storm runoff from areas of impervious surfaces to main trunk channels through culverts or lined ditches, (2) since 1989, construction of detention and sediment filtration facilities to detain excess runoff and slowly release it downstream in order to avoid increasing peak flows and to remove suspended sediment, and (3) in the Moore Creek drainage, the detention of excess runoff behind earthen dams near the base of campus. These practices have helped reduce slope erosion and the release of peak runoff to off-campus areas; however, detention systems do not address runoff from development constructed before 1989 and unprotected trunk channels have been adversely affected by erosion and sedimentation. As noted above, gullying has occurred on off-campus lands adjacent to the eastern campus boundary.

The Campus has developed and has been implementing a set of erosion control standards that are based substantially on Chapter 16.22 of the County Code (Erosion Control Ordinance). These standards are part of a Campus Standards Handbook (UCSC 2001) and are included by reference in the specification for campus projects. The Campus complies with provisions of the Regional Water Quality Control Plan, which specifies that the quality of the surface and ground waters in the Central Coast Region should be managed to provide the highest water quality reasonably possible, by following the Handbook.

Since 1989, UC Santa Cruz has taken several steps to control soil erosion. These have included requiring all new developments to design storm water detention facilities to store and meter out flows to reduce peak flows in drainages. Detention pipes, basins and vaults have been included in new construction on campus in several locations. Table 4.8-2 below lists campus storm water detention facilities.

[4] Flow hydrograph is a plot of stream flow versus time in response to a particular rainfall event.

**Table 4.8-2**
**Main Campus Storm Water Detention Facilities**

| Area | Detention Facilities |
|---|---|
| Social Science I & II | Eleven detention, settling and sand filter tanks |
| College Eight | Detention basin |
| Music Center | Detention basin |
| Hagar Drive at Glenn Coolidge Drive | Detention basin (out of service) |
| E. Remote Parking Lot | Detention basin |
| College Nine Apartments | Three detention, settling and sand filter tanks |
| Interdisciplinary Sciences Building | Prefabricated concrete chamber with metered discharge |
| College Nine Residence Hall | Energy dissipator to Jordan Gulch; two detention, settling and sand filter tanks. |
| Center for Adaptive Optics | Detention basin |
| Core West | Detention basin with to storm drain discharge manifold (infiltration manifold) |
| Engineering Sciences Building | One in-ground detention chamber; one in-ground detention chamber with metered discharge |
| Emergency Response Center | Stormcepter with 36-inch detention chamber |
| Bay Tree Bookstore/ Upper Quarry Plaza | Two vaults |
| Cowell Infill Apartments | One vault |
| Stevenson Infill Apartments | One vault |
| Wellness Center | One vault |
| Porter Infill Apartments | Two vaults |
| Physical Science Building | One vault |

In 1988, the Campus constructed a detention basin to detain flows from College Eight and the existing Family Student Housing complex. Shortly after construction, the detention basin partially filled with sediment and became potential habitat for the California red-legged frog. The basin has not been cleared of sediment and debris and, as a result, the basin no longer functions to detain the design storm flows (Kennedy/Jenks Consultants 2004).

In 2004, the Campus prepared a *Stormwater and Drainage Master Plan* (Plan) as a comprehensive document for planning improvements to the campus storm water drainage system (Kennedy/Jenks Consultants 2004). The Plan developed a list of prioritized, in-channel and out of channel improvement projects for implementation over the next few years. The Plan made the following key findings:

- The UC Santa Cruz campus has a strong commitment to protecting environmental quality, but its efforts to control erosion of natural channels and sinkholes has been hindered by a lack of the hydrological information necessary to formulate effective erosion control approaches.
- On-going channel incision is so severe in many campus drainages that it is a significant consideration with regard to the use of drainage channels for storm water conveyance, and limits future development options.
- Sedimentation of sinkholes is limiting their capacity to convey storm water runoff to the underground karst drainage system.
- Existing detention systems and drainage/erosion control measures have not been effective in preventing channel incision or spilling over of sinkholes in some locations.

- Maintenance of natural channels and sinkholes needs to be given a high priority.
- Channel and sinkhole problems are most severe on the East Fork of Moore Creek watershed including the Baskin, Science Hill, and Kresge subwatersheds.

The Plan also states that

> *…sedimentation from channel incision and other sources is affecting the capacity of campus sinkholes to accommodate normal stormwater flows, resulting in increased discharges to downstream channels from sinkhole overflow. These discharges destroy streamside trees and other riparian vegetation, accelerate channel erosion, and may initiate channel incision in channels that did not support stream flow prior to campus development.*
>
> *Existing detention systems and other drainage and erosion control measures have not been adequate to stop on-going channel erosion and the spilling over of sinkholes. Detention systems have primarily been in use since 1989 and do not address runoff from facilities and roads constructed prior to that time. In several locations on campus, roadway runoff appears to be a major contributor to channel erosion because of the speed at which water flows to the drainage channels from the road surface soon after precipitation begins. Four important sinkholes (McLaughlin Drive, Middle Fork of Jordan Gulch, and the Baskin and Kresge tributaries to the East Fork of Moore Creek) are at or exceeding their inflow capacity. The East Fork of Moore Creek watershed, including the Baskin, Science Hill, and Kresge subwatersheds, is so heavily impacted by excessive stormwater runoff that serious consideration should be given to curtailing all new development in these areas to produce a zero net increase in surface runoff.*

Based on the recommendation in the *Stormwater and Drainage Master Plan*, the Campus is proposing to implement a storm water drainage improvement project to address the existing erosion conditions, in drainages throughout the campus. This project is an element of the Infrastructure Improvements Project, and is described in detail and evaluated for its environmental effects in Volume III of this Draft EIR.

### 4.8.1.4 Watersheds Surrounding the Campus

Watersheds surrounding the campus are shown on Figure 4.8-2, *Watersheds in the Greater Vicinity of UC Santa Cruz Campus*. The northwest portion of the campus along the Ben Lomond Mountain ridge is bordered to the north and northeast by the San Lorenzo River watershed and the Gold Gulch drainage subarea. Bordering the campus to the east are the Pogonip and Arroyo de San Pedro Regaldo drainage subareas of the San Lorenzo River watershed. The San Lorenzo River drains to the Pacific Ocean approximately 2.2 miles southeast of the campus. Of the total San Lorenzo River watershed area of about 87,000 acres, only an area of approximately 500 acres drains from the campus itself.

To the southeast of the campus are the watersheds of Kalkar Quarry, which is also known as Ojos de Agua (60 acres total, with over 90 percent on campus) and High Street (60 acres total, with 40 percent on campus). These two watersheds are subareas of the Jordan Gulch/Neary Lagoon watershed with outflow to Neary Lagoon on the coastal plain. Of the total 1,380 acres of the Jordan Gulch/Neary Lagoon watershed, 440 acres are located on campus and drain to the subsurface through karst sinkholes. About 60 acres of the on-campus portion of the Jordan Gulch watershed drain to the surface south of the campus, where the Jordan Gulch drainage continues south along Bay Street as a spring-fed channel (Bay Creek) toward Neary Lagoon. To the south of the campus and further west are the Arroyo Seco watershed (260 acres total with 44 acres on campus) and the Moore Creek watershed, including the West Tributary Moore Creek subarea (1,240 acres total with 420 acres on campus). Moore Creek discharges to Antonelli Pond before reaching the Pacific Ocean at Natural Bridges State Beach. Arroyo Seco discharges to the Pacific Ocean just east of Natural Bridges State Beach.

Most of the northwest portion of the campus along the Ben Lomond Mountain ridge, is bordered to the northwest and west by the headwaters of Wilder Creek, Peasley Gulch, Baldwin Creek, and Majors Creek. Bordering the west side of the campus are the lower Wilder Creek watershed and Cave Gulch watershed (Johnson 1988 & 1989). Wilder Creek drains into the Pacific Ocean approximately 2 miles southwest of the campus.

## 4.8.1.5 Flooding

As discussed above, the UC Santa Cruz campus relies on a series of natural drainage courses and sinkholes for storm drainage. Storm water drains via pipes into the natural drainages. Most of the storm water enters the subsurface through a series of sinkholes. Detention basins and settling tanks serve local building clusters. While this system meets current overall capacity requirements, there are localized areas of concern. Recent analysis has documented surface flooding, in some locations on and off-campus. Areas that have experienced flooding from surface ponding include the area near the McLaughlin Drive sinkholes and on Moore Creek at Highview Drive south of the campus.

In February 2000, following a large storm event (20 to 40 year storm event, depending on the rainfall station), a culvert on Moore Creek at Highview Drive, a private road to the southwest of the campus below Empire Grade Road, failed. As a result, Highview Drive was flooded and the road embankment was damaged by the flows. Subsequent investigations of the site revealed that the culvert failure was due to a number of factors including inadequate culvert size and erosion from the campus area adjacent to the Empire Grade Road culvert about 400 feet above the location of the affected culvert.

During field investigations conducted in January 2003, it was noted that a large pond had formed on the East Branch of Jordan Gulch in the sinkhole north of McLaughlin Drive (Singer 2003). The last significant rainfall event had occurred two weeks earlier. There was also evidence that the sinkhole had overflowed into the downstream channel during intense rainfall that occurred in December 2002 (Singer 2003).

## 4.8.1.6 Campus Groundwater Resources

The UC Santa Cruz campus is roughly divided into two hydrogeologic systems: upper/north campus system and central/lower campus system. These two hydrogeologic systems are closely associated with campus geology (i.e., rock types, faults and fracture zones). Each of these systems is discussed below.

### Upper/North Campus

The upper/north campus hydrogeologic system (generally north of McLaughlin Drive) includes shallow water-bearing zones of moderate permeability consisting of Santa Margarita sandstone, weathered schist and granitic rocks, which overlie relatively impermeable unweathered schist and granitic rocks. Groundwater occurs in portions of thin (5- to 30-foot) eroded remnants of Santa Margarita sandstone as well as within the upper portions of weathered and fractured schist and granitic basement complex rocks. The primary porosity and permeability of the basement complex is low; however, secondary permeability created by weathering and fracturing is locally high and is important in the storage and movement of upper/north campus groundwater. A weathered and fractured mantle of quartz diorite (a granitic rock), which is permeable and may be up to 100 or more feet deep, underlies about 350 acres in the upper campus.

A study was conducted by Nolan Associates in 1999 and 2000 to evaluate and document existing geologic, hydrologic and groundwater conditions in the north campus, with specific reference to opportunities for and constraints on the potential development of additional campus facilities in this area (Nolan Associates 2000). The study area included about 400 acres of undeveloped land located north and west of existing campus development along McLaughlin Drive and Heller Drive. The data produced by this investigation indicated that the north campus has a relatively uniform shallow groundwater system. Depths to groundwater throughout the main portion of the north campus ranged from about 2 to 16 feet below ground surface (bgs). Due to the shallow groundwater and the moderate permeability of the near-surface materials, the north campus area has a high density of springs and seeps. These surface waters are not the result of underlying impermeable schist, as previously hypothesized. The springs and seeps occur generally where topography becomes steeper and the shallow groundwater table intersects the land surface. Many forest springs are perennial (i.e., flow throughout the year) during years of average rainfall.

The hydrologic system of the upper/north campus is dominated by broad, gently sloping topographic surfaces where surface drainage occurs as overland flow and rills. Drainage divides are poorly defined, but surface flow eventually collects in a few well-defined drainages along the margins of the flats. The dispersed surface flow encourages infiltration of rainwater, recharging the shallow groundwater system, which in turn feeds springs and seeps located throughout the area. Surface runoff to the south and west eventually enters the karst (marble) aquifer system of the central and lower campus via Cave Gulch, Moore Creek and Jordan Gulch. Surface flow to the east enters tributary drainages of the San Lorenzo River system. Due to its limited thickness and extent, and moderate permeabilities, however, the upper/north campus groundwater system is not considered a viable source for long-term groundwater supply for the campus. While there are some domestic wells adjacent to the upper campus area, the yields (typically from 5 to 25 gallons per minute) are not adequate to meet campus water supply needs (Johnson 1985).

### Central/Lower Campus

The southern two-thirds of the campus is underlain almost entirely by marble and schist. Near the middle of the campus, several small fault blocks consist of marble overlain by eroded remnants of schist of varying thickness. Toward the lower end of campus, the schist has been widely removed through erosion, but it is exposed above High Street along the southern campus boundary. Areas underlain by marble on campus are distinguished by the development of karst topography which is characterized by: (1) a relative absence of surface streams and drainage channels with most precipitation discharging to the subsurface through fractures, and (2) the presence of sinkholes, closed depressions, and swallow holes (i.e., the location in karst limestone at which a surface stream goes underground [Sweeting 1973]). The result is a landscape without an integrated drainage system. Sinkholes, sinks, closed depressions and swallow holes caused by subsidence or collapse of subsurface solution cavities in karst terrain are collectively known as dolines, which are a fundamental feature of karst topography (Bloom 1978). The marble area on campus contains more than 50 sinkholes which appear to capture as much as 40 percent of campus runoff.

Groundwater Flow. Within the marble is an extensive underground drainage network of subterranean caverns and channels formed by the dissolution of limestone and marble by groundwater. The locations of these channels are predominantly governed by bedrock fractures that provide a zone where water can penetrate, weather and dissolve the rock, eventually widening the fracture. Dissolution of the marble can only take place where water can flow. Crystalline non-fractured marble will not be readily weathered or dissolved, because unlike sandstone, for example, it does not have space between grains (inter-granular porosity) that would allow water penetration in any appreciable amounts. Much of the marble on campus is dense and has no inter-granular porosity or permeability (Johnson and Weber & Associates 1989). Non-fractured areas in between areas of fractured limestone are typically dry. In 1972, a 300-foot-deep boring was drilled within 30 to 50 feet of one of the large north-south fracture zones on campus without encountering groundwater. By contrast, Well #1 was drilled in this fracture zone (400 to 500 feet north of the dry hole) and groundwater was encountered at 100 feet bgs (Johnson and Weber & Associates 1989).

The two main underground channels on the campus lie in Jordan Gulch and Moore Creek, where they coincide with two north-south trending fault/fracture systems. As shown by the pump test described below, a large volume of water flows in these major underground channels. In addition, there are several east-west fractures in the central and southern portions of the campus (Johnson and Weber 1985, 1989; Weber and Associates 1994). The distribution of these smaller fractures shows a strong correlation with the location of on-campus sinkholes and off-campus springs. Underground channels are inferred to be present along the alignments of these fractures. Figure 4.8-3, *Major Fractures on the Main Campus*, illustrates the relationship between fractures and sinkholes on the campus. Figure 4.8-4, *Springs and Seeps on and Surrounding UC Santa Cruz and On-Campus Wells,* shows known springs and seeps on and adjacent to the campus.

