TABLES

FIGURES

CHAPTER 2

Infrastructure Improvements Project

2.1 INTRODUCTION

The proposed Infrastructure Improvements Project consists of a series of improvements to the campus utilities, including storm water drainage, domestic/fire water, cooling water, heating water, electrical, and natural gas systems, to address existing deficiencies and capacity problems. This section of the EIR describes the proposed project in detail and assesses the environmental impacts that could potentially result from its implementation.

2.2 PROJECT SUMMARY

2.2.1 Project Description

UC Santa Cruz proposes to implement a series of improvements to the utilities and infrastructure on campus, primarily to address problems and deficiencies in the existing systems. These improvements would be implemented in two phases. Construction of the Phase 1 Infrastructure Improvements would begin in the summer of 2006 and would be completed in about January 2008. Construction of the Phase 2 Infrastructure Improvements would begin in the summer of 2007 and would be completed in approximately February 2009. With the exception of cooling water system improvements, all of these improvements would address existing deficiencies and problems and would not result in additional capacity to serve the growth under the 2005 LRDP. Other capacity improvements to serve future campus growth are described in Section 3 of Volume 1. The Infrastructure Improvements Project includes the following improvements:

Storm Water Drainage System Improvements. To address existing flooding and erosion problems, the campus would construct improvements at approximately 94 locations. Work would occur during both Phase 1 and Phase 2.

Domestic/Fire Protection Water System Improvements. To address deficiencies in the domestic/fire protection water system and improve its reliability under fire flow conditions, the project would add or replace sections of pipeline, and add or replace pressure-reducing valves. Work would occur during Phase 1.

Campus Core Cooling Water System Improvements. To address the projected need for more cooling water on the campus, the project would add a new multi-cell cooling tower to the campus core cooling water system and install short new pipeline segments. Work would occur during Phase 1.

Campus Core Heating Water System Improvements. To address inefficiencies in the campus core heating water system, improvements to the campus core heating water system would be implemented. These would include replacement of low-temperature–rated piping in the campus core and small sections of piping in the Theater Arts Complex, and modifications to the Sinsheimer Laboratories heating and cooling system to absorb excess heat from the cogeneration system and allow it to function more effectively. Work would occur during Phase 2.

Electrical System Improvements. Improvements to the campus electrical system would consist primarily of switch replacements. Work would occur during Phase 2.

Natural Gas System Improvements. Problems of inadequate pressure in the natural gas distribution system to the upper portion of the campus core would be addressed by piping upgrades, and one pressure-reducing station in the central campus would be upgraded. Work would occur during Phase 2.

Table 2-1, below, presents a summary of the environmental impacts resulting from the proposed Infrastructure Improvements Project. The table has been organized to correspond with the environmental issues discussed in Section 2.4, *Environmental Setting, Impacts, and Mitigation Measures*, below, and is arranged in four columns: (1) the identified impact under each EIR issue area, (2) the level of significance prior to mitigation, (3) project-specific or LRDP mitigations that would avoid or reduce the level of impacts, and (4) the level of significance after implementation of mitigation measures, if applicable.

Cumulative impacts that would result from implementation of the proposed project in combination with other development on campus under the 2005 LRDP and projected regional growth are discussed in the technical sections of Volumes I and II of this EIR and are summarized in the impact analysis that follows in this volume.

2.2.2 Alternatives

Because only the proposed storm water drainage system improvements have the potential to result in significant environmental impacts, alternatives to that component of the proposed project were evaluated in detail in this EIR (see Section 2.5, *Alternatives*), and the results are summarized below. Alternatives to the other components were found not to be feasible or effective. A No Project Alternative is also evaluated.

Alternative 1: Conventional Piped Storm Drain System. Under this alternative, the campus's existing storm water drainage system, which currently relies primarily on natural drainages, would be converted to conventional piped storm water drain system using gravity feed or pipes to discharge at locations downstream from the campus. All other infrastructure improvements would be the same as the proposed project.

Alternative 2: No Project. Under this alternative, no improvements would be made to any of the deficient utility systems on campus.

The environmental effects of these alternatives, and the extent to which each alternative would meet project objectives, are assessed in Section 2.5, *Alternatives*.

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
2.4.1 Aesthetics				
IIP-SW Impact AES-1	Construction of the proposed storm water drainage improvements could temporarily affect the visual quality in the vicinity of the improvements.	LS	Mitigation not required	NA
IIP-CW Impact AES-2	Construction of the cooling tower would not adversely affect the visual quality of the project vicinity, as it would not be visible from many vantage points.	LS	Mitigation not required	NA
IIP-NG Impact AES-2	Construction of the College Eight natural gas pressure-reducing station would not adversely affect the visual quality of the project vicinity.	LS	Mitigation not required	NA
2.4.3 Air Quality				
IIP-ALL Impact AIR-1	Construction of the proposed project would generate short-term fugitive dust and PM_{10} exhaust emissions.	LS	**IIP–ALL Mitigation AIR-1:** The Campus shall implement LRDP Mitigation AIR-1 (Apply standard MBUAPCD recommended mitigation measures).	NA
2.4.4 Biological Resources				
IIP-SW Impact BIO-1	Construction of storm water drainage improvements could result in placement of fill in waters of the U.S. and of the State.	PS	**IIP-SW Mitigation BIO-1:** The Campus shall implement LRDP Mitigation BIO-3.	LS
IIP-SW Impact BIO-2	Construction of storm water drainage improvements could result in temporary degradation and permanent loss of riparian vegetation.	PS	**IIP-SW Mitigation BIO-2:** The Campus shall implement LRDP Mitigations BIO-4A through BIO-4C.	LS
IIP-SW Impact BIO-3	Construction of storm water drainage improvements could result in temporary impacts to water quality due to increased sediment inputs and potential impacts to water quality from spills of toxic chemicals in construction equipment into the creek.	LS	Mitigation not required	NA

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
IIP-SW Impact BIO-4	Construction of storm water drainage improvements would not result in potential degradation of habitat via alterations in hydrology for special-status cave invertebrates (Santa Cruz telemid spider, Dollof Cave spider, Empire Cave pseudoscorpion, or Mackenzie's Cave amphipod).	LS	Mitigation not required	NA
IIP-SW Impact BIO-5	Construction of storm water drainage improvements could result in temporary direct and indirect impacts to movement habitat for California red-legged frog in the east fork and west entrance fork of the Moore Creek drainage.	S	**IIP-SW Mitigation BIO-**5: The Campus shall implement LRDP Mitigation BIO-9.	LS
IIP-SW Impact BIO-6	Construction of storm water drainage improvements could result in the loss of nesting and roosting habitat for special-status raptors, and disturbance to active nests or roosts.	S	**IIP-SW Mitigation BIO-6:** The Campus shall implement LRDP Mitigation BIO-11.	LS
IIP-SW Impact BIO-7	Construction of storm water drainage improvements could result in the loss of western burrowing owl habitat and potential direct and indirect impacts to owls from construction.	PS	**IIP-SW Mitigation BIO-7:** The Campus shall implement LRDP Mitigations BIO-12A and 12B.	LS
IIP-SW Impact BIO-8	Construction of storm water drainage improvements could result in temporary disturbance of suitable foraging habitat for pallid bat, Pacific Townsend's big-eared bat, western red bat, long-eared myotis, fringed myotis, long-legged myotis, yuma myotis, and greater western mastiff bat.	LS	Mitigation not required	NA
IIP-SW Impact BIO-9	Construction of storm water drainage improvements would not result in the potential loss of San Francisco dusky-footed woodrat nests.	LS	Mitigation not required	NA

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
IIP-SW Impact BIO-10	Construction of storm water drainage improvements would not interfere with the movement of wildlife species or with established native resident or migratory wildlife corridors.	LS	Mitigation not required	NA
2.4.5 Cultural Resources				
IIP-SW Impact CULT-1	Proposed infrastructure improvements could damage or destroy portions of significant cultural resources SCR-182H, SCR-183H, SCR-181, SCR-142, UCSC-001 and UCSC-004, or other undiscovered resources or human remains, as a result of grading, excavation, other ground-disturbing activity, or other project development activities associated with the improvements or related access routes.	PS	**IIP-SW Mitigation CULT-1A:** Pursuant to LRDP Mitigation CULT-1E, the campus shall ensure that the final design of each improvement avoids impact to significant cultural resources, as identified in Table 2-7. The Campus shall also consult confidential cultural resources mapping and the project archaeologist, as needed, to delineate each resource and resource element on construction plans as avoidance areas, and shall implement the resource avoidance measures identified in Table 2-7, below. Table 2-7 is appended to this measure by reference. **IIP-SW Mitigation CULT-1B:** If the measures identified in Table 2-7 or other measures to avoid impacts to significant resource elements are not feasible for any of the identified significant cultural resources, the Campus shall implement the research design and data recovery provisions of LRDP Mitigation LRDP CULT-1F and, for a prehistoric resource, CULT-4B. In the event that these measures, in the professional judgment of a qualified archaeologist in consultation with the campus, cannot mitigate the impact to a less-than-significant level, the Campus shall implement LRDP Mitigation CULT-3A and 3B, as applicable. **IIP-SW Mitigation CULT-1C:** The Campus shall implement LRDP Mitigation CULT-1G, CULT-4C and CULT-4D, as pertinent. **IIP-SW Mitigation CULT-1D:** The Campus shall implement LRDP CULT-1B.	LS

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
2.4.6 Geology, Soils, and Seismicity				
IIP-ALL Impact GEO-1	Proposed improvements could be located on a geologic unit or soil that would become unstable as a result of the project and result in a potential risk to life or property.	PS	**IIP-ALL Mitigation GEO-1:** The Campus shall implement LRDP Mitigation GEO-1.	LS
2.4.7 Hazards and Hazardous Materials				
IIP-CW Impact HAZ-1	Construction and operation of the cooling tower would increase the routine use, transport, and disposal of hazardous chemicals and wastes on the campus, but would not create significant hazards to the public or the environment.	LS	Mitigation not required	NA
IIP-ALL Impact HAZ-2	Construction of the cooling water, heading water and domestic/fire water improvements could potentially expose construction workers and campus occupants to contaminated building materials.	PS	**IIP-CW Mitigation HAZ-2A:** The Campus shall implement LRDP Mitigation HAZ-7. **IIP-CW Mitigation HAZ-2B:** Consistent with standard campus practices, EH&S will investigate whether chromium has been used in the cooling water system in the past and, if appropriate, will conduct testing. If testing reveals that the cooling tower debris is contaminated, it will be handled in accordance with applicable federal, state and local regulations.	LS
2.4.8 Hydrology and Water Quality				
IIP-CW Impact HYD-1	Implementation of the Infrastructure Improvements Project would not result in wastewater that would violate wastewater discharge requirements.	LS	Mitigation not required	NA
IIP-ALL Impact HYD-2	Implementation of the Infrastructure Improvements Project could result in storm water runoff during construction, which could violate water quality standards.	PS	**IIP-ALL Mitigation HYD-2:** The Campus shall implement LRDP Mitigations HYD-2B and 2C.	LS

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
IIP-SW Impact HYD-3	Implementation of the storm water drainage improvements under the Infrastructure Improvements Project would alter drainage patterns and could result in erosion and siltation.	PS	**IIP-SW Mitigation HYD-3A:** The Campus shall monitor dispersion manifolds for evidence of erosion on an annual basis. If there is evidence that the dispersion manifolds are causing erosion, the Campus shall repair the erosion damage and implement any repairs or alterations to the design of the manifolds necessary to prevent further erosion. **IIP-SW Mitigation HYD-3B:** For improvements included in the Infrastructure Improvements Project that increase impervious surfaces (the new cooling tower and the College Eight natural gas pressure-reducing station), the Campus shall implement LRDP Mitigation HYD-3C and HYD-3D.	LS
IIP-SW Impact HYD-4	Implementation of the Infrastructure Improvements Project would alter drainage patterns but would not result in increased flooding on or off site.	LS	Mitigation not required	NA
2.4.10 Noise				
IIP-ALL Impact NOIS-1	Construction activities associated with the Infrastructure Improvements Project would not result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	S	**IIP-ALL Mitigation NOIS-1:** The Campus shall implement LRDP Mitigation NOIS-1 for all improvements that are within 100 feet of an existing campus building or sensitive receptor.	SU
IIP-CW Impact NOIS-2	Operation of the new cooling tower would result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.	PS	**IIP-CW Mitigation NOIS-2:** The Campus shall achieve an exterior noise level of 70 dBA CNEL at the Earth and Marine Sciences Building adjacent to the new cooling tower by selecting a less noisy cooling tower or by design measures and operational changes.	LS

Table 2-1
Infrastructure Improvements Project
Summary of Impacts and Mitigation Measures

IIP Impact		Level of Significance Prior to Mitigation[1]	IIP Mitigation Measures	Level of Significance Following Mitigation[1]
2.4.14 Traffic, Circulation, and Parking				
IIP-ALL Impact TRA-1	The proposed project would add vehicle trips to the study area transportation network.	LS	Mitigation not required	NA

[1] NA: Not Applicable; NI: No impact; LS: Less than significant; PS: Potentially significant; S: Significant; SU: Significant and unavoidable

2.3 DETAILED PROJECT DESCRIPTION

2.3.1 Locations of Proposed Improvements

The facilities and activities associated with the Infrastructure Improvements Project would be distributed throughout the central and lower campus. Locations of the proposed improvements are illustrated on Figures 2-1 though 2-7, presented at the end of this chapter.

Storm water drainage improvements, which would be constructed during both Phase 1 and Phase 2, would involve construction activities at approximately 94 locations along the campus stream channels and drainages that currently are used for storm water conveyance, including Jordan Gulch, Moore Creek, gullies in the San Lorenzo-Pogonip drainage, and the Pump Station and Porter tributaries of Cave Gulch. General locations of the proposed storm water drainage improvements are shown in Figure 2-1, *Storm Water Drainage System Improvements*. Specific locations of the improvements and related access roads are shown in Figure 2-2, *Storm Water Drainage System Improvements (detailed)*. Appendix A of this volume (Volume III) provides figures that detail proposed access roads for these improvements. These proposed routes are also described in Table 2-3, presented at the end of this chapter.

Improvements to the domestic and fire protection water system would take place in Phase 1. These would include installation of replacement pipe segments at several locations on central and lower campus as shown in Figure 2-2. New pipeline segments would be installed only in two locations: south of Family Student Housing complex and along Hagar Drive to the faculty/staff housing complex at Glenn Coolidge Drive. Four pressure-reducing valves (PRVs) would be removed in the Arts area and one would be removed near the Physical Education fields. Three new PRVs would be installed in the vicinity of the faculty/staff housing complex, near the Family Student Housing complex, and near the East Field area. The locations of these improvements are Figure 2-3, *Domestic/Fire Protection Water System Improvements*.

Two options have been identified for the cooling water system improvements. Under Option 1, an existing cooling tower located north of the cogeneration plant would be replaced with a larger cooling tower at the same location and new piping would be installed parallel to the existing lines running from the cogeneration plant to Baskin Engineering and between Sinsheimer Laboratories and the Earth and Marine Sciences Building. Under Option 2, a new cooling tower would be constructed near the Earth and Marine Sciences Building and, as under Option 1, new piping would be installed between Sinsheimer Laboratories and the Earth and Marine Sciences Building. Under Option 2, the new piping between the cogeneration plant and Baskin Engineering would not be installed. The cooling water system improvements would take place during Phase 1 of the proposed project. Locations of proposed improvements are shown in Figure 2-4, *Campus Core Cooling Water System Improvements*.

Campus core heating water system improvements which would take place during Phase 2 would replace low-temperature pipe materials with higher rated components in building connections off the main distribution system at several locations. Small sections of pipe near the Theater Arts Complex would be replaced and an absorption chiller at Sinsheimer Laboratories would be re-piped to receive hot water directly from the core heating water distribution loop. All of the proposed improvements would be located within campus streets or other developed areas, inside mechanical rooms, and inside the cogeneration plant and the Sinsheimer Laboratories. General locations of the proposed improvements are shown in Figure 2-5, *Campus Core Heating Water System Improvements.*

Electrical system improvements would include work at switch locations in the central campus, within existing underground vaults or in aboveground utility boxes, and additional work at the campus's Merrill

Substation, as shown in Figure 2-6, *Electrical System Improvements*. This would occur during Phase 2 of the proposed project.