Four dye tracing studies have been completed to date on the UC Santa Cruz campus that provide information on groundwater in the karst area of the campus. The first study was conducted in 1994 to evaluate groundwater flow paths and to determine whether pumping from Water Supply Well 1 (WSW #1), located in the Jordan Gulch watershed in the lower campus, would affect flow rates in individual springs in the area on and off campus. Dye was injected into monitoring well MW-1a and a sinkhole located near the East Remote parking lot (Weber and Associates 1994). Table 4.8-3 includes a summary of well construction details and Figure 4.8-4 includes the location of the wells and surface sampling points used in the dye tracing study. Results of this study indicated that dye traveled fairly rapidly between the dye injection location and nearby monitoring wells and springs. At four monitoring locations, the dye was detected within 2 days and, at eight monitoring locations, within 2 weeks. The monitoring data also demonstrated that WSW #1 is hydraulically connected (i.e., partial or complete groundwater flow path between locations) to MW-1a, MW-1b, Bay Street Spring, West Lake Spring, and Messiah Lutheran Spring. The connection between MW-1a and WSW #1 is particularly close (i.e., the dye introduced into MW-1a was detected in WSW #1 within 2.25 hours of dye injection. Wells MW-1a, MW-

1b and WSW #1 are located within 100 yards of each other (Weber, Hayes and Associates 2001a). Based on the dye tracing results and other available data, it was concluded that WSW #1, if pumped, would not substantially reduce the flow rates of any individual spring in the area because of the large overall discharge volume of hydraulically connected springs (Aley and Weber & Associates 1994).

**Table 4.8-3**
**Summary of Well Construction Details**

| Well No. | Date Completed | Total Boring Depth (ft bgs)[1] | Borehole Diameter (in OD)[2] | Conductor Casing Interval (ft bgs) | Type of Conductor Casing | Conductor Casing Diameter (in ID)[3] | Total Well Casing Depth (ft bgs) | Well Casing Diameter (in ID)[3] | Type of Well Casing | Depth of Screened Interval (ft bgs) | Perforation Type | Filter Pack Interval (ft bgs) | Filter Pack Type | Ground Surface Elevation (ft above MSL)[4,5] | TOC Elevation (ft above MSL)[6] | Static Water Level 6/4/02 (ft bgs)[7] | Well Yield (gpm)[8] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1A (Well #1) | 1/3/88 | 297 | 10.5 / 7.5 | 0-27 | Steel, 0.156 in | 8.5 | 297 | 5 | PVC, F480/200 | 97-297 | Slotted 0.040 in | 52-297 | 5/16-3/8 in gravel | 420 | 424.10 | 99.10 | 42.0 |
| MW-1B | 8/10/89 | 186 | 7.875 | none | none | none | 160 | 2 | PVC, Sch 40 | 100-160 | Slotted 0.040 in (?)[9] | 90-160 | 8x16 sand | ~415? | 417.90 | 57.90 | ? |
| Well #2 | 1/27/88 | 303 | 8.5 | none | none | none | 303 | 5 | PVC, F480 | 115-303 | Slotted 0.040 in | 50-115; none at 115-303 | 3/8 in gravel above packer at 115 ft[10] | 714 | ? | 117 | 12.5 |
| WSW-1 (Well #3) | 12/30/88 | 226 | 17.5 / 12.25 / 7.875 | 1st- 0-19, 2nd- 0-108 | 1st- steel, 0.188 in; 2nd- PVC F480 | 1st - 12.75 in OD; 2nd- 8.625 in OD | 157 | 5 | PVC, F480/SDR21 | 77-157 (effectively 108-157)[11] | Slotted 0.040 in | 0-157 [11] | 8x16 gravel | 412 | 416.20 | 99.80 | 100.0 |

Well construction data from Weber & Associates March 1989, and Gilchrist & Associates, July 1990.

[1] bgs = below ground surface.

[2] in OD = inches inside diameter; where multiple borehole diameters are listed, the larger are for conductor casing.

[3] in ID = inches inside diameter.

[4] MSL = Elevation Above Mean Sea Level; ground surface elevations are approximate, top-of-casing elevations are surveyed or calculated.

[5] Source: Weber & Associates March 1989, and Gilchrist & Associates, July 1990.

[6] TOC = Top of well casing; MW-1A and MW-1B TOC elevations from Weber, Hayes & Associates August 30, 2001. WSW-1 surveyed TOC elevation not available; approximate TOC MSL elevation calculated by adding 6/4/02 depth to water measurements to groundwater elevation data.

[7] Source: Weber, Hayes & Associates, December 19, 2002, data used in calculating TOC elevations from groundwater elevation table; except for Well # 2 data, which is from well completion January 27, 1988, source: Weber & Associates March 1989, and Gilchrist & Associates, July 1990.

[8] gpm = gallons per minute sustained yield during pump test.

[9] Well construction diagram and DWR drillers report said 0.40" slot size, but probably erroneous.

[10] Borehole sealed by packer at 115 ft bgs, with no filter pack within screened interval below at 115-303 ft bgs.

[11] Well diagram and DWR report are unclear or inconsistent about filter pack interval; apparently screened interval is partially within 2nd conductor casing at 77-108 ft bgs, with filter pack extending to surface(?) inside conductor casing. Since the upper screen interval is sealed from the formation from 77-108 ft bgs by the conductor casing, the effective screen interval is therefore 108-157 ft bgs.

Three subsequent dye tracing studies were conducted on the central campus to evaluate the potential for foundation pressure grouting programs to impact groundwater quality or flow rates at springs around the campus. Dye injected at the proposed grouting locations on the central campus was not detected at any of the off-campus monitoring points within each of the 18-week study periods, indicating that there are no rapid flow paths capable of moving water, grout or other fluid from the dye injection sites to off-campus springs. Because no rapid flow paths were identified, the studies concluded that pressure grouting programs in the areas tested would not have any significant impact on water recharge in the karst aquifer, or on water discharge rates or quality at springs, through leaching or grout transport.

Groundwater Storage. Because a substantial portion (about 40 percent) of the surface runoff on the campus is intercepted by the marble aquifer system, this system has the greatest potential for groundwater supply on the UC Santa Cruz campus. All of the potential water supply study exploratory wells, to date, have been drilled in the lower campus in areas of fractured limestone marble that were expected to exhibit high permeabilities. Three test wells were installed in January and December 1988, one adjacent to the upper quarry (Well #2) and two in Jordan Gulch (Well #1 and Well #3) below the lower quarry. The well construction details are included in Table 4.8-3 and their locations are shown in Figure 4.8-4. In each well, the depth to groundwater was about 100 feet bgs. A fourth test well (MW-1B) was installed in August 1989, with a static depth to groundwater of about 58-feet bgs. Above the groundwater table was as much as 30 feet of marble containing voids or cavities not filled with groundwater. These voids probably extend beneath the entire karst fracture/sinkhole/swallow hole system of the campus and provide substantial storage space for intercepted campus drainage.[5] At this time, groundwater is not extracted on the campus for any purpose, and the Campus depends on the City's domestic water supply for both domestic and irrigation water. In 1989, during a year of severe and prolonged drought, a 7-day pumping test was conducted at Well #3 (previously known as WSW #1) which indicated that this well could produce 100 gallons per minute (gpm) for long-term pumping without causing significant water level declines in the marble aquifer, and without affecting springs around the lower campus.[6] As part of the 7-day pumping test, flow measurements were also conducted at several springs and spring–fed streams near the lower campus in order to evaluate if pumping Well #3 had any effect on spring flow. No pumping impact was seen in the spring flow monitoring. This study also included an inventory of springs with field measurements over a 5-year period from 1984 to 1989.

An expanded Initial Study of the CASFS and Arboretum Irrigation well (Well #3) was prepared in 1990 that addressed the potential environmental impacts from use of a well to irrigate cultivated lands at the CASFS and Arboretum (Gilchrist and Associates 1990). This report included an evaluation of the Well #3 7-day pumping test and concluded that it was unlikely that pumping from Well #3 at 100 gpm would have any effect on the springs surrounding UC Santa Cruz. Even with greater pumping rates, it is probable that

[5] The groundwater storage capacity within the saturated zone of the karst aquifer is estimated to be at least 3,000 acre-feet, with an equivalent potential storage capacity above the groundwater table (Johnson and Weber Associates 1989; Gilchrist and Associates 1990).

[6] Limited drawdown (1.38 feet) in Well #1, located 40 feet away from Well #3, indicated only localized pumping effects with a relatively small, shallow cone of depression. Based on test data, the projected drawdown for Well #1 would be less than 2 feet after 30 days, and about 3 feet after 1 year. The calculated radius of influence after 7 days was about 300 feet, with a very slight increase projected afterward. Maximum drawdown in Well #3 (the pumping well) was 2.7 feet, with about 3 feet projected after 30 days and about 5 feet after 1 year. Pumping test analyses indicated hydraulic conductivity (K) values ranged between 1,528 and 506 gallons per day per square foot (gpd/ft$^{2)}$ (60 feet of thickness) with transmissivity (T) values from 91,680 to 30,345 gallons per day per foot (gpd/ft), and storativity (S) from 0.0264 to 0.0091. Recovery analysis indicated the following hydraulic parameters: K = 1,341 gpd/ft$^2$, T = 80,488 gpd/ft and S = 0.044 (Johnson and Weber & Associates 1989).

any dewatering of the marble aquifer would be rapidly recharged by captured runoff and subsurface flow carried in the solution channels during winter storms. However, the report recommended that use of Well #3 should incorporate long-term monitoring of springs near the campus, as flow patterns and groundwater movement in the karst aquifer are not completely understood.

To date, Well #3 has not been used for any purpose other than to periodically monitor groundwater levels and groundwater quality.

### 4.8.1.7 Groundwater Resources of the Region Surrounding the Campus

The Purisima formation, Santa Margarita sandstone, and weathered granitic rocks are the main water-bearing formations in the area surrounding the campus. The Purisima formation underlies the eastern portions of the City of Santa Cruz and the adjacent communities of Soquel and Live Oak. This formation is the primary source of groundwater in the Santa Cruz area. The City withdraws groundwater from its groundwater wells installed in this formation in Live Oak. This source accounts for about 5 percent of the City's water supply. Other water districts such as the Soquel Creek Water District and private wells also draw water from this formation.

In the areas of the county to the northwest of the campus on Ben Lomond Mountain, private wells are installed in fractured and weathered granitic rock. These wells typically have low yields of 5 to 25 gpm, which are adequate for single households but not for larger developments (Johnson 1985).

A survey of the California Department of Water Resources (DWR) database indicated a total of 142 well logs on file for wells located within, adjacent to, or down-gradient from the main campus.[7] Exact locations, well types and well data are unavailable for most of these wells. One inactive municipal water supply well was identified along the San Lorenzo River approximately 1 mile east of the campus boundary (County of Santa Cruz 2001; SWRCB 2005). The approximate location of a second inactive water supply well was identified by a State of California Water Resources Control Board (SWRCB) GeoTracker website database search in the Pogonip City Park Polo Field area approximately ½ mile east of the campus boundary. The approximate locations of four water supply or agricultural wells were identified at Wilder Ranch State Park along Highway 1 approximately 1½ miles southwest of the campus boundary (California Department of Parks and Recreation 2002).

Groundwater from the campus discharges to surface water in the surrounding areas by way of numerous springs and seeps feeding drainages in the San Lorenzo River watershed to the north and east of the campus; the Cave Gulch and Wilder Creek watersheds to the west of the campus; and the Moore Creek, Arroyo Seco, and Jordan Gulch/Neary Lagoon watersheds south to southwest of the campus. The springs and seeps bordering the north campus at higher elevations originate from shallow aquifers within thin layers of Santa Margarita sandstone and the schist and granitic basement rocks, which intersect steep slopes along the San Lorenzo River drainages. Groundwater outflow from the central and lower campus mostly originates from fractures and solution cavities within the marble karst formation fed by captured

[7] According to the database these wells are located in Township 11S02W Sections 2, 3, 4, 10, 11, 12, 13, 14, 15, 16, 21, 22, 23, 24 and 26.

surface runoff and groundwater flow from the north campus, and emerges from springs and seeps surrounding the campus at lower elevations near the eastern, southern and western campus boundaries.

The springs and seeps that originate from the sandstone/schist/granitic seep zone and feed the San Lorenzo River Watershed north and northeast of the upper campus (Johnson 1988 & 1989) include Tunnel Gulch East and West Springs along the north campus boundary, an unnamed spring shown on the USGS Felton 7.5 minute topographic map about 2,200 feet north of the campus boundary, and Highway 9 Horse Trough Spring located above the San Lorenzo River northeast of the campus. The karst zone springs and seeps that emerge east of the campus boundary and flow toward the San Lorenzo River include Pogonip Springs #1 and #2, the Pogonip Creek Spring, Harvey West Seep, and Wagner Grove Seep (Johnson 1988 &1989; Brady-LSA 1998). To the southeast of the campus boundary, the karst zone springs that flow toward Neary Lagoon on the coastal plain include Kalkar Quarry Spring, Messiah Lutheran Church Spring, High Street Spring, West Lake Spring, and Bay Street Spring. South of the campus, the karst zone Arboretum and Moore Creek seeps feed Moore Creek, which flows to Antonelli Pond and the coastal plain. Two seeps at the head of Arroyo Seco north of High Street near the campus's southern boundary are apparently fed by locally occurring shallow groundwater and flow to the Pacific Ocean about ¼ mile east of Natural Bridges State Beach (Nolan, Zinn and Associates 2004). Along the western campus boundary, the Wilder Creek and Cave Gulch watersheds are fed by the Wilder Creek and Cave Gulch source seeps from the upper/north campus sandstone/schist seep zone, and the Upper and Lower Cave Gulch Springs, and Wilder Creek Spring from the karst aquifer (Johnson 1988 & 1989).

### 4.8.1.8 UC Santa Cruz Hydrologic Monitoring

#### Spring and Stream Flow Monitoring

UC Santa Cruz monitors spring and stream flow as well as water levels in the three wells in Jordan Gulch, at a total of 16 stations. The UC Santa Cruz Spring and Stream Flow database extends from 1984 to the present and includes data from 17 springs, streams, and wells, one of which is no longer monitored. The monitoring locations are shown in Figure 4.8-4. Generally spring and stream flow measurements are collected at the end of the winter wet season and at the end of the summer/fall dry season (Weber, Hayes and Associates 2002). Table 4.8-4 presents a statistical summary of the monitoring data gathered by the Campus since 1984, including average, maximum, minimum spring flows and standard deviation for spring discharge data, and water surface elevations for the monitoring wells. Table D1-1 in Appendix D1 presents a summary of all monitoring data since 1984.

## Table 4.8-4
## Statistical Summary of Spring and Stream Flow Rates and Groundwater Elevation

| Location | Bay Street Spring | West Lake Outlet | Messiah Lutheran Spring | Kalkar Spring Quarry | High- Longview Spring | Wagner Grove Seep | Harvey West Seep | Pogonip Creek System | Pogonip Spring #1 | Pogonip Spring #2 | Upper Cave Gulch | Lower Cave Gulch | Wilder Creek Spring | Moore Creek Spring | | MW-1A | MW-1B | WSW 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (surface elev) | 235 ft MSL | 255 ft MSL | 255 ft MSL | 310 ft MSL | 250 ft MSL | 200 ft MSL | 110 ft MSL (approx) | 150 ft MSL | 435 ft MSL | 500 ft MSL | 540 ft MSL | 330 ft MSL | 330 ft MSL | 410 ft MSL (approx) | | 424.10 (*TOC, ft MSL)* | 417.90 (*TOC, ft MSL)* | 416.20 (*TOC, ft MSL)* |
| **Statistical Summary (Per Monitoring Event)** | | | | | | | | | | | | | | | **Total Q gpm** | **Average** | **Average** | **Average** |
| **Flow Rate** | **gpm** | | | | | | | | | | | | | | | **ft MSL** | **ft MSL** | **ft MSL** |
| Average | 122.70 | 57.68 | 49.08 | 115.50 | 23.05 | 6.63 | 11.54 | 196.61 | 24.78 | 9.16 | 27.98 | 36.98 | 318.42 | 6.49 | 1006.61 | 317.96 | 366.98 | 327.21 |
| Std Dev (average only) | 24.67 | 73.45 | 18.75 | 180.69 | 23.17 | 43.02 | 32.99 | 102.66 | 26.74 | 12.75 | 67.07 | 64.81 | 452.15 | 7.62 | 80.75 | 8.31 | 7.18 | 8.56 |
| Maximum | 192.30 | 350.00 | 129.00 | 1370.40 | 116.00 | 298.30 | 172.20 | 719.58 | 132.50 | 64.61 | 379.27 | 247.78 | 3040.62 | 29.20 | NA | 344.90 | 373.90 | 369.12 |
| Minimum | 61.12 | 0 | 3.6 | 0 | 0 | 0 | 0 | 80.27 | 2.8 | 1.23 | 0 | 1.9 | 14.2 | 0.5 | NA | 308.13 | 321.12 | 311.78 |
| Same Day Maximum (4/13/98) | 116.00 | 287.19 | 73.33 | 1370.40 | Discontinued | 7.80 | 13.80 | 646.87 | 96.67 | 49.80 | 379.27 | 247.78 | 1526.48 | 29.20 | 4844.59 | NA | NA | NA |
| Same Day Minimum (9/28/90)* | 103.8 | 0 | 29.2 | 0 | ** | ** | ** | 113.1 | ** | ** | ** | ** | 28.7 | ** | 274.80 | NA | NA | NA |
| June-October Average | 107.18 | 17.92 | 37.83 | 68.74 | 7.02 | 0.00 | 2.45 | 181.71 | 15.03 | 5.03 | 4.21 | 9.33 | 122.10 | 4.17 | 582.72 | 316.57 | 368.27 | 326.70 |
| **Annual Flow** | **acre-feet/year** | | | | | | | | | | | | | | **Total Q acre-feet/year** | **NA** | **NA** | **NA** |
| Average | 197.96 | 93.05 | 79.18 | 186.33 | 37.19 | 10.70 | 18.61 | 317.18 | 39.98 | 14.78 | 45.13 | 59.67 | 513.71 | 10.48 | 1623.96 | NA | NA | NA |

**Notes:**

* = Data prior to 9/90 not used. Monitoring of 7 additional offsite springs began 9/2/90, with 1 more on 10/15/90 and 1 more on 3/30/95. Data from 2/7/91 and 1/7/00 not used because only 1 spring was monitored.

gpm = gallons per minute. ft MSL = Feet above Mean Sea Level TOC = Top of Casing elevation NA = Not Applicable Q = Discharge Flow

Annual Spring and Stream Flow Data Reports include summaries of the 17 individual station graphs. A comparison of data (by evaluating dye tracing studies, hydrogeologic location, water level and spring/seep discharge hydrographs) indicates that certain groups of monitoring stations are on similar karst fracture systems and are hydraulically related. The stations that are hydraulically related to one another are grouped below:

- Wells MW-1A, MW-1B and WSW #1
- Pogonip Creek and Harvey West Seep
- Upper Cave Gulch, Lower Cave Gulch and Wilder Creek springs
- Pogonip Springs #1 and #2
- Bay Street and Westlake springs
- Westlake and Messiah Lutheran springs
- Messiah Lutheran and Kalkar Quarry springs

Histograms (rainfall/time graphs) of monthly precipitation data have indicated that after significant rainfalls, all springs, streams and creeks show an increase in flow rates, and monitoring wells show a rise in groundwater elevations.

Because wet season measurements are influenced by the amount and timing of rainfall, there is more variation in wet season measurements. The dry season measurements represent base flow conditions and are therefore more suitable for year-to-year comparison. Dry season monitoring has indicated that UC Santa Cruz activities and development have not created a measurable increase or decrease in flow rates at any of the springs and streams monitored, and have not affected groundwater elevations in on–campus monitoring wells.

### Surface Water and Groundwater Quality

Since 1989, water quality sampling has been conducted at six groundwater well, spring and surface water locations as shown in Figure 4.8-4 and at three parking lots. The sampling locations are classified in four groups:

- Karst groundwater location: WSW #1
- Springs that discharge from the schist/sandstone/granitic aquifer: Elfland Spring, College Nine/Ten Spring, and Environmental Preserve Spring (EP-S)
- Surface water locations: Environmental Preserve Gully (EP-G) and Moore Creek
- Parking lot runoff locations: Faculty Housing parking lot, East Remote parking lot, and Crown/Merrill parking lot

The samples are analyzed for a complete California Administrative Code Title 22 suite (general mineral, physical and inorganic) and semi- to non-volatile range hydrocarbons (diesel-kerosene-motor oil range) by Standard Method 8015B. The analytical results are compared against performance criteria (e.g., water quality standards, guidelines, and benchmarks) and the beneficial uses as described in Table 4.8-5, *Beneficial Uses of Surface Water Features on or Near UC Santa Cruz*, and in Tables D2-2 through D2-10 in Appendix D2. Based on an analysis of the historic analytical database, the sampled water on the UC Santa Cruz campus does indicate an increase in urban runoff pollutants over time.

## 4.8.1.9 Water Quality Regulations

Water quality objectives for all California waters are established under the Federal Clean Water Act (CWA) and California's Porter-Cologne Water Quality Control Act. Discharges to surface or groundwater are also covered by regional basin plans. These regulations are described below.

### Clean Water Act

The CWA (United States Code, Title 33) requires the EPA to establish effluent limitations for municipal sewage plant and industrial facility discharges. The CWA provides for two types of pollution control limits:

- Limits to the quantity of pollutants discharged from a point source such as pipe, ditch, or tunnel into a navigable body of water. These limits are established through a nationwide assessment of what is technologically and economically feasible with respect to pollution control for a particular industry.
- Ambient water quality standards for navigable waters of the United States that are based on beneficial uses and require more stringent control of discharge if necessary to achieve water quality objectives. For example, the EPA sets water quality limits to control pollution discharged to waters designated by the states for beneficial uses including drinking, fishing, or recreation.

In addition to these point source and ambient water quality control limits, Section 319 of the CWA provides direction for state control of nonpoint source discharges. Nonpoint source pollution comes from diffuse sources such as urban runoff, agricultural runoff, or construction site runoff. This section requires states to submit a report that identifies: navigable waters that are expected to achieve applicable water quality standards or goals; categories of nonpoint or specific sources that add significant pollution to contribute to non-attainment of water quality standards or goals; and a process to develop best management practices and measures to control each category of nonpoint or specific sources. The states are then required to develop a management program that proposes to implement the nonpoint source control program.

Section 305(b) of the CWA requires states to perform biennial water quality assessments of navigable waters to describe the nature and extent of nonpoint sources, provide recommendations for control programs, and analyze the success of beneficial use protection and pollution reduction.

Section 303(d) of the CWA requires states to identify waters that are not expected to meet water quality standards after effluent limitations for point sources are implemented, develop a priority ranking to determine the order in which Total Maximum Daily Load (TMDL) should be developed for these impaired water bodies, and determine the total maximum daily load of specific pollutants that may be discharged into the water body. TMDLs are developed as part of a program to examine the water quality problems, identify sources of pollutants, and specify actions that create solutions.

The primary method by which the CWA imposes pollutant control limits is the National Pollutant Discharge Elimination System (NPDES) permit program established under Section 402 of the act. Under the NPDES program, any point source discharge of a pollutant or pollutants into any waters of the United States is subject to a permit. In California, the state's Regional Water Quality Control Boards (RWQCBs) are responsible for administering the NPDES program. The NPDES program was initially established to regulate the quality of effluent discharge from wastewater treatment plants. Through the NPDES Waste Discharge Requirements, the RWQCB sets limits on the levels of pollutants that may be discharged into navigable waters of the United States. The limits are designed to meet the water quality objectives established in the Basin Plan.

The 1972 amendments to the CWA prohibit the discharge of pollutants to navigable waters from a point source unless the discharge is authorized by an NPDES permit. In 1987, in recognition that diffuse, or non-point, sources were significantly impairing surface water quality, Congress amended the CWA to address non-point source storm water runoff pollution in a phased program requiring NPDES permits for operators of municipal separate storm sewer systems (MS4s), construction projects and industrial facilities. Phase I, promulgated in 1990, required permits for facilities of these types generally serving populations over 100,000, construction permits for projects five acres or greater, and industrial permits for certain industries. Projects on the campus that disturb over 5 acres are subject to Phase I regulations.

The Phase II program expands on the Phase I program by requiring operators of small MS4s in urbanized areas and operators of small construction sites, through the use of NPDES permits, to implement programs and practices to control polluted storm water runoff. Phase II is intended to reduce these adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges.[8] Under Phase II of the NPDES program, SWRCB has issued three general permits: (1) Municipal permits – required for operators of small MS4s, including universities, (2) Construction permits – required for projects involving one acre or more of construction activity, and (3) Industrial permits. The municipal permit requires development and implementation of a Storm Water Management Program (SWMP). The purpose of the SWMP is: (1) to identify pollutant sources potentially affecting the quality and quantity of storm water discharges; (2) to provide Best Management Practices (BMPs) for municipal and small construction activities implemented by University staff and contractors; and (3) to provide measurable goals for the implementation of the SWMP to reduce the discharge of the identified pollutants into the storm drain system and associated water ways. The goal of the SWMP is to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP), as defined by the EPA. "Minimum Control Measures" (MCMs) is the term used by the EPA for the six MS4 program elements aimed at achieving improved water quality through NPDES Phase II requirements.

The SWRCB's general permit for construction activities requires that for projects that disturb more than one acre of soil, a Storm Water Pollution Prevention Plan (SWPPP) be developed and implemented. The SWPPP must identify potential sources of pollution and describe runoff controls that will be implemented both during construction and after the building is complete.

[8] Downloaded from http://www.epa.gov/npdes/pubs/fact1-0.pdf July 17, 2003.

### Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act of 1969 authorized the SWRCB to provide comprehensive protection for California's waters through water allocation and water quality protection. The SWRCB implements the requirement of CWA Section 303 that water quality standards be set for certain waters by adopting water quality control plans under the Porter-Cologne Act. In addition, the Porter-Cologne Act established the responsibilities and authorities of the nine RWQCBs, which include preparing water quality plans for areas within the region (Basin Plans), identifying water quality objectives, and issuing NPDES permits and Waste Discharge Requirements (WDRs). Water quality objectives are defined as limits or levels of water quality constituents and characteristics established for reasonable protection of beneficial uses or prevention of nuisance. NPDES permits, issued by RWQCBs pursuant to the CWA, also serve as WDRs issued pursuant to the Porter-Cologne Act. WDRs are also issued for discharges that are exempt from the CWA NPDES permitting program, discharges that may affect waters of the state that are not waters of the United States (i.e., groundwater), and/or wastes that may be discharged in a diffused manner. WDRs are established and implemented to achieve the water quality objectives (WQOs) for receiving waters as established in the Basin Plans, as described below. Sometimes they are combined WDRs/NPDES permits.

### Central Coast RWQCB Basin Plan

The UC Santa Cruz campus is within the jurisdiction of the CCRWQCB (Region 3). The CCRWQCB has the authority to implement water quality protection standards through the issuance of permits for discharges to waters located within its jurisdiction. Beneficial uses of inland surface waters and water quality objectives for the region are specified in *The Water Quality Control Plan for the Central Coast Basin* (Basin Plan) prepared by the CCRWQCB in compliance with the federal CWA and the state Porter-Cologne Water Quality Control Act. Table 4.8-5 lists the beneficial uses of creeks and other water bodies on or near the campus. The objective of the Basin Plan is to show how the quality of the surface and ground waters in the Central Coast Region should be managed to provide the highest water quality reasonably possible. The Regional Board implements the Basin Plan by issuing and enforcing waste discharge requirements to individuals, communities, or businesses whose waste discharges can affect water quality. These requirements can be either State WDRs for discharges to land, or federally delegated permits for discharges to surface water. The CCRWQCB has issued TMDLs for nitrate and sediment in the San Lorenzo River watershed in order to restore beneficial uses within the watershed.

**Table 4.8-5**
**Beneficial Uses of Surface Water Bodies on or near UC Santa Cruz**

| Water Body | Beneficial Uses in the Basin Plan |
|---|---|
| Wilder Creek | MUN, AGR, GWR, REC1, REC2, WILD, COLD, WARM, MIGR, SPWN, BIOL, FRESH, COMM |
| Cave Gulch | MUN, GWR, REC1, REC2, WILD, COLD, WARM, COMM |
| Moore Creek | MUN, AGR, GWR, REC1, REC2, WILD, COLD, WARM, SPWN, BIOL, FRESH, COMM |
| San Lorenzo River | MUN, AGR, IND, GWR, REC1, REC2, WILD, COLD, MIGR, SPWN, BIOL, RARE, FRESH, COMM |
| Antonelli Pond | GWR, REC1, REC2, WILD, WARM, MIGR, SPWN, RARE, COMM |

**Source:** CCRWQCB 1994.

**Beneficial Use Definitions:** Municipal and Domestic Supply (MUN); Agricultural Supply (AGR); Industrial Service Supply (IND); Ground Water Recharge (GWR); Freshwater Replenishment (FRSH); Water Contact Recreation (REC-1); Non-Contact Water Recreation (REC-2); Commercial and Sport Fishing (COMM); Warm Fresh Water Habitat (WARM); Cold Fresh Water Habitat (COLD); Wildlife Habitat (WILD), Preservation of Biological Habitats of Special Significance (BIOL); Rare, Threatened, or Endangered Species (RARE); Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and/or Early Development (SPWN).

### 4.8.1.10 Campus Wastewater Discharge

The Campus discharges wastewater to the City's sewer system under a waste discharge permit issued by the City in January 2005 for a period of 5 years. The permit establishes effluent limitations that apply to all dischargers and includes certain specific limitations for the campus. It also requires that the Campus collect and analyze samples for prescribed components on a quarterly basis. Over the course of its monitoring history, the Campus has generally been in compliance with the effluent limits. There have been a few exceedances in the past 15 years: one for silver in 1991, and two exceedances for oil and grease in 1995 and 2002. All exceedances were promptly remedied and the Campus has not had an exceedance since 2002.

### 4.8.1.11 Campus Storm Water Management Program

UC Santa Cruz construction and industrial activities are currently subject to the Phase I NPDES storm water requirements. In April 2004, the Campus submitted a draft SWMP to the CCRWQCB under the Phase II NPDES storm water program. In May 2005, the CCRWQCB asked for revisions to the plan. The Campus revised the plan and resubmitted it to the CCRWQCB in August 2005.

In addition to the six MCMs, mandated by EPA, the UC Santa Cruz SWMP includes an MCM that provides measures specific to UC Santa Cruz to reduce storm water impacts. The BMPs in MCM #7 include but are not limited to the proposed storm water infrastructure improvements (described in Volume III of this EIR), measures to encourage alternative transportation, and storm water related research.