Natural gas system improvements would include installation of a new vault on Heller Drive near College Eight, as well as replacement of existing piping in Hagar Drive between Steinhart Way and McLaughlin Drive and work in other developed areas of the campus, as shown in Figure 2-7, *Natural Gas System Improvements*. This work would occur during Phase 2 of the proposed project.

2.3.2 Project Goals and Objectives

UC Santa Cruz currently is served by a full range of utilities and a well-developed but aging utility infrastructure. The infrastructure includes facilities and distribution systems located on campus, campus distribution networks for water provided by the City of Santa Cruz, and electricity and natural gas provided by Pacific Gas & Electric Company. Almost half of the utility infrastructure at UC Santa Cruz is more than 30 years old. Upgrades and extensions have been carried out since the establishment of the campus four decades ago. These systems require improvements to address safety and reliability concerns for serving existing development. Improvements are also needed to address other existing operational problems erosion in campus drainages and potential impacts to water quality; and to support continuing campus development under the 2005 LRDP. Specific objectives of each project component are described in the following sections.

2.3.3 Proposed Storm Water Drainage System Improvements

2.3.3.1 Goals and Objectives of Storm Water Drainage System Improvements

The campus storm water drainage system, which uses the campus's steep natural arroyos to convey runoff, has been overtaxed by the volume and velocity of runoff associated with increased campus development, and is experiencing problems with channel and sinkhole overflow and erosion. The proposed project would improve and reinforce drainage systems in the canyons, and improve infiltration and dispersion of storm water runoff from existing campus facilities to reduce the rate and volume of flow in the natural drainages. The goals and objectives of the proposed storm water drainage system improvements are to correct existing erosion problems in campus drainages that have resulted from excessive volume and velocity of runoff, and ensure future water quality.

These specific project objectives would contribute to the fulfillment of the above goals:

- Reduce flow concentration, in particular with respect to flows to natural drainages and sinkholes that have already been impacted by erosion or incising
- Improve infiltration, dispersion and filtration of runoff
- Reduce velocity of runoff
- Stabilize eroding channels
- Improve sinkhole infiltration and detention capacity
- Redirect concentrated flows from highly impacted drainages to less impacted areas where dispersion and infiltration can occur

2.3.3.2 Existing Conditions

The northern part of the west side of the city of Santa Cruz and adjacent county lands rely on natural drainage courses for storm water drainage. Since there is no regional piped system to drain into, UC Santa Cruz has used the campus's natural drainages to convey and capture runoff, and to allow continued recharge of groundwater. Storm water runoff from the localized campus building clusters drains via a network of pipes, detention basins, and settling tanks, primarily to the tributaries and channels of Jordan Gulch and Moore Creek. The Pogonip watershed, east of the campus, and the Cave Gulch watershed to the west convey additional flows off campus to the San Lorenzo and Wilder Creek River basins, respectively. Jordan Gulch, the upper reaches of Moore Creek, and Cave Gulch drain into a series of natural sinkholes, and ultimately to underground aquifers via subsurface fractures. On the forested central and north campus, forest duff and highly permeable soils also capture and store a significant amount of storm water and remove residual contaminants through natural filtration. The campus supplements the natural system with multiple types of engineered detention systems, urban contaminant removal systems, and conveyance methods that redirect storm water away from developed areas into the drainage channels.

While this system generally functions adequately to convey the flows generated by the existing development, recent analysis has documented overflows of channels and sinkholes, and concentrated flows and associated erosion in some locations where the natural drainage courses are overtaxed by the volume and velocity of campus runoff. The resulting erosion is cutting deep channels into streambeds, filling critical sinkholes with sediments, undermining trees, destabilizing streambeds and canyon walls, and in some cases threatening other campus infrastructure. In some areas the heads of drainages have eroded rapidly as a result of progressive headcutting (small waterfalls cutting their way upstream), and substantial erosion has also occurred in the lower portions of some of the drainages. Eroded sediment in some cases is reducing the natural holding and drainage capacity of campus sinkholes. The long-term effects on campus sinkholes of loading with sediments deposited as a result of upstream erosion are unknown; the drainage system on campus is dynamic and sinkholes can open or close as a result of natural processes. However, overflowing sinkholes may have effects downstream and could prevent natural seepage/percolation of storm water into the aquifer. Furthermore, as runoff volumes have increased, runoff in some cases has exceeded the absorption capacity of organic duff and vegetation. The natural filtering functions of duff and vegetation thus may be reduced, with adverse effects to water quality.

2.3.3.3 Proposed Facility Types

Brief descriptions are provided below of the classes and types of improvements that would be constructed.

Dispersion and Infiltration Features

<u>Flow Dispersion/Dissipation Manifold</u>. A flow dispersion/dissipation manifold may also be called a surface dissipation manifold or water spreader. It consists of a perforated pipe, which generally is laid out along the contour on a gently sloping surface. The perforated pipe is connected to a flow source, such as a roof downspout or other impervious surface, and distributes the flow along a wide area, directing it away from facilities and problem drainage areas, and facilitating infiltration.

<u>Vegetated Swales</u>. A vegetated swale is a shallow artificial channel with side slopes and bottom covered in vegetation. A swale collects runoff, provides filtering, and allows runoff to infiltrate or to be slowly conveyed to downstream discharge points.

Coir Log Flow Dispersion. Twelve-inch-diameter coconut fiber rolls (“logs”) are laid out along the contours of a slope in several rows and anchored down in 3-inch to 4-inch-deep trenches. This creates a system of baffles that act to divide and disperse concentrated runoff flows from roadways, downspouts, ditches, or pipes.

Infiltration Basin. An infiltration basin is a shallow impoundment that stores storm water and gradually infiltrates it into the soil.

Infiltration Trench. An infiltration trench is a long, narrow, rock-filled trench that receives storm water, stores it in the voids between rocks, and filters out fine sediments and associated pollutants as the water gradually infiltrates into the soil matrix. Vegetated swales, buffer strips, or detention basins are used in conjunction with an infiltration trench to remove coarse sediments, which can clog the trench and interfere with its filtering function.

Detention Features

Detention Basins and Vaults. Detention basins or vaults capture storm water surges and hold the water for short periods of time, releasing it at a reduced flow rate. This serves to limit the peak volume and velocity of runoff and control erosion and flooding.

A detention basin may be situated in a drainage channel or on a development site, and may be a passive recipient of overland storm water or stream channel flow, or it may be connected to other elements of the storm drainage system via piping or artificial channels. Natural depressions in the topography can be used to develop detention storage. The proposed project would include repair and retrofits of existing basins and their inflow and outlet channels, primarily to restore or increase capacity, and construction of new detention basins. Development of a detention basin would involve grading, construction of a berm, contouring, revegetating, and construction of structures to control flow out of the basin. To the extent feasible, native materials from the site would be used in the construction of any new basins. Safety fencing would be installed for above-ground detention storage facilities as required by law, depending on the depth of the ponded water and how long water remains in the facility.

The campus may also construct detention vaults, which are typically installed beneath roadways or parking lots, to store storm water and release it at lower rates.

Proprietary Engineered Treatment Systems. A wide range of commercially manufactured proprietary engineered treatment systems or mechanisms for removing contaminants from runoff is available. These include treatment vaults (e.g., Stormceptors, CDS units, Jenson Interceptors), storm water filters (e.g., Stormfilter and other sand filter systems). These may be installed in detention vaults or at intake or discharge points in the storm water drainage system.

Channel Improvements

Sinkhole Capacity Improvements. Sinkholes detain and drain storm water on campus and are critical to storm water management. Many have lost capacity due to sediment accumulation over time. Capacity improvements could include manual or mechanical excavation of accumulated sediments; drilling and placing culverts through bottom sediments to convey storm water to sinkhole openings; and increasing the height of sinkhole berms. Sinkhole improvements would be accompanied by implementation of upstream, storm water best management practices (BMPs) to treat and remove pollutants from storm water before it enters the sinkhole. The project would not cover up or permanently remove any sinkholes from the drainage system.

Check Dam. Check dams are low structures built across a channel, singly or in groups, to stop channel incision and to slow the velocity of runoff.

Soft and Hard Armoring

These improvements are a broad class of in-channel improvements that use rock and/or plant materials to protect the channel banks or bottom from erosion and dissipate runoff energy downstream. Each installation is designed for the specific location. The design must accommodate specific site access conditions, because placement of the rockwork or other armoring may require heavy equipment. Examples of soft armoring include use of vegetation to stabilize banks, vegetated geogrids (alternating layers of live branch cuttings and compacted soil layers wrapped in geotextile fabric) to rebuild and vegetate eroded banks, brush mattresses (covering a stream bank with live branch cuttings and securing them in place), and coconut fiber rolls staked at the toe of a bank. Specific types of hard armoring include step-pools (accumulations of cobble- and boulder-sized material and large wood, organized into discrete channel-spanning risers or steps oriented perpendicular to the direction of flow); lining with rock or logs to protect channel bottoms and banks; and rock dissipation aprons (fan-shaped shielding over horizontal surfaces or shallow slopes at point of water discharge).

Drop Structures and Rock Chutes. These include a single structure or series of structures constructed in the channel to prevent the headward erosion of knickpoints (drop in channel resulting from erosion), which is a major cause of channel incision. The structures are constructed of concrete, rock, or wood with rock armoring at the bottom, and are sometimes referred to as grade stabilization structures.

Flume or Bypass Pipe

A flume (open trough structure) or a bypass pipeline may be used to bypass locations where a channel has been extensively damaged by erosion.

2.3.3.4 Proposed Improvements

Table 2-2a, *Storm Water Drainage Improvements (Both Phases)*, provides detail about all of the improvements proposed under the UC Santa Cruz Infrastructure Improvements Project,[1] grouped by stream reach and phase. Locations of specific proposed improvements are shown in Figure 2-2, *Storm Water Drainage Improvements (detailed)*. Table 2-2b, *In-Channel Storm Water Drainage Improvements (Both Phases)*, also at the end of this chapter, provides further details about the 54 improvements that would be within or near the channels and therefore may have higher potential to result in environmental impacts. The table also indicates whether ancillary project facilities, such as access roads or staging areas, would be required for each improvement. Table 2-3, *Access Routes to In-Channel Storm Water Drainage Improvements*, shows the routes of access roads that would be needed to access specific storm drainage improvements. These tables and figure are presented at the end of this chapter. Additional detail on access routes is illustrated in figures presented as Appendix A to this volume.

The proposed improvements range from upstream source control using flow dispersion and infiltration measures where feasible and beneficial to in-stream channel improvements. In-stream channel improvements are recommended in the areas with the most severe erosion and downcutting. Where feasible, in-stream channel improvements utilizing vegetation such as redwoods, and other minimally disturbing measures are proposed. However, the majority of the stream channel improvements occur in areas where either the forest canopy is very heavy, thus reducing the sunlight available for revegetation,

[1] The *Stormwater and Drainage Master Plan* prepared by Kennedy/Jenks identified a total of about 120 individual improvements to the campus storm water drainage system. Of this total, 94 will be implemented in Phases 1 and 2 of the Infrastructure Improvements Project, and the campus would implement the remaining improvements at a currently undetermined future time. The campus has assigned an identifying number (Item 1, 2, etc) to all 120 improvements. However, not all 120 individual improvements are included in the proposed Infrastructure Improvements Project. For purposes of the analysis in the EIR, the improvements were not renumbered; therefore, the reader may find certain numbers missing from tables and text. These are the 26 improvements that are not included in the proposed project.

areas where the water supply is ephemeral, thus reducing the water supply available for revegetation, or areas that are very steep and do not have significant vegetative cover in their natural state. An additional and often over-riding constraint on the use of vegetative measures is that in most channels on campus, flow velocities and erosion rates are too high to allow vegetation establishment. Where vegetation was preexisting, it has been undermined and washed away by runoff flows. However, the reduction in flows that may result from this project may increase the feasibility of using vegetative measures over the course of the project. Nevertheless, at this time improvements that utilize pipeline or channel diversions, and rock or concrete structures are proposed at several in-stream locations.

Proposed classes of improvements that would address problems of erosion, excessive runoff, reduced capacity, and threats to water quality in campus drainages are described above. For some of the identified problems, actions at fixed locations are proposed. In other cases, the identified problems and proposed improvements must be considered as a range of actions that could be carried out in a given reach, with precise locations and actions to be determined as the project proceeds. That is, because of the nature of the ongoing erosion in stream channels, which has tended to work upstream and to worsen from storm event to storm event and season to season, the problem points identified in the *Stormwater and Drainage Master Plan* (Kennedy/Jenks 2004) may have altered since the last assessment, and may continue to alter with successive runoff events until such time as improvements are carried out.

The specific improvement actions that would provide the best solutions, and the precise locations of each improvement, can only be determined subsequent to the rainy season immediately prior to the implementation of the actions, and in some cases can only be finally determined by the field engineer at the time of final improvement design and/or installation. Furthermore, access routes to some sites also may have to be designed in the field, depending on the capabilities and requirements of the equipment to be used. For these reasons, the proposed project must be considered to include a range of potential actions within each given reach, to provide a flexible "envelope" within which project design can be adjusted as needed to respond to field conditions as they exist at the time the project is implemented.

Both phases of the project would include work on existing improvements and installation of new improvements, and both likely would also require use of informal access trails and construction of some temporary access roads and staging areas adjacent to the work sites.

Phase 1

Proposed improvements to the storm drain system during this phase of work would focus on erosion control at the tops of the drainage channels and the most severely eroded areas in Jordan Gulch and its tributaries. These improvements would include:

- Construction of additional detention and possibly, retention basins
- Development of relatively short rock-lined channels to redirect storm water from sinkholes/drainages that lack capacity to those with capacity to accept additional flows without causing erosion
- Installation of short bypass pipelines or flumes in existing channels to convey storm water away from some erosion-damaged areas
- Incorporation in new drainage installations of infiltration improvements, such as surface-perforated pipes, to spread runoff over a large area and increase storm water infiltration

Specifically, Phase 1 would include the actions summarized below. Item numbers are cross-referenced with Table 2-2a and Table 2-2b and illustrated on Figure 2-2. These are presented at the end of this chapter.

Cave Gulch Pump Station Tributary (outside of channel)

- Divert flow from Empire Grade Road with shoulder reinforcement; reinforce downstream channel; diversion structures; and energy dissipater (Item 2).

Jordan Gulch East Fork (inside and outside of channel)

- Address erosion in Jordan Gulch Main Stem by diverting runoff from Chinquapin Sinkhole overflow and Chinquapin Road to Upper Quarry sinkholes, by installing a culvert at the McLaughlin/Chinquapin intersection, and expanding armoring for Upper Quarry Sinkhole flow (Item 18).

Jordan Gulch Great Meadow Tributary (inside and outside of channel)

- Carry out five erosion control projects in Reach 1, including reinforcement of sinkhole and sinkhole inflow channel, and installation of two rock drop chute structures, a gabion (wire mesh filled with rock) retaining wall, and a buried storm drain pipe and a short grouted rock channel to connect to the existing storm drain system (Items 19-23).
- Divert water from Music Center detention basin 450 feet northeast for infiltration through sheet flow in a meadow (Item 24).
- Divert multiple downspouts from Visual Arts Painting Studio to the slope below through sheet flow (Item 25).

Jordan Gulch Main Stem (outside channel)

- Install mechanical oil/water separator for Athletics Facilities parking (Item 38).
- Divert flow at south end of Hahn Student Services parking east (Item 40).
- Revegetate parking islands at Physical Planning and Construction, and add drop inlets and flow dispersion manifold (Item 42).

Jordan Gulch Middle Fork (inside channel)

- Implement two erosion control projects in the uppermost reach (above Steinhart Way): pipe culvert discharge from McLaughlin/Science Library intersection to the middle fork and discharge at new energy dissipation apron; and increase height of drainage swale berm at R1-9 (Items 44, 45).
- Divert runoff from Colleges Nine/Ten to Health Center Sinkhole with a larger culvert under McLaughlin Drive, and armor channel between McLaughlin Drive and sinkhole (Item 58).

Jordan Gulch West Fork (inside channel)

- Install check dams and/or upstream diversions in channel, construct new detention basin southeast of Kerr Hall, redirect Kerr Hall flow to new detention basin, and extend Kerr Hall pipe to sinkhole (Items 59-60).
- Jordan Gulch West Fork (outside channel). Address concentrated runoff from Academic Resources Center (ARC) by diverting some downspouts to Great Meadow Tributary or to new flow dispersion manifolds north of ARC, improving capacity of sinkhole south of ARC (Item 64).