## 4.8.2 Impacts and Mitigation Measures

### 4.8.2.1 Standards of Significance

The following standards of significance are based on Appendix G of the CEQA Guidelines. For the purposes of this EIR, hydrology and water quality impacts would be considered significant if campus development under the 2005 LRDP would:

- Violate any water quality standards or waste discharge requirements
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on site or off site
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on site or off site
- Create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff
- Otherwise substantially degrade water quality

### 4.8.2.2 CEQA Checklist Items Adequately Addressed in the Initial Study

Implementation of the 2005 UC Santa Cruz LRDP would not cause impacts within the following CEQA checklist items identified in Appendix G of the CEQA Guidelines. Therefore, these items were focused out in the Initial Study and are not analyzed in the following impact analysis.

- Place housing within a 100- year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?

  Areas proposed for housing on campus are not within a 100-year flood hazard area.

- Place within a 100-year flood hazard area structures that would impede or redirect flood flows?

  Areas proposed for development on campus and at the 2300 Delaware Avenue property are not within a 100-year flood hazard area.

- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?

  The 2005 LRDP development areas are outside the inundation hazard area that could be affected by a failure of levees or dams, including Bay Street Reservoir and Newell Creek Dam.

- Inundation by seiche, tsunami or mudflow?

  The main campus is not in an area subject to inundation by seiche, tsunami, or mudflow.

In addition to the above CEQA checklist items, it was determined that further analysis of hydrology and water quality impacts related to the 2300 Delaware Avenue property was not required because no new facilities or other changes on that property are proposed under the 2005 LRDP that could result in a change in surface or groundwater hydrology. However, because the 2300 Delaware Avenue property is directly adjacent to Antonelli Pond, which is within a tsunami inundation area as mapped by the County of Santa Cruz (County of Santa Cruz 2005), that impact is addressed in Chapter 4, *2300 Delaware Avenue Project* (Volume III).

## 4.8.2.3 Analytical Method

### Surface Water

The effects of increased impervious surfaces on storm water runoff were estimated using the U.S. Army Corps of Engineers' (ACOE) hydrologic modeling software program HEC-HMS. HEC-HMS is a hydrologic modeling system that provides several methods for analyzing rainfall runoff. Within HEC-HMS, the United States Soil Conservation Service (SCS) Curve Number method was used to determine how much of the precipitation would run off from each major watershed on campus. This is the same method used in the *Stormwater and Drainage Master Plan* for the modeling of runoff in the East Fork of Moore Creek (Kennedy/Jenks Consultants 2004). Inputs to the model include the rainfall data for a particular storm event and the watershed properties.

Two hypothetical storm events of different sizes were modeled to demonstrate how increasing the impervious area within the watershed would affect runoff. One event had a 2-year recurrence interval and a 3-hour duration, and the other event had a 25-year recurrence interval and a 24-hour duration. The runoff from the campus watersheds under existing conditions was compared with the runoff that would result from the development proposed under the 2005 LRDP. The model inputs and results are included in Appendix D2.

### Groundwater

Impacts on groundwater recharge were evaluated based on the increase in impervious surfaces in each campus watershed. The impacts from groundwater extraction were evaluated by examining previous studies including well pumping tests conducted on the campus. To evaluate the potential effects of withdrawals from the campus groundwater budget, a water balance for the on-campus karst aquifer was estimated. In the water balance of a groundwater system, groundwater recharge equals groundwater discharge, assuming no long-term changes in groundwater storage. Groundwater recharge is estimated by subtracting evapo-transpiration and runoff from precipitation. Groundwater discharge is estimated from the combined spring flow, surface stream base flow, well pumping, and subsurface flow out of the area.

### 4.8.2.4 2005 LRDP Impacts and Mitigation Measures

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|---|---|
| **LRDP Impact HYD-1:** | Campus development under the 2005 LRDP would not result in wastewater that would violate wastewater discharge requirements. |
| **Significance:** | Less than significant |
| **LRDP Mitigation:** | Mitigation not required |
| **Residual Significance:** | Not applicable |

The UC Santa Cruz campus, including the 18-acre improved property at 2300 Delaware Avenue, does not discharge wastewater directly to any receiving water bodies; therefore, its wastewater is not subject to wastewater discharge requirements. Campus wastewater, including wastewater that is generated at 2300 Delaware Avenue, is discharged to the City of Santa Cruz sewer system and is treated at the City's wastewater treatment plant. Due to the projected increase in total campus population (main campus and 2300 Delaware Avenue) from 17,600 in 2003-04 to 26,900 people through 2020-21 under the 2005 LRDP, the volume of wastewater would increase. As discussed in Section 4.15, *Utilities*, the existing City's wastewater treatment plant has sufficient capacity to handle the expected increase in flow due to campus growth under the 2005 LRDP in combination with other city growth through 2020 (Wolfman 2005)

In general, the types of activities and uses on the campus would remain unchanged, so there is no reason to expect the quality of wastewater that is discharged to the sewer system would change. The use of hazardous materials, including biohazardous materials, on campus is projected to increase under the 2005 LRDP because the amount of laboratory space and associated faculty and students is expected to grow and may include a biomedical science research facility. However, the types of chemicals and biological agents used in the future would likely be similar to those used in existing laboratories on campus. Campus Environmental Health and Safety has developed and implemented comprehensive programs to handle these wastes. See Section 4.7, *Hazards and Hazardous Materials*. All hazardous materials on the campus are handled, stored and disposed of in compliance with the laws related to these materials. Medical wastes are collected by and outside contractor for proper disposal. In addition, EH&S has established drain disposal guidelines for all campus laboratories. These guidelines prohibit the discharge of hazardous materials into sinks and drains on the campus. All new laboratories on the main campus and at 2300 Delaware Avenue would be required to comply with campus procedures and guidelines. Furthermore, as discussed in Section 4.8.1.10, *Campus Wastewater Discharge*, the Campus has generally been in compliance with the permit limits for wastewater discharge. Therefore, increased flows from development under the 2005 LRDP are not expected to cause a violation of waste discharge requirements of the City's wastewater treatment plant, and the impact would be less than significant.

| | |
|---|---|
| **LRDP Impact HYD-2:** | Campus development under the 2005 LRDP could result in storm water runoff during construction, which could substantially degrade water quality. |
| **Significance:** | Potentially significant |
| **LRDP Mitigation HYD-2A:** | For all construction projects less than one acre in area, the Campus shall continue to require the use of construction site controls and best management practices in compliance with the campus draft Storm Water Management Program, the campus Erosion Control Standards, and the Site Requirements for Erosion Control and Drainage in the Campus Standards Handbook. |
| **LRDP Mitigation HYD-2B:** | No grading shall be conducted on hillsides (sites with slopes greater than 10 percent) during the wet season (October 1 through May 31) unless controls that prevent sediment from leaving the site are implemented. Erosion control measures, such as erosion control blankets, seeding or other stabilizing mechanisms shall be applied to graded hillside prior to predicted storm events. |
| **Residual Significance:** | Less than significant |

Campus development under the 2005 LRDP would involve construction activities such as grading and excavation for new student and employee housing, academic buildings, roads, driveways, and utility trenches, which could cause increases in erosion during storm events that would discharge sediment into surface waters. Other pollutants such as fuels, paints, and cleansers could be accidentally released at construction sites and could enter surface waters. These pollutants could adversely affect water quality and other beneficial uses of the campus creeks and drainages as well as downstream receiving waters, including the Monterey Bay and San Lorenzo River. Because in many sub-watersheds on the campus surface water discharges underground via sinkholes, pollutants could also enter groundwater.

Since 1989, the Campus has been implementing erosion control measures during the construction of every project in order to minimize erosion and sedimentation and to avoid water quality impacts. In addition, since 1990, in compliance with NPDES Phase I regulations, the Campus has prepared and implemented storm water pollution prevention plans (SWPPP) for all construction projects five acres and more in size. Currently, contractors working on the campus prepare and implement SWPPPs for all construction sites one acre or more in size, as required by the NPDES Phase II regulations.

In compliance with NPDES requirements, during and following construction proposed under the 2005 LRDP, the Campus would require contractors to prepare and implement a SWPPP for all construction sites larger than one acre. The SWPPP is used to identify and control potential sources of pollutants to runoff. Some typical measures that would be used to comply with the NPDES permit include:

- Minimizing disturbed areas
- Implementing structural and procedural BMPs for collecting, handling, storing, and disposing of wastes generated during construction

- Implementing temporary erosion and sediment control measures during construction
- Stabilization of cleared or graded slopes

Because the Campus is required by law to implement SWPPPs for all construction sites one acre or more in area, the potential for construction activities to cause erosion and other water quality impacts is low. However, the campus is characterized by gently to steeply sloping land, especially in the central campus, and erosive soils are present in several areas including the north campus area where new development is proposed under the 2005 LRDP. While an individual small project would not result in a significant impact, the cumulative effects of numerous small projects could be significant. Therefore, without appropriate controls, construction on small sites (under one acre), which are not subject to the requirement for construction-phase SWPPPs, could result in the release of sediment and other pollutants into surface and groundwater, and thereby could adversely affect water quality. This would constitute a significant impact.

Implementation of LRDP Mitigation HYD-2A and HYD-2B would reduce the impact related to construction-site storm water pollution to a less-than-significant level. For projects under one acre, in compliance with LRDP Mitigation HYD-2A, the Campus would continue to require contractors to implement control measures specified in the draft Campus SWMP and the Campus Standards Handbook (UCSC 2001). In addition, in compliance with LRDP Mitigation HYD-2B, grading on hillsides with greater than 10 percent slope would not be allowed during the wet season unless measures are implemented that would prevent sediment from leaving the construction site. These requirements would be specified in construction contracts and compliance would be monitored by the Campus's construction inspectors. These measures would ensure that potentially significant impacts from construction site runoff are reduced to less-than-significant levels.

In summary, compliance with NPDES requirements for construction sites and the implementation of LRDP Mitigations HYD-2A and HYD-2B would reduce the construction-phase storm water runoff impacts on water quality to a less-than-significant level.

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|---|---|
| **LRDP Impact HYD-3:** | Campus development under the 2005 LRDP would alter drainage patterns in the project area, and increase the rate or amount of surface runoff, which could result in substantial siltation or erosion on or off site, and increase the amount of urban pollutants in storm water runoff, which could affect water quality. |
| **Significance:** | Significant |
| **LRDP Mitigation HYD-3A:** | The Campus shall install additional signs and expand the public education program to inform and educate the campus population about the importance of staying on paved roads and approved paths to prevent vegetation disturbance and soil erosion. |

**LRDP Mitigation HYD-3B:** The Campus shall implement control measures to reduce erosion along new and existing unpaved fire roads, including but not limited to water bars to redirect flow off the road and flow dispersion of runoff from roads.

**LRDP Mitigation HYD-3C:** Each new capital project proposed under the 2005 LRDP that creates new impervious surface shall include design measures to ensure that post-development peak flows from 2-, 5- and 10-year storms do not exceed the 2-, 5-, and 10-year pre-development peak flows and that post-development peak flows from a 25-year storm do not exceed the pre-development peak flow from a 10-year storm. Each new capital project shall also include design measures to avoid or minimize the increase in the volume of runoff discharged from the site to the maximum extent feasible.

**LRDP Mitigation HYD-3D:** The Campus shall incorporate measures into project designs under the 2005 LRDP that maximize infiltration of runoff. Infiltration shall be achieved preferably near the area where new runoff is generated.

**Residual Significance:** Significant and unavoidable

Development under the 2005 LRDP would add new buildings, roads, sidewalks, parking lots and other impervious surfaces to the campus, which would generate more runoff compared to existing conditions, which could lead to more erosion in the creeks on the campus. In addition, the number of persons present on the campus on a daily basis would increase. Water quality impacts stemming from increased human activity and increased impervious surfaces are discussed below.

### Water Quality Impacts from Increased Human Activity

Under the 2005 LRDP, campus population would increase by approximately 8,715 persons. As a result of this growth, the number of vehicles traveling on campus streets and the overall level of activity on the campus would increase. The increased population and human activity would result in an increase in urban pollutants that could be discharged into runoff on the campus.

Another existing problem on the campus is erosion along undesignated trails as a result of use by pedestrians and bicyclists. Although data gathered in an informal survey of bicycle riders on the Wilder Cowell Regional Trail indicate that the designated unpaved roads on the north and upper campus are largely used by persons not related to the campus, it is reasonable to assume that other trails on the campus, especially the undesignated trails in the central and lower campus, would experience increased use by campus affiliates as the population of the campus grows. Increased use of the undesignated trails, especially by bicycles, could result in the disturbance of vegetative cover and ensuing erosion and sedimentation. Some of these trails are close to creeks and streams.

Pollutants, including sediment, present in urban runoff in high concentrations can adversely affect water quality and beneficial uses of the receiving waters. The Campus has been implementing measures to control the discharge of pollutants from new development, including several storm water detention facilities. The Campus has also installed oil/water separators where grease and oil concentrations are expected to be high. The Campus has installed dispersion manifolds which are intended to reduce peak flows but also help remove urban runoff pollutants. Furthermore, the Campus routinely performs other activities, such as street sweeping and parking lot cleaning, which also help reduce the amount of pollutants that enter storm water. As described in Section 4.8.1.8, *UC Santa Cruz Hydrologic Monitoring*, UC Santa Cruz conducts an annual water quality monitoring program. Water quality sampling has been conducted at several surface water, groundwater and spring locations since 1989 and, as discussed in Section 4.8.1.8, the results do not indicate an increase in urban runoff pollutants over time. It is anticipated that current pollution prevention practices will continue under the 2005 LRDP. In addition, the Campus will implement its SWMP. As stated earlier, the Campus is subject to NPDES Phase II regulations, which require small communities (population under 100,000) with a separate municipal storm drain system to develop and implement a Storm Water Management Program. The Campus has submitted such a plan to the Central Coast RWQCB and will implement the provision of the final approved plan. The SWMP includes BMPs required under the six MCMs. To control storm water pollution from new development on the campus, the SWMP also includes existing design requirements, such as the Erosion Control Standards in Appendix D of the Campus Standards Handbook (UCSC 2001), Part III Site requirements of the Campus Standards Handbook (UCSC 2001), and new design requirements to address storm water pollution.

In addition to implementing its SWMP, which would minimize water quality impacts from increased on-campus construction and operations, the Campus would also implement LRDP Mitigation HYD-3A to inform and educate the campus population on storm water impacts from increased erosion associated with unauthorized trail use.

#### Impact from Increased Impervious Surfaces

The existing storm water drainage system on campus consists primarily of a network of pipes and detention facilities discharging to four drainages and their tributaries – Jordan Gulch, Moore Creek, Cave Gulch, and the San Lorenzo River. The *Stormwater and Drainage Master Plan*, as summarized in Section 4.8.1.3, describes reaches within the watersheds on campus that are experiencing significant erosion (Kennedy/Jenks Consultants 2004). To avoid aggravating the erosion in campus creeks, in conjunction with new development, the Campus has been constructing detention basins designed primarily to detain water to reduce peak flows in the channels and release water at a slow rate. These basins also provide the additional benefit of settling out sediment before runoff reaches a creek or sinkhole.

However, the erosion and sedimentation problems have continued and to address them, the Campus proposes to implement the storm water drainage improvements included in the Infrastructure Improvements Project (see Chapter 2, Volume III). These improvements are focused on drainages with the worst erosion, i.e., Moore Creek and Jordan Gulch, and include measures to infiltrate and divert runoff and reduce storm water discharge to creek segments with erosion problems. In addition, some of the improvements would stabilize eroding beds and banks and improve the infiltration capacity of sinkholes. These improvements are expected to be implemented between 2006 and 2009, and are expected to stabilize creek channels and reduce the potential for erosion.

While the Infrastructure Improvements Project would implement several storm water drainage improvements in the major drainages on the campus specifically to address erosion and sedimentation, because new impervious surfaces under the 2005 LRDP would be developed during the same time that the Infrastructure Improvements Project is being implemented, additional runoff could be added to the drainages by new development which could trigger additional erosion in the drainages. Even in drainages where the erosion problems may have been addressed by the Infrastructure Improvements Project, runoff from new impervious surfaces could destabilize the channel. Therefore, the analysis below examines the potential for erosion and sedimentation associated with new impervious surfaces in each of the major watersheds on campus, regardless of the implementation of the Infrastructure Improvements Project.

The increase in impervious surfaces due to construction of paved areas (e.g., roads, pathways, and parking lots) and new buildings associated with the 2005 LRDP would increase the amount of surface runoff. Table D2-1 in Appendix D2 shows the estimated acreages of additional impervious surfaces anticipated to be added to each of the watersheds on the campus under the 2005 LRDP. Tables D2-3 and D2-4 in Appendix D2 show how the projected increase in impervious surfaces could affect the peak flow rate and total volume of runoff from the campus watersheds. These increased total and peak flows could trigger erosion as described below for each watershed on the campus, and the discharge of sediment into the receiving waters could adversely affect the beneficial uses of the campus creeks. As shown in Table 4.8-5, beneficial uses have been established in the Basin Plan for Cave Gulch, Moore Creek, and San Lorenzo River but not for Jordan Gulch.

Cave Gulch Watershed. In the Cave Gulch watershed, an estimated 54 acres of impervious surfaces would be added through development under the 2005 LRDP, which would increase the total impervious area in this watershed to 61 acres. For the 2-year storm that was analyzed in Appendix D2, this could result in increasing the total volume of runoff from 16 to 21 acre-feet (a 31 percent increase in runoff). For the 25-year storm event, the volume of runoff would increase from 239 to 254 acre-feet (a 6 percent increase in runoff). The Pump Station Tributary in the Cave Gulch watershed would be affected by the increased impervious surfaces associated with the connector road to Empire Grade Road and the campus support development. This channel contains existing erosion problems and certain improvements to control erosion in this tributary are included in the Infrastructure Improvements Project, which may stabilize this channel. These improvements are expected to be in place long before the connector road or the campus support development in Cave Gulch would be built. Therefore, it is possible that an increase in volume of runoff due to new impervious surfaces may not trigger substantial erosion in this channel. However, because the grades in this area are steep and the soils are erosive, the Campus will implementation LRDP Mitigation HYD-3B in conjunction with the construction of the new road, and LRDP Mitigations HYD-3C and HYD-3D for other development to avoid potential substantial erosion. While it would be possible to design and incorporate facilities to avoid an increase in peak flows from project sites in this watershed, it is uncertain whether the storm water management facilities could be included in the design of each project in this watershed to avoid or adequately minimize an increase in the volume of runoff discharged from the sites of new development. Therefore, significant new flows could be added to the drainages in the watershed which could result in substantial erosion. This EIR therefore conservatively concludes that even with mitigation, the impact would be significant.

Moore Creek Watershed. In the Moore Creek watershed, it was estimated that the impervious surfaces would increase by 50 acres by 2020 for a total of 115 acres with development projected under the 2005 LRDP. Based on the analysis results shown in Tables D2-3 and D2-4, this could potentially increase the total volume of runoff from a 2-year event from 14 to 19 acre-feet (an increase of about 36 percent in runoff). For the 25-year storm event, modeling results show the volume of runoff would increase from 172 to 187 acre-feet (an increase of about 9 percent in runoff). Even though a significant portion of storm water runoff is captured by sinkholes and the ponds formed by the Arboretum Dam, the East Dam, and the West Dam, there are existing erosion problems in the tributaries of Moore Creek that drain to these ponds. In order to avoid adding to the existing erosion conditions, the Campus would implement LRDP Mitigations HYD-3C and HYD-3D, which, for reasons discussed above would reduce the potential impact to water quality but not necessarily to a less-than-significant level.

Jordan Gulch. In the Jordan Gulch watershed, the estimated area of impervious surfaces would increase by 54 acres for a total of 145 acres. If it is assumed that the entire campus watershed contributes to runoff and that none of the water is lost to sinkholes, as was assumed for the analysis presented in Appendix D2, the volume of runoff from a 2-year storm event could increase from 19 acre-feet under existing conditions to 25 acre-feet with development projected under the 2005 LRDP (an increase of about 32 percent in runoff). The volume of runoff from the 25-year event was projected to increase from 236 to 251 acre-feet (an increase of about 6 percent in runoff). Even though channel conditions in the Jordan Gulch watershed were found to be better than in Moore Creek, there are several locations of accelerated channel incision and areas that need to be stabilized in order to prevent erosion upstream (Kennedy/Jenks 2004). Some of the specific storm water drainage improvements proposed as part of the Infrastructure Improvements Project (discussed in Volume III of this Draft EIR) such as measures to increase infiltration, would address problems found in the Jordan Gulch watershed. Once these measures are implemented, it is possible that the channels within Jordan Gulch watershed could support increases in peak flows or volumes without resulting in significant erosion. However, it is possible that new buildings and other impervious surfaces would be constructed within the watershed before the eroding channels are stabilized by the Infrastructure Improvements Project, and additional runoff generated by these surfaces could trigger substantial erosion. Therefore, in conjunction with every new development in the Jordan Gulch watershed, to avoid and minimize erosion impacts, the Campus would implement LRDP Mitigations HYD-3C and HYD-3D, and in conjunction with the construction of new roads, the Campus would implement LRDP Mitigation HYD-3B.

San Lorenzo-Pogonip Watershed. In the San Lorenzo-Pogonip watershed, an estimated 58 acres would be added to the existing impervious surfaces for a total of 100 acres. For the 2-year storm that was analyzed in Appendix D2, this could result in increasing the total volume of runoff from 15 to 21 acre-feet (an increase of about 40 percent). For the 25-year event, the total volume could increase from 244 to 263 acre-feet (an increase of about 8 percent). The San Lorenzo River watershed was listed by the CCRWQCB as impaired with respect to sediment, nutrients, and pathogens, and TMDLs have been developed for sediment and nitrate for the watershed. A TMDL for pathogens is currently being developed. Many of the gullies draining the San Lorenzo watershed, both on-and off-campus, also have existing erosion problems. The Campus has met with the City of Santa Cruz and Santa Cruz County representatives over the last several years in regards to addressing the erosion of the gullies in Pogonip.

The Campus, the City and the County agreed to share in the cost of repairs and remediation in the gullies adjacent to the campus boundary. Because the repairs and remediation projects have not been completed, an increase in runoff discharged into these gullies could result in a significant impact related to erosion and sedimentation. Therefore, in conjunction with every new development in the San Lorenzo-Pogonip watershed, to avoid and minimize water quality impacts, the Campus would implement LRDP Mitigations HYD-3C and HYD-3D. However, for reasons presented earlier, the impact may not be reduced to a less-than-significant level.

Other Watersheds. In the Arroyo Seco watershed, only a small area near Empire Grade Road would be developed as part of the 2005 LRDP. This would add approximately 1 more acre to the existing impervious area for an estimated total of 22 acres. As shown in Tables D2-3 and D2-4 in Appendix D2, this would not significantly affect the volume of runoff and thus would not result in substantial erosion or siltation, and the impact would be less than significant. Most of the High Street watershed on campus is already developed, and it was assumed that additional impervious surfaces would not be added as part of the 2005 LRDP. Therefore, the impact related to erosion or siltation would be less than significant.

The Kalkar Quarry watershed is mainly undeveloped, with an estimated 1 acre of impervious surfaces under existing conditions and an estimated 1 acre of development to be added under the 2005 LRDP. The increase in impervious surfaces would not significantly affect the volume of runoff and thus would not result in substantial erosion or siltation, and the impact would be less than significant. There is no existing or planned development on campus in the upper Wilder Creek watershed or the Moore Creek Western Tributary watershed. Therefore, there would not be any significant impacts to these watersheds due to campus development under the 2005 LRDP.

In summary, because of the existing problems in the four watersheds on campus, new development cannot increase flows in the channels without increasing the risk of erosion. Implementation of LRDP Mitigations HYD-3C and HYD-3D would require that every new capital project under the 2005 LRDP that would add new impervious surface shall include design measures to ensure that post-development peak storm water flows do not exceed pre-development peak storm water flows and design measures to maximize infiltration of runoff. The Campus has so far been successful in avoiding increases in peak flows from new development. Therefore, there is reasonable certainty that the Campus will be able to maintain peak flows from project sites at pre-development levels. However, it is uncertain whether the Campus will be successful in avoiding or minimizing an increase in the volume of site runoff for all future projects to the extent necessary to prevent substantial erosion. Therefore, this EIR conservatively concludes that even with mitigation, the impact related to erosion and sedimentation due to new development on the campus would be significant.

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| **LRDP Impact HYD-4:** | Campus development under the 2005 LRDP could alter drainage patterns in the project area and would increase the rate or amount of surface runoff, which could exceed the capacity of storm water drainage systems, resulting in flooding on or off site. |
| **Significance:** | Less than significant |
| **LRDP Mitigation:** | Mitigation not required |
| **Residual Significance:** | Not applicable |

As noted in Section 4.8.1.5, *Flooding,* historically flooding has occurred in the area of a few sinkholes on the campus and southwest of the campus where Moore Creek flows through a culvert under an off-campus private road, Highview Drive. The analysis below examines the potential for campus development under the 2005 LRDP to increase the risk of flooding at these and other locations on and off the campus.

As noted earlier, the campus storm water drainage system relies heavily on the discharge of storm runoff to the subsurface through sinkholes. Existing campus erosion problems have contributed to build-up of sediment in the sinkholes, which limits their capacity to infiltrate runoff and results in flooding. The *Stormwater and Drainage Master Plan* identified several sinkholes that are showing signs of having limited remaining capacity, which could increase the likelihood of spilling to downstream reaches and thus of flooding. The sinkholes that were identified included the Baskin Tributary Sinkhole, the Middle Fork Jordan Gulch Sinkhole, the McLaughlin Drive Sinkhole, and the Kresge Tributary Sinkhole. Three of these sinkholes overflowed during storms between December 2003 and February 2004, following a wetter than average month of December (Kennedy/Jenks Consultants 2004). As discussed above under LRDP Impact HYD-3, new development under the 2005 LRDP, by virtue of increasing peak flows and volumes in the creeks, could cause increased erosion and sedimentation and could thereby result in further siltation of sinkholes and increase the risk from flooding on the campus. However, because there are no facilities in the areas near these sinkholes that could be adversely affected by this flooding, the impact would be less than significant. Furthermore, by implementing LRDP Mitigation HYD-3C, the Campus would avoid any increases in peak flows and would also avoid or minimize an increase in the volume of runoff that is discharged off site. This will prevent flooding from occurring more frequently than under existing conditions.

With respect to flooding in the Moore Creek watershed near Highview Drive, the increase in impervious surfaces in the Moore Creek watershed would increase runoff. However, even without mitigation, much of the flow would be detained by dams within the watershed, which would limit peak flow rates. Since the East Dam does not have an outlet, it will discharge only if it is overtopped or if seepage occurs through the dam face. The dam was overtopped for a brief period in the major storm of 1982, and has overtopped a few times since then when the sinkhole behind the dam was clogged (Hall 2005). Flow from the West Dam is limited to the flow released by the 30-inch outlet pipe. Discharge from both the East and West Dam flows to the Arboretum Pond where, in most events, it is discharged through a 14-inch pipe. The Arboretum Pond has to fill with approximately 29 acre-feet before water is released through the 4-foot spillway pipe. It is only in very large storm events (such as the one in February 2000 which was determined to be a 20- to 40-year storm) that flows out of the Arboretum Pond would exceed the capacity of the 12-inch and 18-inch pipes that make up the culvert under Highview Drive. Because adequate storage capacity is available in the Arboretum Pond system, increased impervious surfaces in the Moore Creek watershed would not cause a significant impact related to flooding off campus. No mitigation is required.

**LRDP Impact HYD-5:** Campus development under the 2005 LRDP would not deplete groundwater supplies through pumping of groundwater for beneficial use, interfere with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level, or affect groundwater quality.

**Significance:** Less than significant

**LRDP Mitigation HYD-5A:** The Campus shall implement LRDP Mitigation HYD-3D.

**LRDP Mitigation HYD-5B:** For projects involving construction on karst, if: (a) groundwater is encountered beneath the building site during the geotechnical investigation, and (b) the proposed foundation type would require pressure grouting, the Campus will follow the procedures outlined below:

- Perform a dye tracing study to determine if there is a potential for pressure grouting to affect water quality in springs and seeps around the UC Santa Cruz campus. If a potential impact is indicated, alternative building foundation plans will be considered.
- As an alternative, the Campus may conduct a preliminary hydrogeological study to evaluate whether the groundwater zone encountered during the geotechnical investigation is hydraulically connected to the karst aquifer. If the hydrogeological study indicates that the groundwater zone is hydraulically independent of the karst aquifer, such that there is no potential for grout injected during construction to affect karst water quality, a dye tracing study need not be performed. If results of the hydrogeological study indicate hydraulic connectivity between the groundwater encountered beneath the site and the karst aquifer, the Campus shall conduct a dye tracing study as described above.

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| **LRDP Mitigation HYD-5C:** | If the existing or a new groundwater well is used the Campus shall perform monitoring of water levels within that well and any adjacent wells, and monitoring of those springs in the campus vicinity shown to be connected to the well with a dye tracing study or other applicable testing method for the duration of groundwater pumping to ascertain whether there is any long-term decline in water levels or spring discharge.<br><br>If monitoring of water levels and springs indicates that campus use of groundwater is contributing to a net deficit in aquifer volume, as indicated by a substantial decrease in average water levels in any monitored wells or a substantial reduction of flows in monitored springs, the Campus will terminate or reduce its use of groundwater from the aquifer. The average water levels and flows in springs will be defined through a statistical analysis of historic data, with consideration of associated seasonal rainfall and seasonal variations in spring discharge flow rates. |
| **Residual Significance:** | Less than significant |

Potential impacts on groundwater that could result under the 2005 LRDP include reduced spring flows and lowering of water levels in adjacent wells as a result of a reduction in recharge due to increased impervious surfaces, and as a result of groundwater extraction under drought conditions, in the event that LRDP Mitigation UTIL-9I is implemented to reduce demand for water from the City's water supply. The potential impacts of the 2005 LRDP on groundwater quality as affected by quality of surface runoff are discussed under LRDP Impacts HYD-2 and HYD-3. Other effects such as cave flooding from excess water discharged into the karst aquifer are discussed under LRDP Impact HYD-6.

As described earlier, the campus is divided into two distinct hydrogeologic systems. Impacts on groundwater volume, flow rate, and quality are discussed below separately for each of the two hydrogeologic systems.

#### Upper/North Campus

Since no groundwater extraction is planned for the upper/north campus aquifer, there would be no groundwater extraction-related effects on the upper/north campus seeps and springs or on seeps, springs, and domestic water supply wells in the Cave Gulch and Bonny Doon area.