Moore Creek West Entrance Fork Tributary (primarily outside of channel)

- Potentially construct detention basin north of Heller Drive/Empire Grade Road intersection for flow from Empire Grade Road; potentially reroute flow from Family Student Housing complex via pipe to this basin and use flow dispersion/dissipation techniques at the basin (Item 106).

- Divert flow from Porter College parking and Porter College Academic Building away from Moore Creek East Fork to West Fork and Cave Gulch with trenched pipelines; add infiltration/dispersion and dissipation features at discharge points (Items 101, 102).
- Divert piped storm water from College Eight dorms to new flow dispersion/dissipation features (Item 104).
- Address concentrated runoff from Family Student Housing complex with new flow dispersion/dissipation features to southeast, widen Heller Drive ditch, and divert storm water from ditch to new Empire Grade Road/Heller Drive detention basin (Items 105, 103).
- Improve detention and infiltration at West Remote parking lot (Item 109).

Moore Creek Middle Fork (outside of channel)

- Divert runoff from the east side of the West Remote parking lot. Use flow dispersion/dissipation techniques (Item 96).

Moore Creek Baskin Tributary (outside of channel)

- Divert runoff from Heller Drive bus stop, spread water, and use flow dispersion/dissipation techniques on slope to east (Items 68.2, 68.4).
- Divert Thimann runoff to flow dispersion/dissipation manifolds south of Steinhart. Modify existing Steinhart culvert (southwest of Thimann) to be a dispersion manifold (Items 69, 69.5).

Moore Creek East Fork (inside and outside of channel)

- Divert piped runoff from College Eight apartments using flow dispersion/dissipation techniques (Item 92).
- Modify existing overflow catch basin near Performing Arts entry drive using flow dispersion/dissipation features south of Buildings A, B, and C (Items 93, 107).
- Construct a new detention basin and overflow structure at the northeastern corner of Meyer and Heller Drive intersection (Item 91).

Moore Creek Kresge Tributary (outside of channel)

- Capture flow from North Remote parking lot at either the Campus Trailer Park entrance or Kresge Road Bridge and route to Cave Gulch for dispersion via a flow dispersion/dissipation feature (Item 82).

Moore Creek Science Hill Tributary (outside of channel)

- Install new piping from Thimann Laboratories to a new detention basin (Item 60, above) (Item 72).
- Detain water from Thimann/Sinsheimer parking and, provide system to remove contaminants (Item 60; see Jordan Gulch West Fork [Inside Channel], above) (Item 73).

San Lorenzo-Pogonip Drainage (outside of channel)

- Redirect storm water flows from East Remote parking lot detention basin outlet to new dispersion feature south of parking lot (Item 111).

Phase 2

- Phase 1 of the project primarily focuses on controlling storm water drainage at the source of the runoff and at the top of the drainage channels. Improvements during the second phase of the project would address erosion problems deeper within the drainage channels, and would increase the capacity of some sinkholes. The work would include the following components:

- Improvements at sinkholes, including use of hard and/or soft armoring banks along the lower portion of sinkholes, and boring through or excavating sinkhole sediments.
- Improvements at problem areas throughout the system, including but not limited to construction of new detention basins, retention basins, and drop-chute structures, construction of check dams in the incising channels, and installation of bank armoring using hard and/or soft armoring.

Cave Gulch Porter Tributary (inside and outside of channel)

- Recontour roadway, grade headcut in channel, connect upper sinkhole to lower sinkhole, and install drop structures and water bars (Item 1).

Jordan Gulch East Fork (inside and outside of channel)

- Make improvements in six areas of Reach 2 channel, including check dams, channel armoring, and redwood and sedge plantings; and excavate sinkhole sediment (Items 3-8).

Jordan Gulch Main Stem (inside and outside of channel)

- Make improvements in five areas of Reach 1 including installation of a stilling basin, check dams, step pools, and drop structures (Items 26, 28-31).
- Make improvements in four areas of Reach 2 including drop structure or drop chutes, channel armoring and some tree clearing (Items 32-35).
- Excavate sediments from small sinkhole upstream of Village Housing in Reach 3 and use logs to stabilize bank toe in same reach (Items 36, 37).

Jordan Gulch Middle Fork (inside and outside of channel)

- Increase capacity of Middle Fork Sinkhole in Reach 1 and stabilize channel at entrance to sinkhole (Item 43).
- Make improvements at two locations in Reach 2. Extend culvert outfall, and install dissipation basin/apron (some work may not be required based on outcome of Item 45 in Phase 1, which would increase the height of the drainage swale berm) (Items 46-47).
- Construct two drop structures in Reach 3 (Item 49).

Jordan Gulch West Fork (inside channel)

- Construct a new drop structure downstream of Academic Resource Center discharge in Reach 2 (Item 63).

Moore Creek Baskin Tributary (inside and outside of channel)

- Make improvements in two areas of Reach 1, including clearing of Baskin Sinkhole and installation of check dams in the channel above (Items 65, 67).
- Install new pipe or reinforce channel in reaches 2-4 (Item 66).
- Construct a rock chute, pipe or gabion drop structure at the head of Baskin Sinkhole (Item 68).

Moore Creek Kresge Tributary (inside channel)

- Make improvements in five areas of Reach 1, including installation of check dams and channel lining (Items 74-78).
- Install a new check dam to protect redwood cluster in Reach 2 (Item 79).
- Install a new drop structure in Reach 3, and bore Kresge Sinkhole (Item 80, 81).

Moore Creek Middle Fork (inside channel)

- Detain and redirect flow near Oakes College (Item 97).

Moore Creek Science Hill Tributary (inside channel)

- Construct a series of check dams and/or line channel in Reach 1. Improve parking detention basins. (Items 70, 71).

Moore Creek East Fork (inside channel)

- Make several improvements in five areas of the Reach 1 channel, including step pools, flumes, channel armoring, and drop structures (Items 83-87).
- Make several improvements in the Reach 2 channel including hard and/or soft armoring and check dams (Items 88, 89).
- Repair and install new check dams and armor outfalls in Reach 3 (Item 90).
- Regulate overflow at Moore Creek East Fork Dam to prevent potential flood washout by providing a new spillway or drop drain (Item 94).

Moore Creek Highview Drive Tributary (inside channel)

- Angle and extend existing culvert to redirect and dissipate flow in Reach 1 (Item 95).

Moore Creek West Entrance Fork (inside channel)

- Make improvements at four locations in Reach 2, including rock armoring, willow planting, coir logs, drop chute structure, and dissipation apron (Items 98--100).
- Armor pass-through pipe at West Fork Dam (Item 110).

San Lorenzo-Pogonip Drainage (inside and outside channel)

- Detain flow in lower Crown/Merrill parking lot (Item 116).
- Install culvert down hill at Merrill College Dorms and add dissipation apron (Item 117).

2.3.3.5 Construction

Access Routes

Improvements proposed within the channel generally would require access to the channel by some equipment. Where feasible without extensive damage to the nearby bank, equipment would be transported down the canyon slope or bank on tracks rather than on wheels and would work only within a small area adjacent to the channel, which would minimize the need for road construction. In some cases it might be necessary to construct temporary access roads at otherwise inaccessible locations. Temporary access roads would generally use existing paths and traveled areas; the routes would be improved as necessary to accommodate the required vehicles. It is anticipated that this would require minor grading and cutting of small trees and brush. Access routes would be developed into access roads (e.g., graded or widened) where dump truck or other heavy equipment access is required, such as for hauling rock. The access routes proposed were designed to minimize the need for grading and vegetation removal. Consistent with campus standards, all roads will have drainage facilities sufficient to prevent erosion on or adjacent to the roadway; in areas of high erosion hazard, erosion-proof surfacing would be used. Upon project completion, any access road would be revegetated or otherwise restored. Likely locations for access routes are identified on figures included in Appendix A, Volume III. Table 2-3, *Access Routes to In-Channel Storm Drainage Improvements*, presented at the end of this chapter, correlates proposed access routes with the specific in-channel improvements with which they would be associated.

Staging Areas

Project activity could require the development of small staging areas near clusters of improvement sites, for equipment parking and temporary materials storage. Construction of new staging areas would be avoided to the greatest extent feasible by using existing graded or paved areas for staging and contractor parking. In some cases, contractor employee parking could be accommodated by using a contractor shuttle from remote parking. Where new staging areas are needed, level areas that do not require grading would be selected. New staging areas would be unpaved, but could have a gravel surface in areas of high erosion hazard, and would typically be about 50 feet by 60 feet in area. If unpaved areas adjacent to drainages are required for temporary staging, they would be strictly delimited and all operations would be conducted consistent with erosion control standards that are included in the *Campus Standards Handbook* and additional measures as required by the Campus *Draft Storm Water Management Plan*. Any off-road areas developed as temporary staging areas would be restored at the conclusion of operations by regrading if necessary, scarification, and revegetation in native species. Equipment fueling or fluids maintenance would not be conducted at unpaved staging areas. To the extent feasible, the existing campus corporation yard and existing paved parking on campus would be used for these purposes.

Equipment and Construction Procedures

<u>In-Channel Work</u>. Work in the channel, including construction of check dams and channel armoring of various types, would generally require heavy equipment for movement of rock or logs. Some smaller check dams may be constructed by hand. The degree to which rockwork and armoring could be accomplished would largely be a function of whether heavy equipment could access the site. An excavator would likely be able to access most proposed sites with a minimal amount of road construction. A crane could be required to place some materials. The channel would be accessed from the upper bank where possible, or via existing or new access roads as necessary. Where a backhoe or excavator is required, it would set up on only one side of the channel, and any channel crossing or travel would be minimized and limited to areas where channel degradation would not occur. The side selected for equipment positioning would be determined by accessibility and stability considerations. Work in channels would be conducted during the dry season, when, in most locations, water does not flow. If water diversion were necessary, a temporary pipeline would be used to divert water around the construction site and return it to the channel downstream.

<u>Detention Basins</u>. Detention basin construction would require use of heavy equipment for grading and building berms. The material excavated from the basin would be used for the berms, if geotechnically appropriate, such that the need for off haul would be minimal. If the excavated soil is not appropriate, then soil would be imported to construct the berms. It is not anticipated that new access roads, other than short spur roads, would be needed, as these improvements typically would be near existing and new building sites; however, some old roads would need to be re-opened in order to provide temporary truck access.

Infiltration Improvements. Infiltration improvements would require both mechanical and manual work. These improvements generally would require minimal grading and use of small-scale heavy equipment for trenching and for placement of materials such as pipes and gravel. Access roads typically would not be needed, as most of the proposed improvement locations would be close to existing buildings or roads. Many infiltration improvements can be constructed with hand labor and minimal heavy equipment.

Workforce

Workforce requirements would vary with the specific improvement: most improvements would require crews of three to eight persons depending on the nature of the work. Up to three improvements would be undertaken simultaneously, with the result that a construction crew of up to 24 persons potentially could be present on campus at any given time.

Schedule

Construction of Phase 1 storm water drainage improvements would commence in summer 2006, and would be conducted over an 18-month to 24-month period. Construction of Phase 2 improvements would commence in summer 2007, and would also require 18 months to complete. Duration of construction on individual improvements would be highly variable, ranging from a few hours for a simple proprietary engineered treatment system to 60 days or more a typical detention basin. Some activities would occur simultaneously.

2.3.4 Proposed Domestic/Fire Protection Water Distribution System Improvements

2.3.4.1 Project Objectives

The existing campus domestic/fire protection water distribution system (hereinafter domestic water system) has insufficient pressure to meet all fire safety demands. Pressure zones are regulated somewhat irregularly and water does not turn over well in a few areas of the campus. The objectives of this component of the proposed project are to:

Improve the reliability of the domestic and fire protection water supply

Ensure water quality by improving turnover of water in the system

2.3.4.2 Existing Conditions

The City of Santa Cruz Water Department supplies water to the campus, with four points of connection at the western and southern margins of the campus. Water is pumped from the City’s Bay Street Reservoir to three consecutive in-line reservoirs at different elevations. In addition, the campus has the ability to pump from the City’s SC Reservoir No. 5 to UC Santa Cruz’s 1-million-gallon Emergency Water Storage Reservoir (“University Storage Tank”) on the upper campus. The University Storage Tank provides the campus with an emergency water supply if the City system should be incapable of supplying water, and also is needed to provide adequate pressures for flow to the Crown/Merrill Apartments and undeveloped lands in the north campus. To achieve adequate turnover to maintain water quality, water must be pumped from the City supply and the tank must be used for campus demands on a regular basis. Water from this tank is therefore used in the buildings on the central portions of the campus.

The campus's existing domestic water system is a complex network that includes eight pressure zones isolated through 13 pressure-reducing valves. The campus system has had some difficulty maintaining a balanced flow from the two upper campus connections, and has experienced other difficulties related to regulating pressure in the multiple pressure zones. Assessments of the existing campus water distribution system were conducted in 2001 and 2004, which recommended changes and additions to the system to improve existing operations and to accommodate planned expansions of major capital facilities on campus.

The 2001 hydraulic analysis (Kennedy/Jenks 2001) determined that service pressures in the campus system were adequate for peak flow conditions in both summer and winter, but the system did not meet minimal residual pressure requirements during all fire flow analyses. It was determined that the campus could obtain a more even flow from each source by changing the operational settings of the pressure-reducing valves. This would improve the distribution of water within the system, and would thereby improve water quality, by balancing the use of existing sources and loops.

A water system assessment in 2004 (Kennedy/Jenks 2004) modeled improvements to the system that would be needed to ensure fire flow of 3,000 gpm at maximum day conditions[2] at no less than 20 pounds per square inch (psi) for pressure zones 1, 2, 3, and 5, and of 4,250 gpm at McHenry Library at no less than 20 psi during maximum day conditions in Zone 4. New pressure-reducing valve in (PRV) were also modeled that would better balance the pressure in other pressure zones. The proposal improvements are based on the results of this modeling.

2.3.4.3 Proposed Improvements

Proposed domestic water system improvements include adding, relocating, or removing pressure reducing values (PRVs) throughout the campus and installing approximately 7,700 linear feet (lf) of new pipeline or pipeline size upgrades.

Phase 1

During the initial phase of the project, the campus would carry out the following activities to address the deficiencies in the domestic water system and improve its reliability under fire flow conditions:

- Replace approximately 2,500 lf of pipe with 10-inch and 12-inch-diameter pipe oriented north/south along Hagar Drive extending from the southern edge of Cowell College to the northern edge of Quarry Road or construct 2,500 lf of new main parallel to the existing main service. Relocate PRV from intersection at East Field to the intersection at East Remote parking lot (approximate locations).
- Install approximately 2,800 lf of 10-inch- and 12-inch-diameter new main service pipe oriented north/south along Hagar Drive extending from the southern edge of Quarry Road to the faculty/staff housing complex and install new PRV near Hagar/Coolidge Drive intersection.
- Replace approximately 500 lf of 6-inch-diameter pipe extending east from the Arboretum with 10-inch pipe. Directional boring would be used for any pipeline crossings of Arboretum waterways.
- Replace approximately 375 lf and install approximately 550 additional lf of 8-inch and 12-inch-diameter pipe along Koshland Way near Family Student Housing. Install a new PRV above ground or, if it would be visually obtrusive, in an underground vault. Connect to fire hydrant and to old pipe in four locations.

[2] Maximum day conditions refer to water demand estimated based on a maximum day factor that is derived from the maximum month demand and the total monthly average demand.

- Replace approximately 830 lf of pipe with 12-inch to 14-inch-diameter pipe extending from the east boundary of the faculty housing complex, extending north and then west.
- Install approximately 200 lf of 8-inch-pipe between Baskin Visual Arts Center and the Foundry building. Remove four existing PRVs and install approximately twelve 2-inch PRVs at existing building connections, requiring 150 lf of trenching for controls.

Locations of proposed improvements are shown in Figure 2-3, at the end of this chapter. All of the improvements, including new pipelines, would be located within existing utility corridors or developed areas.

Phase 2

All of the proposed domestic water system improvements would be carried out during Phase 1 of the Infrastructure Improvements Project; therefore, there would be no Phase 2 water improvements.

2.3.4.4 Construction

Access

Existing campus roadways would provide access to most work locations and no roadway modifications or new access roads would be needed. Because the utility corridors are mostly located under campus roadways, some roadways could be restricted to one lane of travel for short periods during pipeline installation.