As shown in Figure 4.6-4, all of the upper campus and the portion of north campus that is west of Empire Grade Road and the off-campus area of Cave Gulch is underlain by granitic rock. This bedrock is fractured in places and covered by a weathered granitic mantle. Groundwater in this area occurs in the weathered mantle as well in the deeper fractures. The remainder of the north campus, on the other hand, is underlain for by schist and is covered by a weathered schist mantle and discontinuous patches of Santa Margarita sandstone and marine terrace deposits. Groundwater in the north campus occurs in the weathered schist as well as in the sandstone. The shallow water-bearing zone in the weathered granitic rock may be hydraulically connected to the aquifer in the schist and Santa Margarita sandstone.

The only development in the upper campus proposed under the 2005 LRDP is a water tank. Out of the total north campus area of 450 acres (excluding the north campus area west of Empire Grade Road), the 2005 LRDP designates approximately 120 acres of land for new development and roadways. Conservatively assuming that impervious surfaces would cover approximately 70 percent of each of the development areas, and that 100 percent of the land under the new north campus loop road and the connector to Empire Grade Road would be impervious, about 85 acres of impervious surfaces would be added on the north campus. This acreage would represent 19 percent of the total north campus area (note that this is based on campus boundaries and is not intended to suggest that the hydrogeologic system underlying the north campus stops at the campus boundaries). These impervious areas would overlie the north campus aquifer. Infiltration of rainfall is a significant source of recharge of the shallow aquifer on the north campus. Although this shallow aquifer is not tapped as a water source on the campus, it does supply water to springs and seeps located throughout the north campus and in adjacent drainages such as Cave Gulch and Wilder Creek. Most of the springs and seeps would be outside the area where new development would occur (see Figure 4.8-4). However, flow in the springs and seeps could be substantially reduced as a result of the local reduction in infiltration.

Implementation of LRDP Mitigation HYD-5A would ensure that runoff from added impervious areas in the north campus would still be allowed to infiltrate and thereby recharge the local groundwater system. This would ensure that north campus springs, as well as springs that discharge in Wilder Creek, Cave Gulch, and Tunnel Gulch on the east and north, and seeps that discharge to the east into drainages of the San Lorenzo River would not be affected.

There are domestic wells (approximately 13 wells according to DWR well log) in the Cave Gulch area that draw water from the weathered granitic mantle or deeper fractures in the granitic bedrock. However, most of the campus development would be cross-gradient (and not up-gradient) from the Cave Gulch wells and would be separated from the Cave Gulch neighborhood by Cave Gulch, a deep channel that likely serves to separate the shallow aquifer in the granitic area from the shallow aquifer in the schist/sandstone area. The proposed Campus Support area adjacent to Empire Grade Road would be on the same side of Cave Gulch as the Cave Gulch wells but this area would be downgradient of the wells. Furthermore, with the implementation of LRDP Mitigation HYD-5A, infiltration of runoff on the north campus would be maximized, which would minimize potential impact on groundwater recharge. Therefore, the Cave Gulch wells would not be adversely affected.

#### Central/Lower Campus

Three types of activities under the 2005 LRDP could affect the groundwater aquifer in the central/lower campus. First, new impervious surfaces would be added which could alter the pattern of recharge of the karst aquifer. Second, construction of new buildings in the karst areas of the campus could require the use of pressure grouting to stabilize weak soils. Third, to offset campus water demand in drought years, as mitigation (LRDP Mitigation UTIL-9I), under drought conditions the Campus would draw groundwater for non-potable uses from the karst aquifer underlying the lower half of the campus. The combined effect of these activities could be to reduce groundwater levels in the aquifer and potentially affect down-gradient wells and springs. Each of these activities is examined below for its effect on the karst aquifer.

Impact Associated with New Impervious Surfaces. Table D2-1 in Appendix D2 shows the estimated increase in impervious surfaces in all watersheds on the campus. Campus watersheds that overlie the karst aquifer include Moore Creek, Jordan Gulch, and portions of the San Lorenzo-Pogonip Watershed. Approximately 104 acres of new impervious surfaces would be added to the Moore Creek and Jordan Gulch watersheds, an increase of approximately 67 percent over current conditions.[9] Although this increase in impervious surfaces would be substantial, for most part it would not significantly reduce recharge of the karst aquifer. Storm water runoff in the Jordan Gulch watershed does not leave the campus by way of surface runoff and is intercepted by the karst sinkholes. Therefore, even if the runoff increased with new impervious surfaces, it would still enter the karst system by way of sinkholes and swallow holes. In the case of the Moore Creek watershed, it is possible that in the event that the sinkholes get filled with sediment and are no longer able to infiltrate the runoff, the runoff from new campus impervious surfaces would no longer enter the karst system and would instead leave the campus as stream discharge. Therefore, some reduction in karst aquifer recharge could occur under those circumstances. However, as discussed under LRDP Impact HYD-3, to avoid erosion problems in these watersheds, the Campus would implement LRDP Mitigation HYD-3C that would reduce erosion and sedimentation of sinkholes and the drainage system would continue to handle the runoff from the campus, and runoff would continue to recharge the karst aquifer. Furthermore, the Campus would implement LRDP Mitigation HYD-3D to maximize infiltration of runoff near the sites where new runoff is generated. These measures would further reduce the less-than-significant impact from new impervious surfaces on groundwater recharge on the central/lower campus. As borne out by the data in Table 4.8-4, even though impervious surfaces have increased with development on the campus, there has been no noticeable reduction in the flows of springs that are down-gradient of the campus.

Impact Associated with Pressure Grouting Program. As discussed in Section 4.8.1.6, *Campus Groundwater Resources*, the Campus uses pressure grouting to densify and stabilize soft soils (associated with dolines) that may be present under a building site by injecting very stiff cement grout into the soil. In the past, the Campus has conducted dye tracing studies to determine if specific building sites are linked hydrologically to the springs and wells in the karst system and whether the placement of grout could affect groundwater quality or flow rates at springs around the campus. Dye injected at these building sites on the central campus was not detected at any of the off-campus monitoring points within each of the 18-week study periods, indicating that there are no rapid flow paths capable of moving water, grout or other fluid from the dye injection sites to off campus springs. Grouting is done close to the ground surface, and has not be done at or below the water table. The grout that is pumped is extremely stiff and does not flow without high pumping pressures. Because grout is expensive to place, extreme care is taken not to pump excessive amounts of grout into bedrock voids and crevices. Pressure readings are taken during the grouting procedure to confirm that grout is not entering into the marble but into the soil. If the pocket of soft soil being grouted is large, sometimes grouting is stopped for a day or two to allow the grout to harden, thus further ensuring that grout is not lost to voids. Typical grout volumes for a building project

[9] Note that this is the total increase in these watersheds and not just the increase in those portions of the watersheds that overlie the karst aquifer. As shown in Figure 4.8-1, the upper portions of both watersheds lie in the north campus, which is not underlain by karst.

are in the range of a few hundred or a few thousand cubic yards (UC Santa Cruz 2005). Because of all these precautions, the pressure grouting program that the Campus has been using has not resulted in impacts to water flow or quality.

Campus development in the central campus under the 2005 LRDP could require the use of pressure grouting to stabilize the building sites in some locations. If grout were to be placed where groundwater is present, the program could potentially result in effects on the quality of the groundwater. To ensure that a significant impact to groundwater quality is avoided, for new buildings that are proposed for construction in karst areas under the 2005 LRDP, the Campus would implement LRDP Mitigation HYD-5B. This will ensure that the building sites are evaluated on a case-by-case basis and foundations are designed and built to minimize potential impact.

Impact Associated with Extraction of Groundwater. The City of Santa Cruz supplies water for potable and non-potable uses to the Campus. The City is examining options to increase the supply of water in order to address the current problem of water shortage during drought conditions and to plan for future growth. To reduce the campus's demand for water from the City's supply system, pursuant to LRDP Mitigation UTIL-9I, during drought years the Campus will operate an existing well (WSW #1 also known as Well #3) located in Jordan Gulch below the Lower Quarry to draw water for non-potable uses, principally irrigation. For purposes of evaluation in this EIR, it is assumed that the water would be extracted during the 8 driest months and would be used for irrigation on the CASFS and the Arboretum. Based on campus irrigation water usage data, it is estimated that over a period of 8 months a total of 1.1 million gallons (3.38 acre-feet) of water would be extracted, and the maximum pumping rate would be 100 gpm for 16 hours per day, although water would not be pumped at this rate throughout the 8-month period.

As discussed in Section 4.8.1.6, a number of exploratory borings and monitoring wells have been drilled on the lower campus in the past. The pumping tests conducted at WSW #1 show minimal drawdown in the pumping well and nearby monitoring wells with no effects on the flows in surrounding springs. The calculated radius of influence (i.e., cone of depressed groundwater levels in response to pumping) after pumping WSW #1 at 100 gpm for seven days was 300 feet. Maximum drawdown was 2.7 feet in WSW #1 and 1.38 feet in Well #1, which was located 40 feet away. These results indicate that pumping of WSW #1 at 100 gpm would have little to no effect on off-campus springs and wells.

The withdrawal of a total volume of 3.38 acre-feet would also have little or no effect on the karst aquifer. The estimated combined annual average recharge for the watershed areas supplying the on-campus karst aquifer is summarized in Table 4.8-1. The watershed area directly or indirectly recharging the on-campus karst aquifer consists of approximately 2,394 acres, of which approximately 672 acres are off-campus. The estimated annual average precipitation and evapo-transpiration are 38 inches and 19.7 inches, respectively (Johnson and Weber/Hayes 1989). Runoff percentage is estimated for each watershed based on modeling for a 2-year storm event (Table D2-1), with a combined annual average of 6.5 inches. The estimated mean annual recharge for the on-campus karst aquifer under current conditions is approximately 11.8 inches, or 3,073 acre-feet per year. Of this total, based on historic spring and stream discharge data (which is summarized in Table 4.8-4), approximately 1,624 acre-feet per year is surface discharge, including spring flow and groundwater-fed surface stream base flow. By subtracting the groundwater discharge from recharge, the groundwater budget yields a surplus of approximately 1,449 acre-feet per year, which must leave the campus area as subsurface outflow. Additionally, the groundwater storage capacity within void spaces in the karst aquifer is estimated to be at least 3,000 acre-feet (Johnson and Weber Associates 1989; Gilchrist and Associates 1990). The water that would be extracted would represent a small fraction of the total volume of groundwater in the karst aquifer.

In summary, geologic and hydrogeologic analyses of the limestone marble karst aquifer system indicates that the storage and yield are large enough that it could be used for water supply during drought years without significant impacts. The impact from groundwater extraction during drought conditions would be less than significant. Implementation of LRDP Mitigation HYD-5C would ensure that any long-term pumping from the aquifer would not result in a net deficit in aquifer volume or a significant reduction in spring discharge.

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| **LRDP Impact HYD-6:** | Implementation of the 2005 LRDP would alter drainage patterns on the campus, increase the rate and amount of surface runoff, potentially affect the quality of runoff, and therefore could cause flooding and water quality impacts in caves on or off site. |
| **Significance:** | Potentially significant |
| **LRDP Mitigation HYD-6:** | The Campus shall implement LRDP Mitigations HYD-3C and 3D. |
| **Residual Significance:** | Less than significant |

Caverns are commonly encountered in karst topography. While some caverns are entirely underground, some are caves with entrances or openings in the walls of creek canyons. Similar to other karst features, these are produced by the solution action of groundwater in areas where the limestone or marble is fractured. Although no caves are known to be present in Jordan Gulch or Moore Creek at this time, several caves are present in the Cave Gulch and Wilder Creek canyons. Caves in Cave Gulch canyon include Empire Cave, which is on campus to the south-west of Kresge College, Stump and Dolloff Caves which are off campus just south of Empire Cave, and Bat Cave and IXL Cave, both of which are off campus and to the south-west of the campus's western entrance. Dolloff Cave is located on a tributary of Cave Gulch, whereas the other four are within Cave Gulch. Empire Cave is located close to about 50 feet above the base of the channel of Cave Gulch. Empire Cave and Dolloff Cave periodically flood during the rainy season as a result of flow in surface and subterranean streams. Empire Cave and Bat Cave are located on the eastern wall of the canyon whereas the other three caves are on the western wall.

As discussed previously, a significant portion of stormwater runoff on the UC Santa Cruz campus is captured by sinkholes, and transmitted within the subsurface karst aquifer by an extensive network of bedrock fractures. The manner in which water travels within the karst aquifer is not fully understood and therefore a direct link between a cave and any on-campus area cannot be assumed. However, based on site topography and the locations of Empire Cave and Bat Cave on the eastern wall of Cave Gulch, it is considered likely that some or all of the water that drains through these caves has its origin on the campus. Because Stump, Dolloff, and IXL caves are located on the western wall of Cave Gulch, these caves do not discharge water from the campus.

An increase in surface runoff due to increased impervious surfaces could increase the quantity of water that drains into sinkholes and enters the karst system, and therefore could potentially cause flooding of Empire and Bat Caves.[10] However, the Campus would implement LRDP Mitigation HYD-3C which would ensure that post-development peak flows do not exceed pre-development peak flows from a 25-year storm, and LRDP Mitigation HYD-3D which would maximize infiltration. As a result, peak flows would generally remain at the same levels as under existing conditions, and because infiltration of runoff would occur adjacent to the new impervious surfaces, the general pattern of infiltration would not be significantly affected. In light of these measures, water levels in these caves may not increase. To the extent that there is periodic flooding and water levels in the caves are somewhat higher than under existing conditions, this would not adversely affect the caves. The caves are not used for any purpose other than by students for recreation and by some campus scientists to study cave invertebrates and salamanders. The recreational use of caves by students is not appropriate and is discouraged by the Campus. The periodic flooding of the caves would not substantially reduce the opportunities for scientists to study the caves. As discussed below, the caves are occupied by certain special-status insects. However, the periodic flooding would be within the range of the natural fluctuation in water levels that results from large storms.

Changes to the quality of water in the caves are a concern for cave invertebrate species that are known from the Cave Gulch caves. Santa Cruz telemid spider, Dolloff Cave spider, Empire Cave pseudoscorpion, and MacKenzie's cave amphipod are special-status insects that are known to occur in Empire Cave, and the Dolloff Cave spider is also known to occur in the nearby Dolloff Cave. As discussed above under LRDP Impacts HYD-2 and HYD-3, increased human activity on the campus could result in changes in the quality of storm water runoff. Because Dolloff Cave is to the west of Cave Gulch, groundwater from the campus development areas would not affect that cave. Campus development generally upgradient of the Empire Cave would include student and employee housing areas and the campus support area on Empire Grade Road. The campus support area is underlain by granitic rock rather than marble. Therefore, urban runoff from that site would not enter Empire Cave through infiltration into the karst system. However, runoff that does not infiltrate would drain to Cave Gulch and, to the extent that flows in the cave derive from surface flows in that drainage, could enter the cave. On account of the largely residential uses that would be in karst areas upgradient of Empire Cave, the runoff that could potentially enter this cave via the karst system is unlikely to be highly polluted. Bat Cave is located high on the wall of Cave Gulch so it would not be affected by surface flows in Cave Gulch. However, this cave is on the east side of Cave Gulch, adjacent to the lower campus, so runoff from the western portion of the central campus could potentially enter this cave via the karst system.

The monitoring data shows that campus development has not resulted in an increase in urban runoff pollutants, and because storm water management requirements would increase over the LRDP horizon, runoff water quality would not decrease. With the Phase II NPDES requirements, the Campus will be required to implement a rigorous program to avoid water quality impacts. Furthermore, the Campus will implement LRDP Mitigations HYD-3C and HYD-3D that are in addition to the requirements of the

[10] Note that even under existing conditions, most of the rain that falls on the campus ends up in the karst aquifer; however there is some water that is lost via evapotranspiration. If more areas are placed under impervious surfaces, the rain that falls on these impervious surfaces would become runoff that will end up as additional discharge in the karst aquifer.

campus's draft SWMP. With this increased effort, the quality of runoff that drains through these caves should not degrade, and the impact would be less than significant.

### 4.8.2.5 Cumulative Impacts and Mitigation Measures

The cumulative context for the evaluation of hydrology and water quality impacts includes campus development proposed under the 2005 LRDP in combination with existing development and anticipated development in Santa Cruz County that has the potential to impact the Moore Creek, Wilder Creek, Jordan Gulch, and San Lorenzo River watersheds or the underlying groundwater aquifers.

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| **LRDP Impact HYD-7:** | Campus development under the 2005 LRDP, in conjunction with other development in the region, would increase impervious surface coverage in the study area watersheds and increase storm water runoff, but would not result in substantial sources of runoff in off-campus watersheds, and therefore would not have a substantial adverse effect on receiving water quality. |
| **Significance:** | Less than significant |
| **LRDP Mitigation:** | Mitigation not required |
| **Residual Significance:** | Not applicable |

Urban development within the study area watersheds would increase impervious areas and consequently increase storm water runoff. This increased runoff could potentially aggravate erosion and sedimentation problems within some of the watersheds. Increased urbanization could increase the amount of urban pollutants that are discharged into the creeks and the Monterey Bay. On-going construction activities could also release sediment and other pollutants into the waterways. Discharge of urban pollutants and sediment could adversely affect water quality and the beneficial uses of the creeks, downstream ponds and lagoons, and the Bay. The cumulative impact on water quality from campus development in conjunction with existing development and other future development is discussed below by watershed.

#### Wilder Creek Watershed

The Wilder Creek watershed, which includes Cave Gulch, a tributary of Wilder Creek, is large (about 74,000 acres) and for the most part is undeveloped. The few areas with existing development include the Cave Gulch rural residential area on Empire Grade Road and a few westerly areas of the campus. The Cave Gulch portion of the watershed contains some areas with a high potential for erosion. With respect to the 2005 LRDP, although no new campus facilities are planned for the Wilder Creek watershed in the upper campus, some new facilities are proposed in the Cave Gulch subwatershed. Therefore, there would be an increase in impervious surfaces within the Wilder Creek watershed on campus that would generate additional urban runoff. With respect to other urban development within this watershed, not much growth is envisioned because a large portion of the watershed is within the Wilder Ranch State Park and is protected from development. The one unincorporated community within this watershed is Cave Gulch which is zoned rural residential and is not projected to expand in the foreseeable future. Thus, little urbanization is likely to occur within this watershed. Furthermore, in compliance with NPDES Phase II requirements, the Campus will implement the Campus SWMP as well as mitigation measures included in this EIR. Although development under the 2005 LRDP could have a significant and unavoidable impact relative to erosion in the Cave Gulch subwatershed, there would be little to no other development in the Wilder Creek watershed. Therefore, the cumulative impact on water quality in this watershed would be less than significant.

#### Moore Creek Watershed

As described earlier, Moore Creek has its headwaters on the north campus. It drains to the south through the central and western portions of the campus and continues south through the upper west side neighborhoods, passes under Highway 1 and then down to Antonelli Pond and Monterey Bay at Natural Bridges State Beach. Most of this watershed has a high to very high erosion potential. On the campus, the upper portions of this watershed are developed with campus facilities. In the lower campus, the watershed is largely undeveloped. South of the campus, between Empire Grade Road and Highway 1, residential uses are present on the eastern side of the watershed whereas the western side is largely undeveloped. South of Highway 1 (lower Moore Creek), the watershed is partially developed with industrial and residential uses. The 2300 Delaware Avenue property is also located within the lower Moore Creek watershed.

As noted earlier, a fair amount of new campus development is proposed for this watershed under the 2005 LRDP. To mitigate for the significant increase in erosion that could result from the additional runoff from the new development, all new development would be required to maximize infiltration of runoff which would minimize the increase in the volume of runoff to Moore Creek. However, the impact on campus drainages is considered significant and unavoidable. Sediment in Moore Creek above the Arboretum dam is contained on campus below the East, West and Arboretum dams, and therefore would not contribute to a cumulative impact of sediment on Moore Creek downstream of the dams. There is a small area of the campus that discharges to Moore Creek below the Arboretum dam. There would be only minor development in that area under the 2005 LRDP, related to ongoing activities of the Arboretum, so development under the 2005 LRDP would not exacerbate erosion conditions below the Arboretum dam. The Infrastructure Improvements Project would also improve existing conditions by addressing specific erosion sites within this watershed on the campus, including erosion on campus below the Arboretum dam. No new impervious surfaces would be created on the 2300 Delaware Avenue property. Therefore, development under 2005 LRDP would not result in any contributions to increases in sedimentation in lower Moore Creek.

With respect to other development within this watershed, much of the developable land within the city limits is already developed, with only few undeveloped parcels remaining. According to the 1994 City General Plan Land Use Element, the City envisions that not much new development would occur in the portion of the watershed between Empire Grade Road and Highway 1. In the area between Highway 1 and Delaware Avenue, there would potentially be more industrial infill and intensification. The plan also identifies the same area as a potential redevelopment area. Because there is still substantial underutilized land in the west side of the city, it is reasonable to assume that over the next 15 years the City will continue to consider this area for infill and redevelopment at a higher density. As a result, human activity in the lower Moore Creek watershed would increase and would result in an increase in urban runoff pollutants.

As part of its General Plan, the City has adopted the Moore Creek Corridor Access and Management Plan. The purpose of the plan is to ensure public access to the Moore Creek corridor and to manage existing and new development within the plan area so as to reduce soil erosion, sedimentation and vegetation removal, and to protect and improve water quality. Two of the key policies in the plan (MC 1.3 and 1.4) focus on maintaining the water quality of Moore Creek at the highest level feasible by regulating the discharge of storm waters into the creek and its tributaries, by requiring detention and retention of post-development runoff, use of sediment and grease traps, regular street sweeping, equipping outfalls with energy dissipators, and controlling construction-phase erosion and sedimentation. All future development projects within the watershed would be required to comply with the plan. Furthermore, it is reasonable to expect that the City will comply with its NPDES permit requirements and that all future projects in the watershed would be subject to NPDES Phase II regulations, which require that source control and nonpoint source BMPs be employed to control potential effects on water quality and that storm water quality control devices be incorporated into storm water collection systems to collect sediment and other pollutants. Therefore, the cumulative impact on water quality in the Moore Creek watershed would be less than significant.

### Jordan Gulch Watershed

Jordan Gulch originates in the north campus, flows through the central and lower portions of the campus to end in a sinkhole near the campus entrance. South of the entrance, it emerges as a surface stream in the median of Bay Street for a short stretch between Iowa and Escalona streets and then enters a culvert which eventually discharges into Neary Lagoon in the south-central portion of Santa Cruz. On campus, the upper portion of the watershed is developed but most of the lower portion is undeveloped. South of the campus, the watershed is almost entirely developed, mainly with residential uses between High Street and Mission Street (Highway 1) and mixed residential/commercial uses south of Mission Street.

Runoff from most of the developed areas of campus within the Jordan Gulch watershed enters the subsurface through sinkholes and swallow holes above Glenn Coolidge Drive. Therefore, sediment from the upper portions of Jordan Gulch would not contributed to any cumulative sediment impact. A portion of the campus runoff that enters the karst aquifer in Jordan Gulch does, however, emerge in springs and seeps off-campus, so pollutants in campus runoff could contribute to cumulative water quality impacts. Although on campus, new development under the 2005 LRDP would be located in this watershed, not much new development would occur off campus as the watershed is already largely developed. Therefore, cumulative impacts to water quality in this watershed would relate mainly to increase in discharge of urban pollutants as the traffic and urban activities in the area increase. Because both the Campus and the City of Santa Cruz would implement storm water management plans to control nonpoint source pollution and to comply with NPDES Phase II regulations, the quality of runoff from the watershed should improve over current conditions. The cumulative impact would be less than significant

### San Lorenzo River Watershed

The gullies along the eastern edge of the campus drain to the east into Henry Cowell State Park and the Pogonip City Park and eventually the runoff discharges into San Lorenzo River which traverses the central portions of the City of Santa Cruz and discharges into Monterey Bay. The San Lorenzo River has been listed on the Federal CWA 303(d) list as impaired due to sediment, nutrients, and pathogens. Runoff from the campus has contributed to existing erosion conditions in drainages in the Pogonip City Park. The upper portion of the watershed is largely undeveloped while the central and lower portions of the Pogonip-San Lorenzo watershed are highly developed. The upper portion includes areas with steep slopes (slopes greater than 30 percent) and erosive soils and therefore has a high potential for erosion.

Very few new campus facilities would be built within the campus portion of the San Lorenzo River watershed under the 2005 LRDP. Additional playing fields would be added in the area of the East Field House. A limited amount of infill housing is anticipated to occur within the watershed. North of Crown College, additional student housing and academic core facilities would be built. Most of the portion of the watershed adjacent to the campus is a designated greenbelt (the Pogonip City Park) where no new development would be allowed by the City. In the lower portion of the watershed, especially in the Harvey West area, according to the City General Plan some infill and intensification of industrial land uses could potentially occur. The General Plan also identifies the Harvey West area as a redevelopment area along with large portions of downtown Santa Cruz.

Campus development in this drainage could have a significant impact by increasing runoff that could cause substantial erosion. Cumulative impacts to water quality in the San Lorenzo watershed would relate mainly to increase in discharge of urban pollutants as the population, level of development and urban activities in the area increase. Because the City of Santa Cruz and the Campus would implement storm water management plans to control nonpoint source pollution and to comply with NPDES Phase II regulations and the TMDL for sediment and nitrates in the San Lorenzo River watershed, the quality of runoff from the watershed should improve over current conditions. However, because of the existing water quality problems in the San Lorenzo River, the cumulative impact of development on water quality in the watershed would be significant. Under the 2005 LRDP, the Campus could develop 58 acres within the San Lorenzo River watershed. This would be a very small fraction of the 74,000 acre watershed. Furthermore, the Campus would implement LRDP Mitigation HYD-2A and 2B, and LRDP Mitigation HYD-3A through HYD-3D to minimize water quality impacts. Therefore, the contribution of development under the 2005 LRDP to this cumulative impact would not be cumulatively considerable.

#### Other Watersheds

Runoff from the southeastern portion of the campus discharges to the High Street and the Kalkar Quarry watersheds (which are subareas of the Neary Lagoon watershed), and runoff from a small area in the southwestern portion of the campus drains into Arroyo Seco. All of these drainages enter the City's storm sewer system and drain either to the ocean or to Neary Lagoon. Very limited land development is proposed on campus in these watersheds and only infill development would occur within the city in these watersheds. The cumulative impact on water quality would relate primarily to increased population and activity. Because the City and the Campus in compliance with their storm water management plans would implement BMPs to reduce discharge of pollutants into storm water, the quality of runoff should improve over current conditions. The cumulative impact would be less than significant.

In summary, campus development under the 2005 LRDP could result in erosion and sedimentation in drainages on-campus and in the immediate vicinity. However, this would not constitute a cumulatively considerable impact to a significant cumulative impact in any of the regional watersheds. Efforts at the state, county and city level to control and reduce pollutants in storm water will offset and eventually reduce the overall cumulative contribution to water quality degradation of the ocean and Bay resulting from the cumulative development in the region. In response to the statewide NPDES General Permit for Phase II municipalities, agencies designated by the State Water Resources Control Board are mandated to implement specific types of urban runoff pollutant control measures. The City of Santa Cruz would be expected to comply with its NPDES requirements to initiate programs to reduce storm water pollutants, improve storm water system maintenance, and provide educational activities to individuals, businesses and agencies that impact storm water. The City of Santa Cruz has adopted a Storm Water Ordinance establishing standards for reducing pollutants in storm water. It is also currently developing and implementing best management practices for specific areas such as retail, industrial, and construction activities. Similarly, the Campus has developed a SWMP to reduce pollutants in campus runoff to the maximum extent practicable. In combination, these storm water management programs will reduce storm water pollution and the cumulative impact on water quality would be less than significant.

| | |
|---|---|
| **LRDP Impact HYD-8:** | Groundwater extraction by the Campus during drought periods would not contribute to a net deficit in the regional aquifer volume or a lowering of the local groundwater table. |
| **Significance:** | Less than significant |
| **LRDP Mitigation:** | Mitigation not required |
| **Residual Significance:** | Not applicable |

The main source of groundwater in the Santa Cruz area is the Purisima formation, which is used by the City, other water districts, and private wells. According to its' Integrated Water Plan (IWP), the City plans to withdraw groundwater from its Live Oak wells at the rate of about 187 million gallons a year (MGY), which would be about 20 mgy higher than the average production from these wells in the last four years. The City has analyzed the effect of this pumping on groundwater overdraft, well interference, stream flow and surface water depletion, and ground subsidence and determined that the project-level impacts would be less than significant. The City has also evaluated the cumulative impact on the aquifer from withdrawal of groundwater and determined that the cumulative impact on groundwater storage and saltwater intrusion would be significant (City of Santa Cruz 2005). The Campus would not draw water from the Purisima formation and would.

The other water-bearing formation in the region is the Santa Margarita sandstone in which several private wells are installed, especially in Ben Lomond Mountain region, and some water is also extracted from groundwater present in weathered and fractured granitic rocks such as those in the Cave Gulch area. As described in LRDP Impact HYD-5, the Campus would not extract water from the limited patches of Santa Margarita sandstone that occur on the upper/north campus, and the Campus may draw a limited amount of water from the karst aquifer during drought years. The campus karst aquifer is not hydrologically linked to the Purisima formation, nor is it hydrologically linked to the occurrences of Santa Margarita sandstone on Ben Lomond Mountain or the weathered granitic rock in Cave Gulch that are at higher elevations than the campus karst area. Furthermore, at the contact between the upper/north campus schist and the karst marble on the campus, there is a precipitous drop in water table. Therefore, groundwater extraction on the central/lower campus would not lower the groundwater in these other aquifers. There would not be a cumulative impact related to groundwater withdrawal. For discussion of cumulative impacts of growth under the proposed 2005 LRDP on regional water supply, see LRDP Impact UTIL-9.