Equipment and Construction Procedures

Pipelines. The proposed project includes approximately 3,500 lf of new pipe and 4,200 lf of pipeline upgrades. Pipeline upgrades would replace existing smaller-diameter pipelines with new larger-diameter lines. These alignments generally would entail little new ground disturbance, since they would use existing utility corridors in or adjacent to existing roads, but some short-term, temporary traffic diversions from one lane could be required during construction. Generally, to maintain service in existing lines until the new service is available, the existing line would be left in place, the new line would be installed adjacent to the existing line and activated, and then the old line would be abandoned. In cases where this is not feasible, or where the pipeline corridor is tight, an old line would be replaced with a new line in the same trench. Some existing utility corridors diverge from roadways and cross open space or developed areas. In these cases, the new pipeline would be installed in the same corridor; this may entail some new disturbance of open ground. New pipeline alignments in most cases will run along existing roadways, and in two areas will run cross-country for short distances within existing utility corridors.

In either case, pipeline trenches typically would range between 3 and 7 feet in depth and 24 to 36 inches in width. Working rights-of-way generally would be no more than 25 feet in width, and typically would be much narrower. Construction equipment would include a backhoe, dump trucks to haul away spoils and import clean fill, a compactor, manual equipment for pipe installation and connection, and paving equipment to restore roadways. It is anticipated that new staging areas would not be required, but that equipment could be parked and materials stored in existing paved areas and along roadways as needed.

Point of Connection, Valve, and Vault Improvements. These improvements would require only minimal, short-term work at each site, including cutting of pavement or opening of existing vaults. Installation of new equipment would be carried out manually or with the aid of heavy equipment such as a crane or forklift, as needed.

Workforce

Crews of up to five persons would be involved in the construction of the water system line and valve improvements. Two improvements might be undertaken simultaneously. Thus a total of up to 10 persons engaged in domestic water system improvements could be present on campus at any given time.

Schedule

Domestic water system improvements would be implemented during Phase 1, beginning in summer 2006, and would be conducted over a 12-month period. Duration of construction on individual project elements would be highly variable, and some activities would occur simultaneously.

2.3.5 Proposed Campus Core Cooling Water System Improvements

2.3.5.1 Objectives of Campus Core Cooling Water System Improvements

The campus core cooling water system is essentially at capacity (with completion of the Physical Sciences Building in 2005) and will not support planned and approved development. The goals of this component of the project are to:

Improve the efficiency, reliability and flexibility of the core cooling water distribution system

Provide additional cooling water capacity to supply demands of envisioned and planned buildings

2.3.5.2 Existing Conditions

The campus core area cooling water system consists of three system-cooling towers, located adjacent to the campus Central Heating Plant/Cogeneration Facility in the northern part of the central campus, and loop piping to chillers serving individual buildings and clusters of buildings. Water from the cooling towers is used to cool the chillers at outlying sites, which then provide environmental and process cooling to the buildings. An underground pipe system supplies the centralized cooling water system’s cooling towers to the building chillers and returns water to the cooling towers to dissipate the heat generated by the chillers to the atmosphere. Some buildings, such as Sinsheimer Laboratories, house larger chillers that serve as a distribution plant for adjacent buildings. The looped cooling system arrangement, with central towers and chilled water plant clusters, provides service efficiency and centralizes maintenance.

Together, the existing towers currently have a total capacity of 2,125 tons/hour. In 2004, peak demand for cooling water was 1,922 tons/hour. The Engineering Building and the Physical Sciences Building, previously approved projects that will be completed in 2004-05 and 2005-06, respectively, included upgrades to Cooling Tower #1. These upgrades would increase total cooling water capacity on campus to 3,238 tons/hour, but the projects would also increase demand for cooling water to 3,179 tons/hour. While the system can thus serve current and near term demand, the demands of development envisioned to occur in the next five years would exceed the capacity.

In addition to the overall capacity problems, the existing system is structured such that the total capacity is not available to all buildings in the campus core. The immediate concern is the lack of cooling capacity available to buildings in the southern portion of the campus core, including future science facilities. The chilled water systems at research-intensive buildings in the southern core area are already operating at or near capacity. New research programs that require process or environmental cooling cannot be considered at these facilities unless the cooling system capacity for the southern core campus is expanded with a new tower.

2.3.5.3 Proposed Improvements

The Infrastructure Improvements Project would address anticipated shortfalls in the near-term by expanding the overall capacity of the campus core cooling water system. All of the proposed improvements would be located within campus streets or near other developed areas. Locations of proposed cooling water system improvements are shown in Figure 2-4, *Campus Core Cooling Water System Improvements*, at the end of this chapter.

Phase 1

The campus would construct the following improvements, which would expand the capacity of the central cooling tower system and support the future science facilities to be located in the campus core south of McLaughlin Drive.

Expand the capacity of the central cooling tower system by constructing a new cooling tower. The following two options are under consideration. Under Option 1, the Campus would construct a new 1,700-ton cooling tower in place of the existing 562-ton Cooling Tower #2 north of the Central Heating Plant. The cooling tower would be generally similar in design to existing cooling towers on the campus, and would be a steel tower with stainless steel panels. Construction of the new cooling tower north of the Central Heating Plant would also include installation of 1,000 feet of new condensing water line in an 800-foot trench, and replacement of approximately 400 lf of 10-inch, 12-inch, and 14-inch PVC-lined asbestos cement and steel pipe with 24-inch welded steel pipeline. Several valves would be installed to tie the old and new piping together. Under Option 2, the Campus would construct a 3,500-ton tower adjacent to the loading dock of the Earth and Marine Sciences Building. The tower would be a two-story steel structure with one or two cylindrical towers on the second level, surrounded by stainless steel panels and four pumps on the ground level. The tower would be approximately 33 feet wide, 28 feet long and 30 feet high. A chemical storage shed would be constructed adjacent to the tower. New cooling water piping would be installed from the new tower to the Earth and Marine Sciences Building basement area, and through the interior of the building to that building’s chiller.

Interconnect chilled water pipe between Earth and Marine Sciences Building, the Interdisciplinary Sciences Building, Natural Sciences 2, and Sinsheimer Laboratories to allow existing chiller plant clusters to serve multiple buildings. Install approximately 1,100 lf new pipe on building roofs and interior spaces and 300 lf pipe in trenches.

Phase 2

There would be no Phase 2 cooling water system improvements.

2.3.5.4 Construction

Access

Existing campus roadways would provide access to all work locations and roadway modifications or new access would not be needed. Installation of new or replacement pipelines potentially could require temporary closures of one lane of some roadways, but this effect would be minimal for this project component.

Equipment and Construction Procedures

Pipelines. The proposed project includes approximately 300 feet of new underground pipe. In addition, under Option 1, 1,400 lf of piping would be installed in 1,000 feet of trench. Trenching equipment and necessary disturbance would be similar to those discussed under Domestic/Fire Water System Improvements, above.

Point of Connection and Valve Improvements. These improvements would require only minimal short-term work at each site. This could include cutting of pavement or opening of existing vaults. Installation of new equipment would be carried out manually or with the aid of heavy equipment such as a crane or forklift as needed.

New Cooling Tower. Under the first option, the replacement cooling tower would be placed on the existing concrete pad of Cooling Tower #2 near the Central Heating Plant, with some expansion of the pad and installation of new piping and pumps. Construction staging for improvements would occur on site on unpaved compacted dirt. Under the second option, the same improvements plus a new mat slab foundation approximately 48 feet by 34 feet would be necessary, and the project would disturb an area of about 0.5 acre, which is currently undeveloped. There are two trees approximately 20 inches in diameter on the site. Because the Option 2 site near Earth and Marine Sciences Building has a 5 percent slope, cut and fill would be necessary to build the pad and a retaining wall may be required.

Workforce

Crews of up to 5 persons would be involved in the construction of the cooling water system pipeline improvements. Installation of the new cooling tower would require a workforce of 6 persons. Multiple improvements could take place simultaneously, with a maximum workforce at any one time of 10 persons.

Schedule

Construction of the cooling water system improvements would begin in July 2007, and would be conducted during the subsequent 12-month period. The construction duration of individual improvements would be highly variable, and some activities would occur simultaneously.

2.3.5.5 Other Considerations

Utilities

The cooling water production and distribution system is a closed-loop system, so very little new water is needed each day. Potable water from the campus domestic water system is needed mainly to make up for water loss that occurs in the cooling towers due to evaporation and to maintain water quality. Up to approximately 339,000 gallons per month (approximately 4 million gallons per year) of potable water would be used for this purpose assuming the Campus selects Option 2. Under Option 1, the increase in cooling capacity would be smaller and the increased water demand would be smaller than with Option 2.

Approximately 51,000 gallons per month of wastewater could be generated through bleeding and flushing (blow down) of the new cooling tower. The wastewater would be discharged to the campus wastewater collection system for treatment at the City of Santa Cruz wastewater treatment plant (WWTP). Chemicals are added to the existing cooling water system and would also be used in the new cooling tower to keep the system sanitary and operating properly.

Approximately 250 kW of electricity would be needed to operate the expanded cooling water system.

Hazardous Materials

To maintain optimal plant conditions, water used in the cooling tower would be treated with several chemicals. Sulfuric acid would be used to control pH, biocides would be used to minimize bacterial growth, and other chemicals would be used to control corrosion in the cooling tower. Sulfuric acid, which would be added periodically and in controlled amounts to the water circulating in the cooling towers, is currently stored in a 55-gallon drum on the Central Heating Plant site and the three existing towers use approximately 110 gallons per month. Under Option 2, the new cooling tower at the Earth and Marine Sciences Building site would use approximately 100 gallons per month. Based on the amount of corrosion inhibitor currently used at the Central Heating Plant, it is expected that about 30 gallons would be used per month in the cooling tower. The chemicals would be stored in a new shed designed with secondary containment, adjacent to the new cooling tower. If Option 1 is selected, the new cooling tower would be smaller than under Option 2, and the amount of chemicals used would also be smaller. Unused chemicals would be stored according to relevant regulations and would be disposed of in accordance with state and federal laws by the campus Environmental Health and Safety office.

The use of hazardous chemicals as part of the proposed project would generate small quantities of hazardous waste that would be collected, transported, and shipped off campus for disposal.

2.3.6 Proposed Campus Core Heating Water System Improvements

2.3.6.1 Objectives of Campus Core Heating Water System Improvements

Portions of the existing heated water system on campus are inadequate for current applications. The principal objective of this component of the proposed project is to provide more heating water capacity for buildings that are currently planned under the 1988 LRDP.

2.3.6.2 Existing Conditions

The campus core heating water system is designed for high-temperature water. It originally consisted of two heating water boilers and more than two miles of insulated welded steel pipe through a system of concrete tunnels, manholes, expansion loops, pipe anchors and piping that allowed for thermal expansion and contraction. In the mid-1980s, the Campus completed construction of a 2.5 MW cogeneration plant located near the Central Heating Plant to generate electricity on campus. The by-product heat from the cogeneration plant is used to preheat water for the heating water system boilers. This alteration significantly reduced the operating temperature of the heating water system, and subsequent connections to the system used components rated for lower temperatures. Subsequently, the campus completed two expansions of the Central Heating Plant, which includes three 23.4 million Btu (Mbtuh) boilers. The system currently uses the three boilers and the cogeneration system to heat water to approximately 210 to 220 degrees Fahrenheit (ºF). The heated water is distributed to campus core buildings through the distribution system. Building heating water is received either directly from the distribution system or through heat exchange systems and is reduced to 180 ºF for use within the buildings. The distribution system returns the water to the Central Heating Plant for reheating and redistribution.

Peak demand for heated water in 2003 was 43.740 Mbtuh (Rogers & Associates 2003). Although the existing system had adequate capacity to supply this demand, an evaluation in 2003 identified system deficiencies (Rogers & Associates 2003). Some components of the distribution system are not capable of accepting design temperatures and thus cannot be operated at system capacity. The pipe network in the Theater Arts Complex is poorly insulated and operates inefficiently. The heat rejection equipment associated with the cogeneration plant is overloaded during period of low heating demand (hot days), such that the cogeneration operation must be reduced to avoid overheating the system, and this adversely affects the electrical output of the cogeneration system.

2.3.6.3 Proposed Improvements

Proposed improvements to the campus core heating water system would include replacement of low-temperature–rated piping in the campus core and small sections of piping in the Theater Arts Complex. In addition, modifications to the Sinsheimer Laboratories heating and cooling system would absorb excess heat from the cogeneration system and allow it to function more effectively.

Phase 1

Phase 1 of the proposed Infrastructure Improvements Project would not include improvements to the core heating water system.

Phase 2

Under Phase 2, the Campus would construct the following improvements:

- Replace low-temperature piping with higher-rated materials in building connections off the main distribution system and in mechanical rooms of campus core buildings.
- Replace segments of piping to avoid heat loss in the Theater Arts Complex. Excavate and upgrade approximately 400 lf of 4-inch-diameter hot water and hot water return pipe. Install two valves with risers and boxes, one expansion loop, and one concrete anchor or as an alternative, install two boilers at Theater Arts Complex in lieu of replacing pipe.
- Re-pipe the absorption chiller at Sinsheimer Laboratories to the campus core heating water distribution loop to absorb some of the heat that would normally be rejected at the campus cogeneration plant.

All of the proposed improvements would be located within campus streets or other developed areas, inside mechanical rooms and in the Sinsheimer Laboratories building. The locations of the proposed improvements are shown in Figure 2-5, *Campus Core Heating Water System Improvements*.

2.3.6.4 Construction

Access

Existing campus roadways would provide access to most work locations and no roadway modifications would be needed. Most work would take place within existing facilities or complexes.

Equipment and Construction Procedures

The proposed project includes installation of short pipeline segments. Trenching equipment and necessary disturbance would be similar to those discussed under Domestic/Fire Protection Water Distribution System Improvements, above, but since pipelines modifications would be minimal, operations would be generally on a smaller scale.

Workforce

Crews of up to 5 persons would be involved in the construction of the campus core heating water pipeline improvements. Assuming two improvements are constructed simultaneously, a total of up to 10 persons engaged in heating water system improvements might be present on campus at any given time.

Schedule

Construction of heating water system improvements would begin in September 2008, and would take place during the subsequent 8 months.

2.3.6.5 Other Considerations

The increased consumption of natural gas, electricity or domestic water that would result from the heating water system improvements is accounted for in the utility estimates for all campus growth under the 2005 LRDP, as reported in Chapter 3, *Project Description* (Volume I).

2.3.7 Proposed Electrical System Improvements

2.3.7.1 Objectives of Electrical System Improvements

Some components of the campus electrical system are outdated, are not rated to handle anticipated loads, and may pose potential fire safety issues. The principal objective of this component of the project is to improve the reliability of the electrical distribution system.

2.3.7.2 Existing Conditions

Pacific Gas and Electric (PG&E) supplies the campus with 21 kilovolt (kV) electrical service with parallel feeders from a substation at the southeast campus boundary. From this point of delivery, power is conveyed to the Merrill Substation, a campus substation near Merrill College, where two transformers reduce the voltage to 12 kV. Power is then distributed throughout the central campus from this substation via four feeder lines. Lower campus buildings receive power directly from PG&E via a single separate electrical line. Power is distributed throughout the campus using underground, concrete-encased duct banks. High voltage switches located in subsurface manholes are used to isolate sections of the campus electrical grid as needed for repairs and maintenance.

A natural gas-fired cogeneration plant was installed on the campus in 1984-85 to provide 2.5 megawatts (MW) of power. This plant has the capability to operate independently from the PG&E grid, and can provide back-up power for laboratories and other facilities in the campus core that have critical power needs.

Electrical system peak demand in 2003 was approximately 9.49 megavolt-amperes (MVA), for which the system had adequate capacity and back-up capacity. However, an Electrical Systems Master Plan prepared for the campus in 2002 revealed potential deficiencies in the existing 12 kVA distribution system, which present concerns for safety, could hinder emergency response, and pose a threat of extensive power failure (Applied Power 2002). The campus's underground sectionalizing switches are nearly 40 years old and contain hazardous, flammable insulating oils. Failure of these older switches could result in fires, spills or explosions that could be dangerous in manholes and surrounding areas. Furthermore, the electrical feeders from the Merrill Substation to the northeastern portion of the campus pose a high risk of power failures, and do not have ground fault protection switches to section off portions of the lines in the event of a failure. A power failure along any of these lines would affect the entire feeder and result in a loss of power to all the buildings supplied by the line. The campus's high-voltage electrical system design allows continued operation of the electrical system in most locations during maintenance and power failures. However, an outmoded and inadequately designed switch at the Merrill Substation would be hazardous in the event of a major failure, cannot be maintained without shutting down the entire campus, and poses a threat of power failures that could affect the entire portion of the campus that is served by the substation.

2.3.7.3 Proposed Improvements

Phase 1

No work on the electrical system is proposed during Phase 1 of the Infrastructure Improvements Project.

Phase 2

The Campus would conduct the following activities during Phase 2 of the proposed project:

- Replace oil-filled sectionalizing switches in the central campus with new switches either within the same underground vaults or in aboveground utility boxes.
- Replace a recloser switch at Merrill Substation.
- Install protective relaying at the Merrill Substation and cogeneration plant.
- Splice feeder near Earth and Marine Sciences Building.

The proposed improvements would be located within campus roadways or other developed areas and at the Merrill Substation. The locations of the proposed improvements are shown in Figure 2-6, *Electrical System Improvements.*

2.3.7.4 Construction

Access

Existing campus roadways would provide access to all work locations. Roadway modifications or new access roads would not be needed.

Equipment and Construction Procedures

Switch replacements would require accessing existing underground vaults through existing hatches, and could also include installation of new aboveground vaults. A crane or forklift could be required to open hatches or move switching equipment. The remainder of the work likely would be accomplished with manual labor. Very short-term temporary power shutoff would be required to change out each switch.

Workforce

Switch changes and other improvements could be accomplished by a crew of two to four persons. It is anticipated that switches would be changed sequentially by a single small crew.

Schedule

The campus would begin work on electrical system improvements in September 2008, during Phase 2 of the proposed project. The improvements would be completed during the 8 subsequent months.

2.3.8 Proposed Natural Gas System Improvements

2.3.8.1 Objectives of Natural Gas System Improvements

The campus's natural gas distribution system does not have sufficient pressure to provide gas to certain campus areas on cold days. The principal objective of this component of the project is to improve regulation and reliability in the natural gas distribution system.

2.3.8.2 Existing Conditions

Most campus buildings at UC Santa Cruz are heated with natural gas, either directly through the use of gas-fired heating equipment within the building, or indirectly through the use of hot water from gas-fired boilers in the Central Heating Plant. Natural gas is also used in the campus cogeneration facility. In addition to using gas for heating, many campus research facilities use natural gas for laboratory and experimental purposes.

PG&E supplies the campus with natural gas from a high-pressure connection at the southern end of the campus, near Western Drive. The campus-owned natural gas distribution system consists of approximately 12 miles of piping. The system is laid out ladder-fashion, with primary piping extending up Heller Drive and Hagar Drive and east/west cross-connections along Meyer Drive and McLaughlin Drive. The campus network operates at 12 psi with two pressure-reducing stations; one at the supply point and one farther north near College Eight. From the College Eight pressure-reducing station (which is located on the west side of Heller Drive across from College 8 parking lot and southeast of Family Student Housing complex), a dedicated unregulated higher-pressure gas main runs north to supply the cogeneration system at the campus Central Heating Plant near the Engineering building.

Recent analysis of the natural gas distribution system has identified the need for the repair of deteriorated or constrained areas of the network and the replacement or upgrade of system components. The Infrastructure Improvements Project would address these existing operational problems.

2.3.8.3 Proposed Improvements

Phase 1

No improvements to the natural gas system are proposed in Phase 1 of the Infrastructure Improvements Project.

Phase 2

The Campus would carry out the following improvements in Phase 2 of the proposed project:

- Replace the existing below-grade College Eight pressure-reducing station with an above-grade vault. The new College Eight vault would be located in the meadow area west of Heller Drive at or near the location of the existing below-grade College 8 station. The project would include the construction of a 6-foot by 18-foot housekeeping pad surrounded by 50 lf of 6-foot to 8-foot-tall fencing and installation of necessary equipment.
- Upgrade the piping in Hagar Drive between Steinhart Way and McLaughlin Drive, which supplies core campus areas to the north, and which is undersized for the current demand.

The locations of the proposed improvements are shown in Figure 2-7, *Natural Gas System Improvements*.

2.3.8.4 Construction

Access

Existing campus roadways would provide access to all work locations.

Equipment

Pipelines. The proposed project includes pipeline upgrades. Trenching equipment and necessary disturbance are discussed under Domestic/Fire Protection Water Distribution System Improvements, above. Installation of new or replacement pipelines could require short-term temporary closures of one lane along some roadways.

Pressure-Reducing Station Improvements. A 6-foot by 18-foot concrete pad would be poured for the new College Eight pressure-reducing station. This would require access to the site by a concrete truck. The new vault, likely a manufactured or modular structure, and associated fencing would be installed using a forklift, truck, fence-post auger, and manual labor.

Workforce

Crews of up to five persons would be involved in the upgrade of the natural gas line in Hagar Drive, and a crew of two to three persons would be involved in the work on the pressure-reducing station site.

Schedule

Natural gas system improvements would be undertaken during Phase 2, starting in September 2008, and would be completed during the subsequent 8 months.

2.3.9 Workforce Summary

Under the proposed Infrastructure Improvements Project, improvements to multiple facilities might be underway at any given time. It is anticipated that, considering all utility activities, construction crews totaling up to 35 to 40 persons might be present during a 36-month period. Higher numbers of construction crew personnel would likely be present during the first 12 months of Phase 1 and again during the first 8 months of Phase 2. Due to overlapping of work phases, the largest workforce (up to 40 persons) could be present between July and December 2008.

The principal population associated with the proposed project would be contractor personnel who would work on campus in variable numbers during the 36-month span of the project. It is assumed that labor would be obtained locally or regionally to provide the necessary construction workforce. Because the proposed project would address existing problems and deficiencies of existing utility systems, it would not require the Campus to hire new staff to service or maintain these systems. Therefore, the proposed project would not increase the population of the campus.

2.3.10 Schedule Summary

Phase 1 of the Infrastructure Improvements Project, including storm drainage, cooling water, and domestic water system improvements, would be implemented beginning in summer 2006. Cooling system and domestic water improvements would be completed in July 2008, while storm drainage improvements would continue through January 2008. The Phase 2 improvements, including storm water drainage, core heating water, electrical, and natural gas system improvements, would be implemented beginning in summer 2007. Core heating water, electrical and natural gas system improvements would be completed in March 2009, while storm water drainage improvement activities would continue through January 2009.

The proposed schedule for all improvements is illustrated in Figure 2-8, *Infrastructure Improvements Project Construction Schedule.* This figure is presented at the end of this chapter.

2.3.11 Permits and Approvals

The Regents will consider the approval of Phase 1 of the Infrastructure Improvements Project soon after the anticipated approval of the 2005 LRDP in 2006. Phase 2 of the project will be subject to final review and approval upon completion of design sometime in 2007.

It is anticipated that some of the activities associated with the storm water drainage improvements that would encroach on or be located within stream channels will require one or more of the following permits and approvals:

- Section 404 permit from the U.S. Army Corps of Engineers (ACOE)
- Biological Opinion from the U.S. Fish and Wildlife Service (USFWS)
- Section 401 certification from the Central Coast Regional Water Quality Control Board
- Section 106 compliance and concurrence from the State Historic Preservation Office
- Section 1601 permit from California Department of Fish and Game (CDFG)

In addition, all components of the Infrastructure Improvements Project would require coverage under SWRCB's NPDES General Permit for Storm Water Discharges Associated with Construction Activities. The new cooling tower would require an Authority to Construct and Operate from the Monterey Bay Unified Air Pollution Control District.

2.4 ENVIRONMENTAL SETTING, IMPACTS, AND MITIGATION MEASURES

As discussed above, the proposed project consists of a number of components (storm water drainage system, cooling water system, natural gas system, etc). Therefore, to assist the reader in identifying which component would result in environmental impacts that are discussed in the sections that follow, the following abbreviations have been used in numbering the impacts:

- IIP-SW - Infrastructure Improvements Project, Storm Water Drainage Improvements
- IIP-DW - Infrastructure Improvements Project, Domestic Water System Improvements
- IIP-CW - Infrastructure Improvements Project, Cooling Water System Improvements
- IIP-NG - Infrastructure Improvements Project, Natural Gas System Improvements
- IIP-ALL - Infrastructure Improvements Project, All Systems

The heating water and electrical system improvements would not have any potential impacts other than those associated with all systems.

As discussed above in the detailed project description, each component includes more than one improvement or element (listed in the descriptions above as Items 1, 2, etc.). As appropriate, tables have been included in the sections that follow showing specifically which improvement would result in a certain environmental impact. It should be noted that not all improvements would result in environmental impacts. In fact several of the improvements to the domestic water, cooling water, heating water, natural gas and electrical systems are minor improvements that would be located in areas that are already disturbed and developed and therefore significant environmental impacts from these improvements are not considered likely. A large number of storm water drainage system improvements by virtue of their locations in creeks and drainages, the new cooling tower, and a few of domestic water system and natural gas system improvements are the main elements of the proposed project that could result in environmental impacts. The analysis below focuses on these improvements.

As described earlier, some of the utility systems improvements would be constructed in Phase 1 of the proposed project, some would be constructed in Phase 2, and improvements to some of the systems would be made in both phases. Because of the overlapping construction schedules of these improvements, for purposes of estimating certain impacts (such as construction-phase air emissions), the analysis assumes that several elements of each of the system improvements will be under construction simultaneously. The impacts from this reasonable worst-case scenario are evaluated. At all other times during the 42-month construction period, the level of construction activity would be lower than this analysis estimates, and the construction-phase impacts would therefore be lower.

2.4.1 Aesthetics

2.4.1.1 Environmental Setting

Section 4.1, *Aesthetics* (Volume I), presents the existing visual character, quality and resources for the entire UC Santa Cruz campus. The Infrastructure Improvements Project involves a large number of small sites located throughout the campus, with practically all of the storm water drainage improvements located within or near water courses on the campus, and other utilities located mostly within roadways, utility corridors or other developed portions of the campus. Table 2-2b, *In-Channel Storm Water Drainage Improvements*, presented at the end of this chapter, identifies which of the storm water drainage improvements would be moderately to highly visible, and those that would not be visible to most viewers on campus. Only those elements of the proposed project that would be moderately to highly visible are assessed here, with respect to potential aesthetic impacts, since there is not potential for impacts from improvements that were not easily seen.

2.4.1.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.1 in Volume I for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.1 (Volume I) for the analytical method relative to visual resources.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. All of the proposed domestic water system improvements would involve replacement or installation of underground pipelines within existing utility corridors, which are mostly within campus roadways. Similarly, all heating water system improvements, all of the natural gas system improvements, and most of the cooling water improvements also would include underground pipelines located in already developed areas. Electrical system improvements would consist of switch replacements at already developed sites. None of these improvements has the potential to result in impacts on visual resources. The only improvements with a potential for visual impacts are the storm water drainage improvements, the proposed cooling tower, and the College Eight natural gas pressure-reducing station. Impacts from these improvements are discussed below.

Project-Specific Impacts and Mitigation Measures

IIP-SW Impact AES-1:	Construction of the proposed storm water drainage improvements could temporarily affect the visual quality in the vicinity of the improvements.
Significance:	Less than significant
IIP–CW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

The storm water drainage system improvements include approximately 94 small improvements throughout the campus. About one-third of these would be constructed in Phase 1 and the remainder would be constructed in Phase 2. All of the improvements would be built over a period of about three years. As shown in Table 2-2b, most of the improvements have very small footprints (less than 0.1 acre), and several of the improvements would not be visible to viewers on the campus. The table also identifies those improvements that would be highly visible because they would be near roads and paths used by the campus population. These include a new detention basin at the confluence of Kresge and Baskin tributaries (Item 91), a new detention basin southeast of Kerr Hall (Item 60), Steinhart Way culvert extension (Item 46), improvements to Chinquapin Sinkhole (Item 8), improvements to the Music Center Sinkhole (Item 19), several small improvements in the Great Meadow Tributary (Items 20 through 23), a new detention basin to the north of the Heller Drive/Empire Grade intersection (Item 106), and several improvements in Moore Creek East Fork adjacent to Oakes College (Items 83 through 86). In addition, the natural landscape in several areas of the campus would be temporarily disturbed locally by access roads that would be constructed to access the work sites (see Table 2-3, at the end of this chapter, for a description of associated access roads). All of the work sites and access roads would be disturbed for the duration of the construction activities. However, because the duration of construction of all facilities is fairly short (less than 45 days), the visual change during the construction period would not represent a significant impact. Furthermore, consistent with campus standards, all disturbed areas would be restored to their pre-construction conditions. Once construction and restoration have been completed, most of the improvements would be small and visually unobtrusive. Although some in-channel improvements, such as gabions, would be apparent as human-engineered devices within the natural setting of the drainage, these would not generally be visible except in the immediate vicinity. Detention basins would be larger and more widely visible; however, like the existing detention basins on campus, they would not obstruct any views and would be similar in appearance to other open spaces on campus. Therefore, the visual impact of the storm water drainage improvements after construction would be less than significant.

IIP-CW Impact AES-2:	Construction of the cooling tower would not adversely affect the visual quality of the project vicinity, as it would not be visible from many vantage points.
Significance:	Less than significant
IIP–CW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

Two alternate locations are under consideration for the new cooling tower. The Option 1 site would be the site of the existing Cooling Tower #2 to the north of the Central Heating Plant. Although the new tower would be about two to three times larger than the current cooling tower, at this site, the cooling tower would not result in a significant visual impact to the character of the area as the area is already developed with similar facilities. Furthermore, the tower would not be visible from McLaughlin Drive, which is the nearest heavily used campus roadway. To the north and west of the new tower existing vegetation within the Jordan Gulch drainage would screen the tower from College Ten facilities that are located east of Jordan Gulch. The visual impact would be less than significant.

Under the second option, the new cooling tower would be located about 40 feet southeast of the Earth and Marine Sciences Building at the southeastern edge of the Science Hill area. At this site, the tower would be located in a wooded area near the service loading dock for the Earth and Marine Sciences Building. The tower would not be visible from any of the major roadways or other facilities to the north and west of the tower because of intervening buildings or to the east because of topography and vegetation. A campus pedestrian path that runs from the southern end of Science Hill to the Student Union and Student Services area on Hagar Drive is located about 50 feet south of the proposed tower site. The tower would only be partly visible to persons using this path because it would be screened by existing vegetation. Tree removal around the project site would be avoided and landscaping would be installed and the new tower would be close to the existing buildings. Therefore, the new tower would not result in a significant impact on visual resources.

IIP-NG Impact AES-2:	Construction of the College Eight natural gas pressure-reducing station would not adversely affect the visual quality of the project vicinity.
Significance:	Less than significant
IIP–NG Mitigation:	Mitigation not required
Residual Significance:	Not applicable

The proposed project would replace the existing below-grade College Eight pressure-reducing station on the slope west of Heller Drive and southeast of Family Student Housing with an above-ground station. The proposed equipment would be installed on a small pad (6 feet by 18 feet in dimensions) surrounded by a 6 to 8 foot fence. Because the proposed structure would be small, and because the area nearby is developed with several other structures associated with the Family Student Housing complex and pedestrian overcrossing, it would not result in a substantial change in the visual quality of this area and the impact would be less than significant.

Cumulative Impacts

The proposed project would not contribute to cumulative impacts on visual resources and scenic vistas (LRDP Impacts AES-7 through AES-9) because the project generally involves small scale improvements, most of which would be below grade or in drainages, and they would not be visible from key vantage points on or off campus.

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2.4.2 Agricultural Resources

2.4.2.1 Environmental Setting

Section 4.2, *Agricultural Resources* (Volume I), presents the existing conditions with respect to agricultural resources at the UC Santa Cruz campus and the areas surrounding the campus.

2.4.2.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.2 (Volume I) for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.2 (Volume I) for the analytical method relative to agricultural resources.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. None of the proposed improvements would be located in the one area on the main campus that is designated Unique Farmland. Therefore the proposed project would not directly result in the conversion of farmland to non-agricultural uses. None of the utility system improvements would facilitate or indirectly result in the conversion of designated farmland. No project-specific analysis of this impact is required.

Project-Specific Impacts and Mitigation Measures

Not applicable.

Cumulative Impacts

The proposed project would not cause the campus population to increase and therefore the proposed project would not contribute to cumulative LRDP Impact AG-3.