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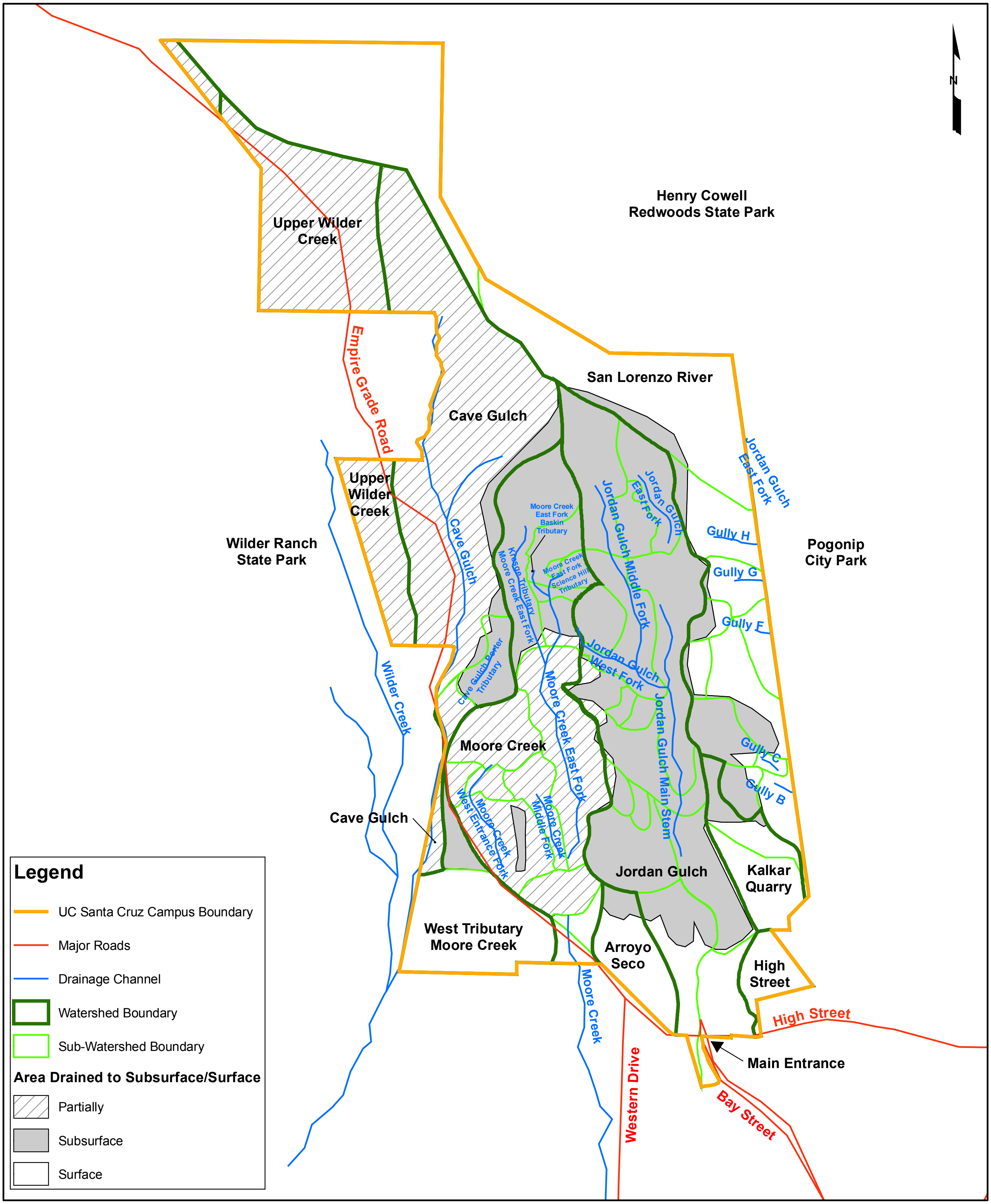


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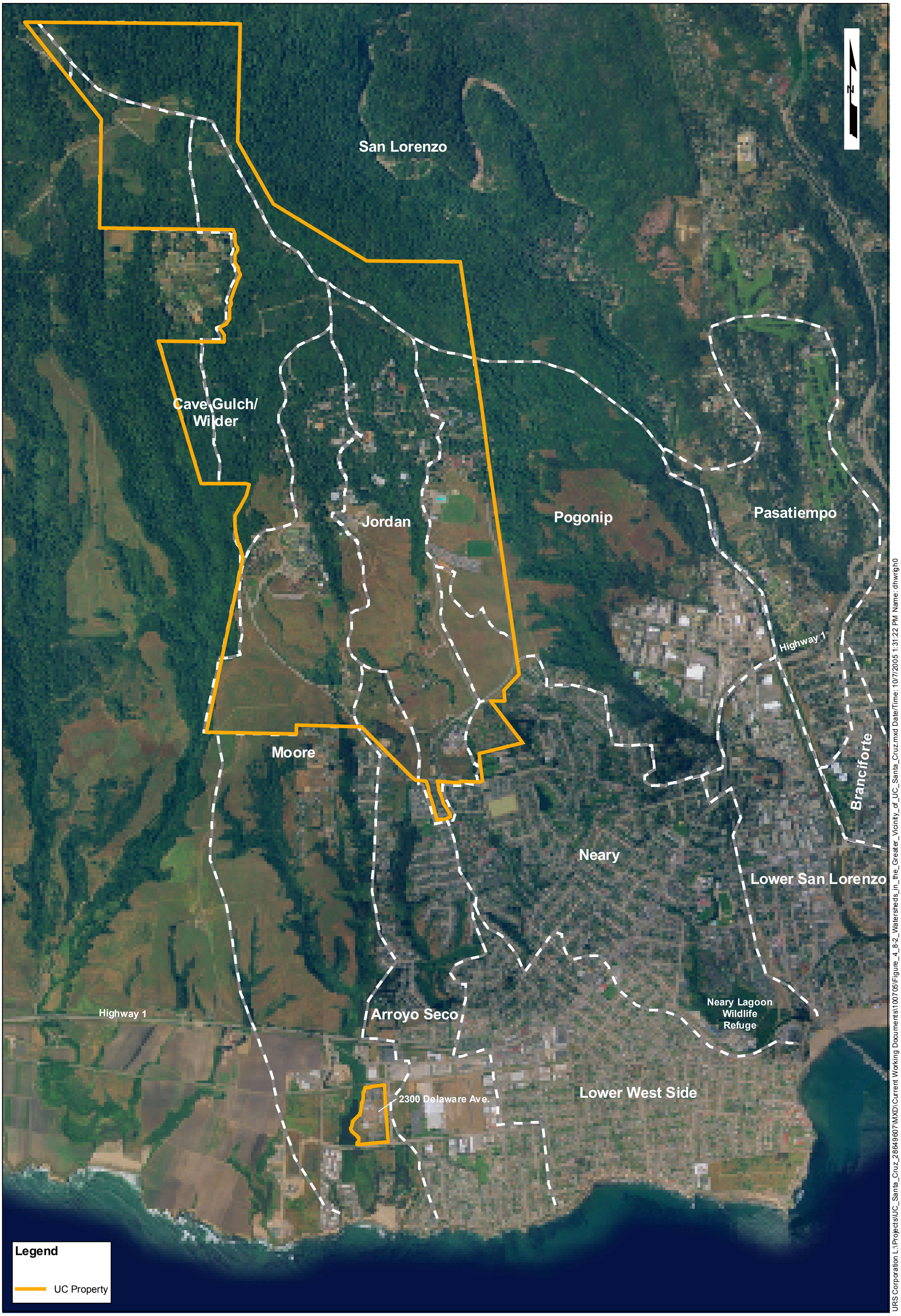
**WATERSHEDS AND SUB-BASINS ON UC SANTA CRUZ CAMPUS**

October 2005
28649607

UC Santa Cruz LRDP EIR
Santa Cruz, California

URS

FIGURE 4.8-1

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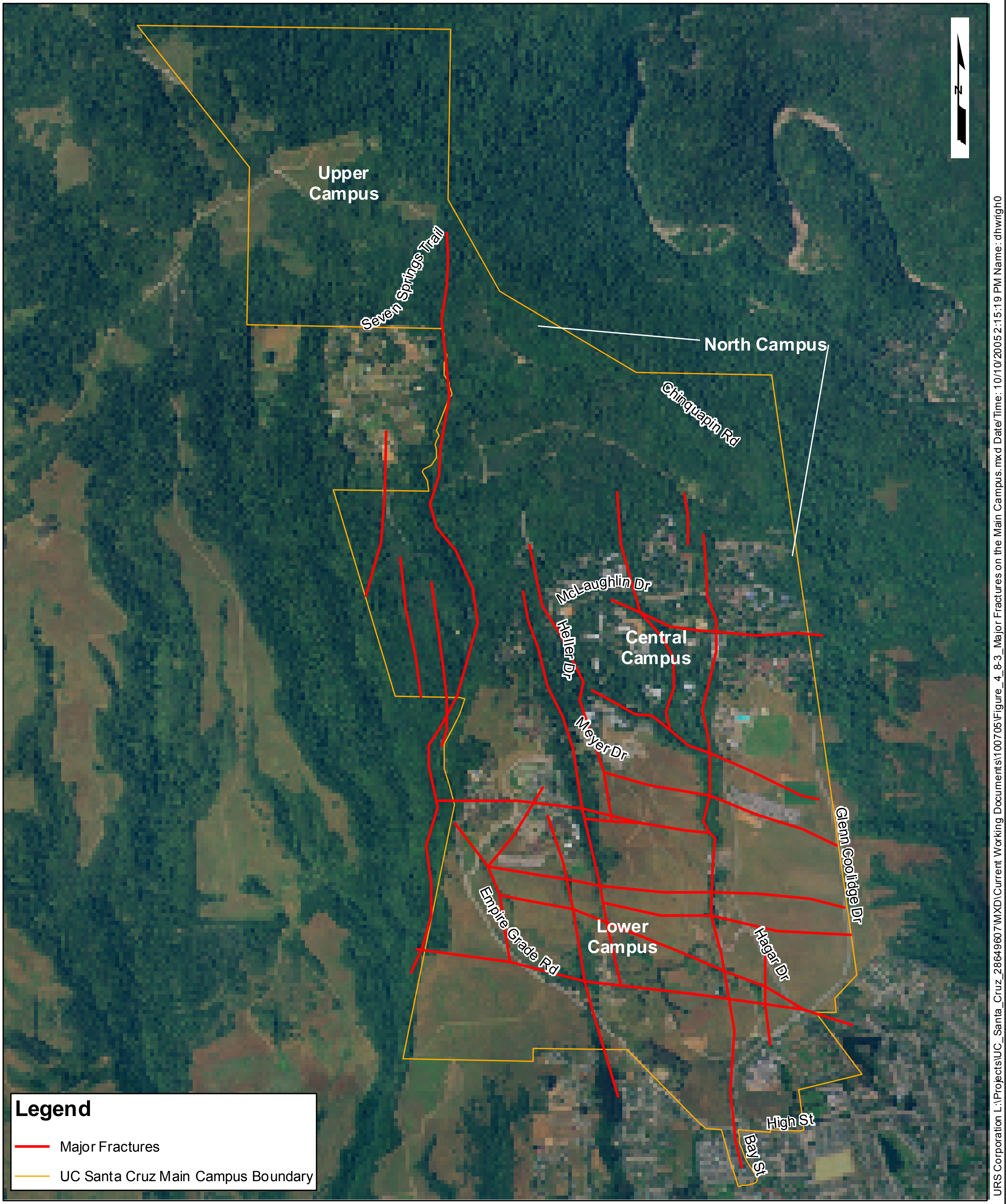
**WATERSHEDS IN THE GREATER VICINITY OF UC SANTA CRUZ CAMPUS**

October 2005
28649607

UC Santa Cruz LRDP EIR
Santa Cruz, California

URS

FIGURE 4.8-2




Data Source: John Gilchrist and Associates (July 1990)

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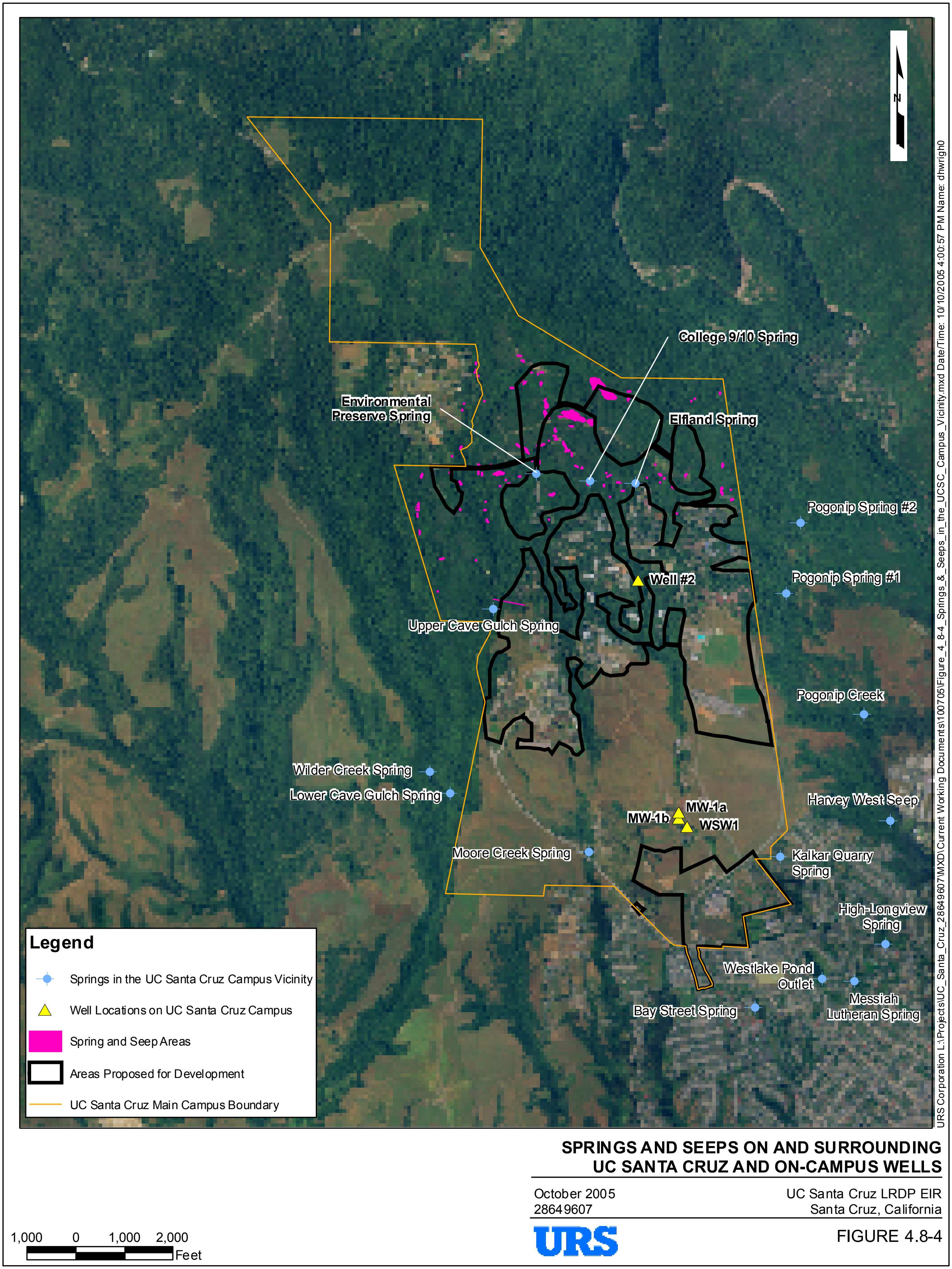
**MAJOR FRACTURES ON THE MAIN CAMPUS**

October 2005
28649607

UC Santa Cruz LRDP EIR
Santa Cruz, California

URS

FIGURE 4.8-3

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**SPRINGS AND SEEPS ON AND SURROUNDING UC SANTA CRUZ AND ON-CAMPUS WELLS**

October 2005
28649607

UC Santa Cruz LRDP EIR
Santa Cruz, California

URS

FIGURE 4.8-4