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2.4.3 Air Quality

2.4.3.1 Environmental Setting

Section 4.3, *Air Quality* (Volume I), presents the existing air quality for the entire UC Santa Cruz campus, including the various sites that would be affected by the proposed Infrastructure Improvements Project. As part of the campus core cooling water system improvements, an existing cooling tower near the Central Heating Plant would be replaced with a larger cooling tower or a new tower may be built near the Earth and Marine Sciences Building. The new cooling tower would be a minor source of particulate matter. No existing or proposed sensitive receptors such as schools, hospitals, or daycare centers are located near the sites under consideration for the new cooling tower.

2.4.3.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.3 in Volume I for a discussion of applicable Standards of Significance.

Analytical Method. Air quality analysis for the Infrastructure Improvements Project is tiered from the discussion presented in Section 4.3. Construction activities generate short-term fugitive dust emissions, equipment exhaust emissions, and worker vehicle exhaust emissions. Impacts from fugitive dust were examined by evaluating the potential area of disturbance for any grading activities. The MBUAPCD considers fugitive dust emissions to be less than significant when they result from minimal grading activities involving less than 8.1 acres of ground disturbance per day or major earthmoving involving less than 2.2 acres of ground disturbance per day. According to the MBUAPCD CEQA guidelines, temporary exhaust emissions of VOC and NO_x from typical construction equipment are accounted for in the air quality plans, and quantification of these emissions is not needed.

For purposes of estimating construction emissions under reasonable worst case conditions, based on the schedule that is laid out in Section 2.3.10, it was assumed that during Phase 1 of the project, there would be simultaneous construction on three storm water drainage improvements (each involving 0.23 acre of land disturbance, including about 0.13 acres[3] disturbed by access roads), two domestic water pipeline improvements (each involving 0.1 acre of disturbance), and one cooling water system improvement involving 0.5 acre of land disturbance for a total of about 1.4 acres of disturbance. During Phase 2, up to six storm water drainage improvements, two heating water and one natural gas pipeline improvements could be underway simultaneously for a total land disturbance of about 1.7 acres.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. LRDP Impacts AIR-2 and AIR-3 addressed the impact from emissions of criteria pollutants that could result from the increased traffic associated with the growth on campus under the 2005 LRDP. The Infrastructure Improvements Project would not cause the campus population to grow and therefore would not contribute to vehicle emissions. Potential impacts to human health from toxic air contaminants (TACs) (LRDP Impact AIR-5) estimated for the campus as a whole took into account TACs from all major stationary and mobile sources. The Infrastructure Improvements Project does not involve any major TAC source and would therefore not contribute to the estimated health risk reported in LRDP Impact AIR-5. Because the proposed infrastructures improvements would be small, construction emissions of TACs would be lower than the emissions evaluated in LRDP Impact AIR-6. The risk from the emissions would not exceed the risk reported under LRDP Impact AIR-6. In fact the risk would be much lower. Furthermore, there is no reasonable way to estimate the risk from small construction activities that would not remain at one location for more than 1 month. Analysis of localized CO impacts from all the traffic associated with the 2005 LRDP (LRDP Impact AIR-3) shows that the LRDP-related traffic would not result in a significant localized impact from CO emissions. Furthermore, the proposed project would not increase campus population and would not result in CO emissions. No odor sources are associated with the project; therefore, odor impact is not an issue. Because of the low emissions associated with the project, it would not conflict with the regional air quality management plan.

Project-Specific Impacts and Mitigation Measures

IIP-ALL Impact AIR-1:	Construction of the proposed project would generate short-term fugitive dust and PM_{10} exhaust emissions.
Significance:	Less than significant
IIP–ALL Mitigation AIR-1:	The Campus shall implement LRDP Mitigation AIR-1 (Apply standard MBUAPCD recommended mitigation measures).
Residual Significance:	Not applicable

Construction vehicles and equipment and earthmoving activities would produce PM_{10} and other criteria air pollutants during the construction period. According to the MBUAPCD, minimal earthmoving activities that involve less than 8.1 acres per day of area disturbed would generate PM_{10} and fugitive dust emissions less than the 82 pounds per day significance threshold. The types of construction activities that would be involved in the proposed project are described in detail in Section 2.3. As explained earlier, based on the construction schedule, the total area that may be disturbed at one time due to the proposed

[3] Access roads that would be constructed to access storm water drainage improvement sites are listed and described in Table 2-3, and would vary from a minimum length of about 60 feet to a maximum of 2,125 feet. Also, not all improvement sites would require the construction of an access road. To estimate emissions from roadway construction, it was conservatively assumed that an access road would be associated with each improvement. Based on lengths reported in Table 2-3, the average length of access roads is estimated to be about 545 feet. Assuming a roadway width of 10 feet, each access road would entail about 5,450 square feet or about 0.13 acre of disturbance.

project is expected to be less than 2 acres, and would involve minimal grading. Because the area that would be disturbed would be substantially lower than 8.1 acres per day, the construction-related PM_{10} and fugitive dust emissions would be low. Therefore, impacts from PM_{10} and fugitive dust are expected to be less than significant.

Even though impacts from construction activities are anticipated to be less than significant, the dust control mitigation measures identified in LRDP Mitigation AIR-1 would be implemented to further reduce emissions from construction activities.

Cumulative Impacts

The LRDP-level analysis took into account the increased traffic and other activity associated with the growth on campus. The LRDP-level analysis concluded that regional emissions would be significant and that campus growth would likely hinder the attainment of the regional air quality plan since the population growth was not accounted for in the AMBAG forecasts that form the basis of the 2004 Air Quality Management Plan (AQMP) (LRDP Impact AIR-2 and AIR-4). Implementation of LRDP Mitigation AIR-2 and AIR-4 would reduce the impacts, but the impacts would remain significant and unavoidable. The proposed project would not contribute to the significant and unavoidable impacts identified in LRDP Impacts AIR-2 and AIR-4.

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2.4.4 Biological Resources

2.4.4.1 Environmental Setting

Section 4.4, *Biological Resources* (Volume I), presents the regional environmental setting for the entire UC Santa Cruz campus, including the sites that would be affected by the Infrastructure Improvements Project.

Potential impacts to biological resources are evaluated based on a review of the available literature regarding the status and known distribution of the special-status species within the project area, and data collected from studies conducted at UC Santa Cruz for other projects. Botanical and wildlife surveys have been conducted for a majority of the campus (EcoSystems West 2000, 2004a; Entomological Consulting Services 2002; Jones & Stokes 2002, 2004a, 2005). Habitat assessment surveys were conducted of all of the infrastructure improvement project sites on June 27-28, 2005 by Jones & Stokes wildlife biologists and botanists. Additional sources used in the impact analysis include the following.

- U.S. Fish and Wildlife Service (USFWS) List of Endangered and Threatened Species that May Occur in or Be Affected by Projects in Santa Cruz County, current as of April 15, 2005
- The California Department of Fish and Game’s Natural Diversity Database query results for the U.S. Geological Survey’s 7.5-minute quadrangles of Santa Cruz and Felton (CNDDB 2005)
- The California Native Plant Society’s Electronic Inventory (2005)
- Recent environmental documents for projects at UC Santa Cruz, including the Ranch View Terrace HCP Environmental Assessment and the EIR for the Ranch View Terrace Project (Jones & Stokes 2005, 2004b), the West Kiosk Improvement Area Biological Assessment (Ecosystems West 2004b), and the College Infill Apartments EIR (UC Santa Cruz 2001)
- Relevant campus infrastructure studies, including the UC Santa Cruz Stormwater and Drainage Master Plan (Kennedy/Jenks Consultants and Balance Hydraulics, Inc. 2004) and the Erosion Control Plan and Preliminary Design Report for the Great Meadow Tributary (Singer et al. 2004)

Once all data sources were reviewed, a final list of special-status species with a moderate or high potential to occur within the project areas was compiled, and each of the species was evaluated for presence on or absence from the site. In addition, the presence of suitable habitat characteristics was evaluated. Table 2-4, *Special-Status Plant Species with the Potential to Occur in the Project Area*, and Table 2-5, *Special-Status Wildlife Species with the Potential to Occur in the Project Area*, are provided at the end of this chapter. *Special-status species* are defined below in the Special-Status Species section of this document. For informational purposes, these tables include species that occur on campus or in the region but have no or low potential to occur in the Infrastructure Improvements project area.

Species are rated in Tables 2-4 and 2-5 for their potential to occur at the proposed improvement sites and/or access routes. Species rated as having "no potential to occur" have no suitable habitat on campus or are thought to have been extirpated from the region. Species rated as having "low potential to occur" include species whose known distribution does not include the campus; species for which little appropriate habitat or only marginal habitat is present at project sites and/or access routes; and species that have not been observed on campus during recent surveys. Species rated as having "moderate or high potential to occur" include those species for which suitable habitat characteristics are present at project sites and/or access routes, even though the species was not detected during focused surveys. Species rated as "known to occur" have been observed at the specific project sites and/or access routes. Species rated as having "moderate or high potential to occur" or "known to occur" at project sites were considered in the impact analysis.

Project Setting - Storm Water Drainage Improvements

Although approximately 94 storm water drainage improvements are proposed and 36 potential access routes are necessary to complete these projects, the majority of projects are confined to a few specific riparian corridors and adjacent uplands within the creeks and drainages at UC Santa Cruz. Thus, the setting of the proposed improvements and habitat characterization is described and analyzed for these creeks and drainages.

Jordan Gulch East Fork. The east fork of Jordan Gulch originates near Spring Road, east of the College Nine. This drainage flows generally southeast to its confluence with the main stem. Approximately five storm water drainage improvement projects are located within the east fork of Jordan Gulch; the project sites are served by two access routes.

The east fork of Jordan Gulch traverses an area of redwood forest. The channel itself is unvegetated. Vegetation adjacent to the channel is dominated by redwoods in the forest canopy, hazelnut (*Corylus cornuta* var. *californica*) and California blackberry (*Rubus ursinus*) in the shrub/vine layer, and coastal wood-fern (*Dryopteris arguta*) and western swordfern (*Polystichum munitum*) in the herb layer. Patches of sedge (*Carex* spp.) are present. Non-native plant species are also present, notably forget-me-nots (*Myosotis latifolia*) in shaded areas and smartweed (*Polygonum* spp.) and bull thistle (*Cirsium vulgare*) in openings, such as sinkholeareas.

Wildlife that may be found in the east fork of Jordan Gulch includes several bird species such as the spotted towhee (*Pipilo maculates*), oak titmouse (*Baeolophus inornatus*), house finch (*Carpodacus mexicanus*) and the Steller's jay (*Cyanocitta stelleri*). During the site visit, a yellow warbler (SSC) (Dendroica petechia) was heard in the gulch. The dusky-footed woodrat (SSC) (*Neotoma fuscipes*) could also be found in open spaces adjacent to the channel. The riparian zone also provides foraging and nesting habitat for special status raptors. No California red-legged frogs (CRLF)(FT) (*Rana aurora draytoni*) are known from the east fork of Jordan Gulch nor was any suitable California red-legged frog habitat identified in this drainage. The channel was completely dry at the time of the June surveys.

Jordan Gulch Great Meadow Tributary. The Great Meadow Tributary (GMT) runs from the Music Center detention basin southeast to its confluence with the main stem of Jordan Gulch at the

Village student housing facility. A paved bicycle trail runs along the creek for a portion of its length. Approximately five infrastructure improvement projects are located within the Great Meadow Tributary, and are served by three access routes.

The Great Meadow, through which the tributary flows, is composed of California annual grassland. This grassland is dominated by non-native grasses, such as wild oats (*Avena* spp.), big quaking grass (*Briza maxima*), bristly dogstail (*Cynosurus echinatus*) and soft chess (*Bromus hordeaceus*). However, purple needlegrass (*Nasella pulchra*), a perennial native bunchgrass, also forms a significant component of the grassland in the Great Meadow. Coyote brush (*Baccharis pilularis*) is occasionally found in the channel, and in small patches in the adjacent grassland. Unstable portions of the channel are dominated by non-native, ruderal species, such as Italian thistle (*Carduus pycnocephalus*), prickly lettuce (*Lactuca serriola*), black mustard (*Brassica nigra*), Canadian horseweed (*Conyza canadensis*), and French broom (*Genista monspessulana*).

The Great Meadow provides habitat for many ground squirrels (*Spermophilus beecheyi*). Other species often utilize ground squirrel burrows, including special status burrowing owls (*Athene cunicularia*), small mammals, invertebrates, amphibians, and reptiles. Karst invertebrates could potentially be present in this area due to the karst system underlying areas along the Great Meadow Tributary. Special status raptors, including golden eagles and sharp shinned hawks, use the Great Meadow for foraging. Common wildlife species observed in the Great Meadow grassland habitats during previous campus surveys include Western meadowlark (*Sturnella neglecta*), red-tailed hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*) common raven (*Corvus corax*), meadow vole (*Microtus pennsylvanicus*), black-tailed hare (*Lepus californicus*), brush rabbit (*Sylvilagus bachmani*), and mule deer (*Odocoileus hemionus*) (Jones & Stokes 2004a).

Jordan Gulch West Fork. The west fork of Jordan Gulch is a relatively short drainage channel that flows south from Kerr Meadow around McHenry Library to join the middle fork. A sinkhole is located in this drainage, adjacent to McHenry Library. Approximately three storm water drainage improvement projects would be located within the west fork of Jordan Gulch, and would be served by four access routes.

Vegetation in and adjacent to the channel is dominated by redwoods and California bay (*Umbellularia californica*) in the forest canopy. The shrub layer is dominated by poison oak (*Toxicodendron diversilobum*), snowberry (*Symphoricarpos alba*), hazelnut, and California blackberry. The herb layer is dominated by forget-me-nots, trail plant (*Adenocaulon bicolor*), and western sword fern.

Kerr Meadow, the site of the proposed detention basin, consists of California annual grassland, dominated by non-native grasses, such as big quaking grass, wild oats, bristly dogstail, and canary grass (*Phalarus canariensis*). Native forbs, such as hedge nettle (*Stachys bullata*), are also present.

Wildlife found in the west fork of Jordan Gulch at the time of the June 2005 surveys consisted of a red-shouldered hawk (*Buteo lineatus*) and common song birds. Wildlife not observed during the 2005 surveys, but that are likely to inhabit this area, include the dusky-footed woodrat and special-status bat species that may forage in the riparian corridor. The sinkhole which occurs in this area could provide suitable habitat for karst invertebrates if it were connected underground to occupied habitat in the western portion of the campus.

Jordan Gulch Middle Fork. The middle fork of Jordan Gulch originates south of Spring Road and west of College Ten. The channel runs south under McLaughlin Drive. It continues south between McHenry Library and the Hahn Student Services Building, and turns east to its confluence with the main stem of Jordan Gulch. A sinkhole is located along the middle fork just north of McLaughlin Drive. Approximately seven infrastructure improvement projects would be located within the middle fork of Jordan Gulch, and would be served by four access routes.

The middle fork of Jordan Gulch flows through redwood forest. The channel itself, and the area immediately adjacent to it, is sparsely vegetated. Vegetation in and adjacent to the channel is dominated by redwoods and California bay (*Umbellularia californica*) in the forest canopy. The subcanopy and shrub layers are dominated by tanoak (*Lithocarpus densiflorus*), poison oak (*Toxicodendron diversilobum*), California honeysuckle (*Lonicera hispidula*), hazelnut, and California blackberry. Common species in the herb layer include redwood sorrel (*Oxalis oregana*) and trail plant (*Adenocaulon bicolor*). Non-native species such as English ivy (*Hedera helix*), forget-me-nots, black nightshade (*Solanum nigrum*), and Ehrharta grass (*Ehrharta erecta*) are also present in and adjacent to the middle fork channel.

The middle fork of Jordan Gulch forms a substantial corridor through the campus that is likely used by a wide variety of wildlife including rodents (including woodrats), raptors, song birds, bats, and mule deer. Little wildlife was seen during the June surveys. However, songbirds and raptors could be heard and woodrat scat was seen at the east side of the library. The site provides suitable habitat for the dusky-footed woodrat and the presence of scat suggests likely nesting in the vicinity of the project. Despite the lack of observations on the days of the survey, the site provides extensive potential nesting and foraging habitat for special-status raptors. The site also contains potential foraging habitat for special-status bat species.

<u>Jordan Gulch Main Stem.</u> The Jordan Gulch main stem originates at Hahn Student Services and flows south to the Village, running parallel to Hagar Drive. A small sinkhole is located adjacent to the channel just upstream of the Village. The drainage is culverted under the Village, and emerges south of the Village detention basin, where it continues south along a bicycle path east of the Center for Agroecology and Sustainable Food Systems. Approximately eight infrastructure improvement projects would be located within the main stem of Jordan Gulch, and would be served by three access routes.

The Jordan Gulch main stem flows through redwood forest and mixed evergreen forest. The channel itself is sparsely vegetated. Vegetation in and adjacent to the channel is dominated by redwoods and California bay in the forest canopy. The subcanopy and shrub layers are dominated by hazelnut, and also contain poison oak, California honeysuckle, snowberry, and California blackberry. Common species in the herb layer include western swordfern, coastal woodfern, redwood sorrel, and hedge nettle. Non-native species such as golden spurge (*Euphorbia oblongata*), bull thistle, English ivy, forget-me-nots, and Ehrharta grass (*Ehrharta erecta*) are also present in and adjacent to the main stem channel, and in the sinkhole.

The main stem of Jordan Gulch provides high quality roosting and foraging habitat for raptors, bats, and songbirds. Songbirds seen during a site visit included the oak titmouse, American robin (*Turdus migratorius*), and bushtit (*Psaltriparus minimus*). A doe and two fawns were seen resting at the north end of the gulch, indicating that this reach is used as a wildlife movement route for deer. Although no woodrats were seen, brush piles in the channel could possibly contain woodrat nests. While no special-status species were visible or audible at this location, the area provides extensive foraging habitat for special-status bats and raptors and nesting habitat for special-status raptors.

<u>Moore Creek East Fork.</u> The east fork of Moore Creek flows from the confluence of the Kresge and Baskin tributaries, at the intersection of Heller Drive and Meyer Drive. It flows south to the Arboretum, where an earthen dam is located, upstream of the Arboretum Pond. Approximately ten infrastructure improvement projects would be located within the east fork of Moore Creek, and would be served by seven access routes.

The east fork of Moore Creek flows through redwood forest, mixed evergreen forest, and riparian scrub. Grassland and developed areas are located adjacent to the riparian corridor. The upstream reach, from the confluence of the Kresge and Baskin tributaries to Oakes College, consists of redwood forest. The channel is sparsely vegetated in this reach. Redwoods and California bay dominate vegetation in and adjacent to the channel in this reach. The subcanopy and shrub layers are dominated by hazelnut, and also contain poison oak, California honeysuckle, and California blackberry. Common species in the herb layer include western swordfern, coastal woodfern, Baltic rush (*Juncus balticus*), and sedges (*Carex* spp.). Non-native species such as English ivy are also present in and adjacent to the channel.

Mixed evergreen forest is present around the east fork of Moore Creek downstream of the redwood forest reach for approximately 600 feet. Vegetation in the mixed evergreen forest reach is similar to that described above, but California bay and coast live oak (*Quercus agrifolia*) are more dominant in the forest canopy in this reach.

A band of riparian scrub is present along an approximately 800 foot long reach of the east fork of Moore Creek just upstream of the Arboretum. Vegetation in this area is dominated by arroyo willow (*Salix lasiolepis*), with coast live oak dominating a band of adjacent forest. The shrub layer is dominated by poison oak and Himalayan blackberry (*Rubus discolor*), and also contains California barberry (*Berberis pinnata*). Dominant species in the herb layer include stinging nettle (*Urtica dioica*), poison hemlock (*Conium maculatum*), forget-me-nots, and hedge nettle. This is one of two areas on campus with significant stands of willow-dominated riparian woodland and scrub (the west fork of Moore Creek is the other site).

The east fork of Moore Creek provides high quality habitat for special-status raptors and bats because of the foraging opportunities in the area. The proximity of the area to the Great Meadow also increases the value of this site as a nesting habitat in close proximity to high quality foraging habitat for special-status raptors. This reach provides suitable dispersal and foraging habitat for California red-legged frog, and suitable breeding habitat (occupied) at the Arboretum Pond. The east fork of Moore Creek was the only consistently wet channel segment observed at UC Santa Cruz during the June 2005 surveys.

Moore Creek Kresge Tributary. The Kresge Tributary to Moore Creek originates in the vicinity of the North Remote parking lot and flows south, parallel to and west of, Heller Drive. It joins the Baskin Tributary at Meyer Drive to form Lower Moore Creek. A sinkhole is located adjacent to the channel near the southern end of Kresge College. Seven infrastructure improvement projects would be located within the Kresge Tributary, and would be served by five access routes.

The Kresge Tributary flows through redwood forest. The channel itself is sparsely vegetated. Vegetation adjacent to the channel is dominated by redwoods and California bay. The subcanopy and shrub layers are dominated by tanoak and hazelnut. Common species in the herb layer include redwood sorrel and western swordfern. Mixed evergreen forest vegetation is present adjacent to the upstream reach of this channel. Douglas-fir (*Pseudotsuga menziesii*), tanoak, and coast live oak are found in the canopy, while California blackberry, baltic rush, and western lady fern (*Athyrium filix-femina* var. *cyclosorum*) are found in the vine and herb layers.

The Kresge Tributary supports diverse habitat including grassland/oak woodland and redwood forest, both providing suitable habitat for dusky-footed woodrats. The area provides nesting and foraging habitat for special-status raptors. Common wildlife seen during the site visit includes banana slugs (*Ariolimax columbianus*), songbirds, mule deer, and a woodpecker (call heard).

Baskin Tributary and Science Hill Tributary. The Baskin Tributary flows from McLaughlin Drive south to its confluence with the Kresge Tributary. It runs parallel to and east of Heller Drive. A sinkhole is located adjacent to the channel west of the Thimann Laboratories. The Science Hill Tributary is a small drainage that flows approximately 500 feet from the Sinsheimer Laboratories southwest to join the Baskin Tributary. Approximately four infrastructure improvement projects would be located within the Baskin Tributary, and would be served by four access routes. Two infrastructure improvement projects would be located within the Science Hill Tributary, and would be served by a single access route.

The Baskin and Science Hill tributaries flow through redwood forest. The channels and the sinkhole are sparsely vegetated. Vegetation adjacent to the channels is dominated by redwoods and California bay in the forest canopy. The subcanopy and shrub layers are dominated by tanoak and California blackberry. Common species in the herb layer include redwood sorrel, western swordfern, hedge nettle, and western Solomon-seal (*Smilacina racemosa*). Baltic rush and sedges (*Carex* spp.) are also present in the herb layer.

The Baskin and Science Hill tributaries support diverse habitat including riparian redwood forest, which provides suitable habitat for dusky-footed woodrats. The area provides nesting habitat for special-status raptors. The area also provides foraging habitat for special-status raptors. This area also provides a wildlife movement corridor created by the riparian forest.

Moore Creek West Entrance Fork. The west fork of Moore Creek originates at the detention basin south of College Eight. It runs southwest parallel to Heller Drive for approximately 500 feet, then flows southeast and flows to the West Dam, adjacent to the Arboretum. Approximately eight infrastructure improvement projects would be located within the west fork of Moore Creek, and would be served by four access routes.

A band of riparian woodland and scrub approximately 50 feet wide and 30 feet tall grows along the banks of the west fork of Moore Creek for most of its length. California annual grassland surrounds the riparian corridor and is found adjacent to the creek in some areas. This riparian woodland and scrub (about 3.4 acres) represents the largest and most important stand of this natural community on campus. It is one of only two such stands on campus (Lower Moore Creek is the other).

The College Eight detention basin at the upstream end of this drainage supports dense riparian scrub, dominated by arroyo willow and white alder (*Alnus rhombifolia*). Downstream of the detention basin, the riparian corridor is dominated by coast live oak in the canopy layer, with arroyo willow and poison oak in the subcanopy and shrub layers. French broom is also found in the shrub layer adjacent to portions of the creek. Western lady fern is found in the herb layer, as well as annual grasses such as big quaking grass. Grassland areas along the creek are dominated by non-native annual grasses such as big quaking grass and wild oats. Scattered coyote brush and poison oak are present in this grassland as well.

The site of the proposed detention basin on the northeast side of the Heller Drive/Empire Grade intersection is characterized by annual grassland vegetation with a significant component of ruderal species. Dominant species include Italian rye (*Lolium multiflorum*), bristly ox-tongue (*Picris echioides*), and English plantain (*Plantago lanceolata*).

The west fork of Moore Creek supports riparian woodland habitat that is suitable for the same suite of wildlife species as Lower Moore Creek. The west fork of Moore Creek also provides suitable dispersal and foraging habitat for California red-legged frog. The College Eight detention basin may provide suitable breeding habitat for CRLF, although no breeding has been observed there (EcoSystems West 2000). The riparian corridor provides nesting habitat for special-status raptors. The adjacent grasslands provide foraging habitat for special-status raptors. Due to the slope of the channel banks and the close proximity of grasslands to the channel, habitat for woodrats is not present near project sites.

Special-Status Species

Special-status species are defined as plants and animals that are protected under the ESA or CESA or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing (See Section 4.4 in Volume I for more details).

Forty-six *special-status plant species* were identified as having the potential to occur in northern Santa Cruz County and are listed in Table 2-4, at the end of this chapter. Of these species, 36 are associated with habitats that are not present in the project area. The remaining 10 species are found in riparian woodland, grassland, redwood forest or mixed evergreen forest. However, none of these species were identified in the 2002 and 2005 botanical surveys of the project area.

Four special-status plants are known or suspected to occur on campus: Santa Cruz manzanita, Point Reyes Horkleia, Marsh microseris, and San Francisco popcorn flower (Buck 1986; EcoSystems West 2004a; Jones & Stokes 2004a). Habitat for these species does not occur in the project area.

Forty-three *special-status wildlife species* were identified as having the potential to occur in northern Santa Cruz County/ Twenty-one of these species were identified as having the potential to be affected by storm water drainage improvements and/or construction access routes to the work sites, as indicated in Table 2-5 (at the end of this chapter).

Special-status wildlife species observed or determined to have a moderate to high potential of occurring in the project areas are discussed briefly below.

Cave Species. The Santa Cruz telemid spider (*Telemid* sp.), Dolloff Cave spider (*Meta dolloff*), Empire Cave pseudoscorpion (*Microcraegris imperialis*), and MacKenzie's cave amphipod (*Stygobromus mackenzei*) are special-status insects that are known to occur in Empire Cave, which is located in central campus. The Dolloff Cave spider is also known to occur in the nearby Dolloff Cave on the west side of Empire Grade Road, off campus. All of these species are listed as federal species of special concern. Special caving surveys have been conducted for these species in six caves within Cave Gulch (Briggs and Ubick 1988; Muchmore and Cokendolpher 1995; Muchmore 1996; Ubick 2001).

Suitable habitat for special-status cave species may also be present in central and lower campuses where sinkholes and other karst features in Jordan Gulch, the Great Meadow tributary, Lower Moore Creek, and the west fork of Moore Creek could be connected to the subterranean habitats of karst invertebrates. These caves are formed through years of water runoff that has dissolved pockets of limestone and created an underground network of small and large caverns. Large well-explored caves, like Empire and Dolloff, share subterranean connections with small, inaccessible cavities that are poorly documented. Small subterranean cavities likely provide the same suitable habitat conditions for the special-status cave species as do larger cavities more navigable to humans, but documentation is absent because of their inaccessibility. The four special-status cave species addressed here are capable of completing their entire life cycle below ground. These species are therefore capable of moving throughout the uncharted networks of caves and colonizing all suitable habitat, regardless of their proximity to a surface entrance. Literature suggests that the species likely do not inhabit small fractures or features that are within 1.5 meters (4.9 feet) of the surface where the heating and cooling during the summers and winters may be too variable for the species (Veni and Reddell 2002). There have been no surveys of most of the caves and sinkholes on campus so the network of underground connections is unknown. Although the special-status cave species have only been observed in Cave Gulch, they could occur in other limestone caves in the study area that are more than 2 meters (6.6 feet) in length or diameter and more than 1 meter (3.3 feet) deep (Veni and Reddell 2002).

California Red-Legged Frog. CRLF is federally listed as threatened and is a California species of special concern. Extensive surveys for CRLF on campus have documented the species only within the lower campus in Lower Moore Creek and the west fork of Moore Creek. CRLF is known to breed in only one location on campus—the Arboretum Pond within Lower Moore Creek (EcoSystems West 2000; Jones & Stokes 2002). The size of the breeding population is unknown because of the dense vegetation in and around the pond and the difficulty in surveying the site. The only other suitable breeding habitat on campus is the College Eight detention basin at the head of the west fork of Moore Creek. No CRLF have been found breeding at this site (EcoSystems West 2000, 2004a). Adult and subadult CRLF have been found in Lower Moore Creek and the west fork of Moore Creek, which provide suitable movement, foraging, and aestivation habitat but are not suitable for breeding. The individuals found in Moore Creek likely dispersed from the Arboretum Pond.

The nearest observation of CRLF off campus was approximately 0.4 mile northwest of the north campus, west of Empire Grade Road along Adams Creek, a tributary of Wilder Creek (EcoSystems West 2000).

All other occurrences of CRLF have been south or southwest of the campus (see Jones & Stokes 2004a for these off-campus locations). The closest observations of breeding CRLF off campus were 1 to 1.8 miles away in Wilder Ranch State Park and in ponds near Highway 1. The closest observations of non-breeding CRLF were 1.3 to 2 miles from campus in the Moore Creek and Wilder Creek drainages. Because CRLF occurs in Wilder Creek, CRLF may migrate between the Wilder Creek and Moore Creek drainages in the southwestern part of campus over the grassland and prairie habitat in that area.

EcoSystems West (2000) conducted a campus-wide assessment of habitat for CRLF that was subsequently refined by Jones & Stokes (2002). These studies mapped four zones on campus that corresponded to the likelihood of occurrence of CRLF based on the presence and quality of suitable habitat, barriers, or hazards to dispersal, and distance from known occurrence and the Arboretum Pond. Based on these surveys, it is likely that CRLF could be present at project sites in Lower Moore Creek and in the west fork of Moore Creek. It is unlikely that CRLF would be found in any of the other areas of proposed improvements due to the distance from known suitable habitats and due to the lack of habitat at the site. For more details on the ecology of this species, its occurrence on and near campus, and the presence of suitable habitat, see Jones & Stokes (2002, 2003, 2005) and EcoSystems West (2000, 2004a).

Southwestern Pond Turtle. Southwestern pond turtle (*Clemmys marmorata pallida*) is a federal species of concern and a California species of special concern. Southwestern pond turtles have been reported in Moore Creek south of the campus (CNDDB 2003). The Arboretum Pond and the pool area of Lower Moore Creek are the only suitable breeding habitat for southwestern pond turtles on the campus (Jones & Stokes 2004a). Given the high site fidelity of the species, it is unlikely that pond turtles would be found at any of the areas proposed for storm water drainage improvements.

Cooper's Hawk. Cooper's Hawk is a California species of special concern. Cooper's hawk has been recorded as breeding on the campus (Warrick 1982; Clark 1997). However, the exact locations of these observations were not described. This species is reported to have bred in the lower campus in 1988, down slope of McHenry Library (Stanley et al. 1990), which is near some of the proposed improvements. Suitable nesting habitat for Cooper's hawk is present in Lower Moore Creek (Jones & Stokes 2004a). While there is a potential for Cooper's hawk to nest in all of the watersheds in which improvements are proposed, it is unlikely that the species currently nests at UC Santa Cruz due to the lack of current nesting or foraging observations.

Sharp-Shinned Hawk. Sharp-shinned hawk (*Accipiter striatus*) is a California species of special concern. Potential nesting habitat for sharp-shinned hawk occurs on the north campus in tall stands of coniferous or deciduous trees, especially near water sources such as springs, drainages, and creeks including the upper reaches of all forks of Jordan Gulch. The sharp-shinned hawk has been recorded as breeding on the UC Santa Cruz campus and in surrounding mixed evergreen forests, including behind the Baskin Engineering Building and across from the Campus Trailer Park entrance (Warrick 1982; EcoSystems West 2004a) near the Kresge, Baskin, and Science Hill tributaries. Breeding behavior has also been observed near Red Hill Road on the north campus (EcoSystems West 2004a). The hawk may also be present as a winter migrant. All of the proposed improvement sites at UC Santa Cruz provide potential foraging and/or nesting habitat for the sharp-shinned hawk.

Golden Eagle. Golden eagle (*Aquila chrysaetos*) is federally protected under the Bald and Golden Eagle Protection Act and is a California species of special concern. There is one historical record of a golden eagle nest on campus but no recent records of golden eagles nesting on the campus (Warrick 1982; Clark 1997). Nesting and wintering golden eagles are relatively rare in Santa Cruz County and are thought to be limited to fewer than 10 pairs (EcoSystems West 2004a). Golden eagles are observed regularly foraging over the UC Santa Cruz and in Pogonip City Park (EcoSystems West 2004a). One juvenile and one adult golden eagle were observed foraging and perching on the ground in the grassland habitat east of Hagar Drive during 2002 field surveys (EcoSystems West 2001) and could potentially forage over the grassland of the Great Meadow near the Great Meadow Tributary. Suitable nesting and foraging habitat is present on the lower campus, but the relatively high degree of human disturbance makes it unlikely that this species would nest in any of the riparian areas on campus given the sensitivity of the species to human disturbance. Foraging habitat is likely limited to the grasslands around the Great Meadow Tributary.

Northern Harrier. Northern harrier (*Circus cyaneus*) is a California species of special concern. Suitable nesting habitat is present in the grasslands of the Great Meadow near the Great Meadow Tributary. Northern harriers were not observed during field surveys in 2002 (Jones & Stokes 2004a). The species presence is likely limited to the grasslands around the Great Meadow Tributary.

White-Tailed Kite. White-tailed kite (*Elanus caerules*) is a fully protected species under Section 3511 of the California Fish and Game Code. White-tailed kites have been observed foraging over the lower campus grasslands on a regular basis (Clark 1997; EcoSystems West 2004a; Jones & Stokes 2004a) and are likely to be found foraging at sites within the Great Meadow Tributary. The Great Meadow Tributary provides the only suitable foraging habitat at UC Santa Cruz. During surveys in 2000, biologists observed a pair of white-tailed kites exhibiting active nesting behavior in the north campus in the top canopy of a Douglas-fir tree (EcoSystems West 2004a). This tree was approximately 180 feet tall with a diameter at breast height of 8 feet 6 inches. A courting pair was found in the lower campus in June of 2005 during the site visit for this EIR. Given the proximity to grassland foraging habitats, nesting is most likely in the drainages of the main stem of Jordan Gulch, the east fork of Moore Creek, and the west fork of Moore Creek, but is possible in all of the storm water drainage improvement sites on campus, with the exception of the Great Meadow Tributary, which only provides grassland foraging habitat.

White-tailed kites are known to have both nest-site fidelity as well as colonial winter-roost fidelity; therefore, nests on campus are potentially revisited each year for nesting and during winter migration.

Western Burrowing Owl. Western burrowing owl (*Athene cunicularia hypugea*) is a federal species of concern and a California species of special concern. The UC Santa Cruz western burrowing owl population is one of very few known populations in Santa Cruz County, but consists primarily of a small and dispersed overwintering population (Alley 1988; Biosystems Analysis 1989; Pelc 1995; Beyer 2001). Several breeding pairs of western burrowing owls were observed on campus during the 1970s, and active burrows were last observed in the grasslands south of the East Remote parking lot in 2001 (Beyer 2001). Other records indicate the presence of owls in the meadow north of the CASFS and Arboretum, the southwest corner of UC Santa Cruz, and in the adjacent Campus Resource Lands west of Empire Grade Road (Pelc 1995; Beyer 2001). The majority of owl sightings were between Hagar Drive and Coolidge Drive, south of the East Remote parking lot (Alley 198; Pelc 1995; Beyer 2001).

While no western burrowing owls were identified during field surveys in 2002, suitable breeding and foraging habitat is present east of Hagar Drive and between Wilder Creek and Empire Grade Road, where the grass is sufficiently short to allow visibility for foraging owls, and ground squirrel burrows are abundant (EcoSystems West 2004a). The larger blocks of grassland habitat north of the Arboretum are suitable foraging and nesting habitats for western burrowing owl. Thus, burrowing owls have a potential to occur at Great Meadow Tributary improvement sites/access routes and in access routes to the main stem of Jordan Gulch, the east fork of Moore Creek, and the west fork of Moore Creek that pass through grasslands.

Vaux's Swift. Vaux's swift (*Chaetura vauxi*) is a California species of special concern. Vaux's swifts were not observed during field surveys of most of the campus in 2002 (Jones & Stokes 2004a). However, suitable habitat could occur in forest stands of older age classes, such as those located east and southeast of Marshall Field in the upper campus as well as in chimneys in campus buildings. Thus, suitable habitat is likely limited to Kresge Tributary, Baskin Tributary, and the three forks of Jordan Gulch.

Yellow-Breasted Chat. Yellow-breasted chat (*Icteria virens*) is a California species of special concern. A few breeding pairs of yellow-breasted chats have recently been recorded in Santa Cruz County (Suddjian 2004). Although this species was not observed on campus during the 2002 surveys, the east fork of Moore Creek has been used as migratory stopover habitat and could host migrants in the future (EcoSystems West 2004a). The riparian woodland along the east fork of Moore Creek could serve as breeding habitat.

California Yellow *Warbler.* The California yellow warbler (*Dendroica petechia brewsteri*) is a state species of special concern. Yellow warblers were not detected during surveys of the north campus in 2000 (EcoSystems West 2004a) and in surveys of the rest of campus in 2002 (Jones & Stokes 2004a), and nesting by yellow warblers has never been recorded on campus. However, nesting habitat is present along the east fork of Moore Creek northeast of the Arboretum. Yellow warblers are common migrants throughout the region and chaparral, riparian, ornamental plantings, and mixed evergreen forests are suitable migratory stopover habitats.

Special-Status Bats. The UC Santa Cruz is particularly rich in its diversity and abundance of bat species, many of which have special status. Bat species that occur or may occur on the project sites are the pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii townsendii*), western red bat (*Lasiurus blossevillii*), long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), yuma myotis (*Myotis yumanensis*), greater western mastiff bat (*Eumops perotis californicus*), big brown bat (*Eptesicus fuscus*), Mexican free-tailed bat (*Tadarida brasiliensis*), hoary bat (*Lasiurus cinereus*), and California myotis (*Myotis californicus*). Of these, the first eight are considered special-status species, and are described below.

Pallid Bat. Pallid bat is a federal species of concern, a California species of special concern, and a Western Bat Working Group (WBWG) species of high priority. Although suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch, pallid bats have not been detected on the UC Santa Cruz during any surveys and no suitable roosting habitat exists within the project drainages.

Pacific Townsend's (Western) Big-Eared Bat. Townsend's big-eared bat is a federal species of concern, a California species of special concern, and a WBWG species of high priority. EcoSystems West observed evidence of roosting and foraging Townsend's big-eared bat on the north campus during the 2000 surveys (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Western Red Bat. Western red bat is a WBWG species of high priority. EcoSystems West detected western red bats during the 2000 acoustic and mist net surveys in the north campus (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Long-Eared Myotis. Long-eared myotis is a federal species of concern. EcoSystems West detected long-eared myotis on the north campus in 2001 (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Fringed Myotis. Fringed myotis is a federal species of concern and a WBWG species of high priority. EcoSystems West detected fringed myotis on the north campus in 2001 (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Long-Legged Myotis. Long-legged myotis is a federal species of concern and a WBWG species of high priority. EcoSystems West detected long-legged myotis in the north campus in 2000 (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Yuma Myotis. Yuma myotis is a federal species of concern. EcoSystems West detected Yuma myotis in the 2000 survey in the north campus (EcoSystems West 2004a). Suitable foraging habitat is present in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch. No suitable roosting habitat exists within any of the project drainages.

Greater Western Mastiff Bat. Greater western mastiff bat is a federal species of concern, a California species of special concern, and a WBWG species of high priority. Although potential habitat is present in the main stem of Jordan Gulch and the middle fork of Jordan Gulch in major karst sinkholes with rocky ledges, the species was not detected during the 2000 surveys (EcoSystems West 2004a) or during the 2002 surveys at UC Santa Cruz.

San Francisco Dusky-Footed Woodrat. San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) is a California species of special concern. This subspecies is known to occur on the San Francisco peninsula. During the 2002 survey (Jones & Stokes 2004a), biologists observed a woodrat nest adjacent to the east fork of Moore Creek that lies within 200 feet of storm water drainage improvements in Moore Creek. Suitable San Francisco dusty-footed woodrat habitat is also present in chaparral and mixed evergreen forest on the upper campus and occurs in the riparian, chaparral, redwood and mixed evergreen forest habitats within the north campus in the three forks of Jordan Gulch, the Baskin Tributary, and the Kresge Tributary. EcoSystems West (2004a) observed three woodrat nests in the chaparral habitats in the northeastern portion of the north campus along Chinquapin Road. None of these nests could be definitively confirmed as San Francisco dusky-footed woodrat nests because nests of the San Francisco dusky-footed woodrat are indistinguishable from those of the more common dusky-footed woodrat. The nests lacked evidence of recent use (e.g., tracks, scat, or debris) and appeared to have been unoccupied for more than a year. Surveys conducted through the summer of 2004 found that woodrats preferred mixed evergreen habitats. These areas had roughly three inhabited nests per acre. Slightly lower densities were found in mixed evergreen habitats that also contained chaparral and dwarf redwood (Bankie 2005). Thus, San Francisco dusky-footed woodrats could potentially be found in all project areas with the exception of the Great Meadow Tributary.

Wildlife Movement. Many birds and mammals (e.g., bats, black-tailed deer, raccoon, gray foxes, and bobcat) that forage in the grassland of the lower campus seek both water and forest shelter (nest sites, roosts, and cover) within the north campus, upper campus, and on adjacent parklands. Due to existing development in the campus core, only two corridors likely provide consistent access between the Great Meadow, where many species forage, and the north campus: the east fork of Moore Creek and the Jordan Gulch drainage (UC Santa Cruz 1989; EcoSystems West 2004a; Jones & Stokes 2004a). However, all of the drainages on UC Santa Cruz provide some movement habitat for resident species, with the exception of the Great Meadow Tributary.

Project Setting - Other Infrastructure Improvements

All of the proposed domestic water system improvements would consist of replacement or installation of underground pipelines within existing utility corridors, which are mostly within campus roadways. Similarly, all heating water system improvements, all of the natural gas system improvements, and most of the cooling water improvements would also include underground pipelines located in already developed areas. Electric system improvements would be switch replacements at already developed sites. With a few exceptions, these improvements would be located in areas where biological resources would not be affected. The only exceptions are a short segment of domestic water pipeline south of Family

Student Housing complex that would be located in undeveloped ruderal grassland, the College Eight natural gas pressure-reducing station that would also be located in an area that is undeveloped, and the site of the cooling tower near Earth and Marine Sciences Building on a slope adjacent to the middle fork of Jordan Gulch. The cooling tower site vicinity near Earth and Marine Sciences Building is moderately forested and the site contains two trees. No other biological resources, including sensitive vegetation or special-status wildlife or plant species, are present at these sites.

2.4.4.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.4 in Volume I for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.4 for analytical methods relative to biological resources. Impacts were analyzed using a combination of qualitative and quantitative information. The impact assessment focuses mainly on the impacts from the storm water drainage improvements, because these would be located in areas where biological resources could be present.

Impacts associated with each drainage improvement can be categorized into permanent and temporary impacts. In general, permanent impacts are caused by construction of new structures, while temporary impacts are associated with construction activities such as access routes, equipment staging areas, and other ground disturbance that will eventually allow the natural vegetation to recover. Both permanent and temporary impacts can be categorized as either a *direct* impact or an *indirect* impact. Direct impacts occur at the immediate location and time of the activity causing the impact (i.e., at the project footprint). In contrast, indirect impacts occur as a result of the same activity but occur at a distance or later in time. Examples of potential indirect impacts include the effects of construction noise on nesting raptors or the introduction of noxious weeds to an area from construction vehicles. This analysis considers all types of impacts: permanent, temporary, direct, and indirect.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. While the domestic water pipeline south of Family Student Housing complex and the College Eight natural gas pressure-reducing station also southeast of Family Student Housing would be located in a currently undeveloped area of UC Santa Cruz, both of these sites lie within future development areas that were analyzed for potential impacts at the LRDP level. Furthermore, no sensitive biological resources are present at these sites. A project-level evaluation is therefore not necessary.

Project-Specific Impacts and Mitigation Measures

Because of the large number of components and individual improvements included in the proposed project, the impacts are analyzed below by component. As explained earlier, the storm water drainage improvement program is the one component of the proposed project with the greatest potential for environmental impacts, including impacts to biological resources. Table 2-6, *Summary of Biological Resource Improvements by Storm Water Drainage Improvement*, presented at the end of this chapter, summarizes the impacts of this component of the project, and presents the impacts and mitigation measures by individual improvement (by item number).

IIP-SW Impact BIO-1:	Construction of storm water drainage improvements could result in placement of fill in waters of the U.S. and of the State.
Significance:	Potentially significant
IIP-SW Mitigation BIO-1:	The Campus shall implement LRDP Mitigation BIO-3.
Residual Significance:	Less than significant

The drainage improvements would involve the construction of permanent structures within campus drainages including placement of riprap, check dams, flumes, and other structures in Jordan Gulch, Moore Creek, and their tributaries. Up to 37,000 square feet (0.85 acres) of these drainages could be permanently filled by these improvements. This would be a potentially significant impact, and the Campus would implement LRDP Mitigation BIO-3 to reduce this impact to a less-than-significant level.

Portions of these drainages are waters of the United States and waters of the State. The jurisdictional portions of the project area are generally limited to the drainage channels, between ordinary high water marks (federal jurisdiction) or between the tops of the channel banks (CDFG jurisdiction). Where riparian vegetation is present, CDFG jurisdiction would apply. Therefore, it would be necessary to obtain a permit from the ACOE and an agreement with the CDFG.

Note that the net effect of the project on waters of the U.S. in Moore Creek, and its tributaries would be positive. Constructing permanent structures within the drainages would limit the ability of the drainage channels to shift naturally, and would reduce their ability to transport sediment naturally. If coarse sediment transport is compromised by the project, it could degrade habitat quality downstream for those species that require riffles, which are formed in areas of coarse sediment deposition. However, drainages in the project area are currently degraded by elevated peak flows and elevated fine sediment transport. The net effect of the project would be to reduce peak flows and reduce channel erosion, incision, and bank instability. The net effect on habitat function of the drainages would therefore be positive.

IIP-SW Impact BIO-2:	Construction of storm water drainage improvements could result in temporary degradation and permanent loss of riparian vegetation.
Significance:	Potentially significant
IIP-SW Mitigation BIO-2:	The Campus shall implement LRDP Mitigations BIO-4A through BIO-4C.
Residual Significance:	Less than significant

Temporary degradation of riparian vegetation would occur as a result of the construction of some of the storm water drainage improvements. Riparian understory herbs and shrubs would be crushed by equipment accessing project areas. It is estimated that up to 27,000 square feet (0.62 acres) of temporary impact to riparian vegetation could occur as a result of the project. In addition, permanent loss of riparian vegetation would also occur as a result of project construction. Small areas of riparian vegetation would be lost when check dams and other structures are installed. It is estimated that 16,600 square feet (0.38 acres) riparian vegetation would be removed by construction activities. Riparian vegetation is considered a sensitive community by CDFG. Although riparian vegetation that is lost or disturbed would be expected to be restored by the natural growth, due to the potential of dominance by invasive weeds and the low light level and consequent slow growth of riparian vegetation in the redwood forest, recovery from impacts may be uncertain and slow. Therefore, this impact is considered substantially adverse and potentially significant. Implementation of LRDP Mitigations BIO-4A through 4C would reduce this impact to a level below significance.

IIP-SW Impact BIO-3:	Construction of storm water drainage improvements could result in temporary impacts to water quality due to increased sediment inputs and potential impacts to water quality from spills of toxic chemicals in construction equipment into the creek.
Significance:	Less than significant

IIP-SW Mitigation: Mitigation not required

Residual Significance: Not applicable

The project could temporarily degrade water quality in Jordan Gulch and Moore Creek and their tributaries through increased inputs of sediment and hazardous construction-related materials. Ground disturbance associated with construction equipment, as well as installation of structures in the creek banks, could result in inputs of fine sediment into the creeks, temporarily degrading water quality. Construction-related runoff could contain pollutants, which may contribute to wildlife and plant mortality and reduced habitat quality in wetlands and drainages in the project area. Construction equipment would use toxic chemicals (e.g., gasoline, oils, grease, lubricants, and other petroleum-based products) that could be released accidentally.

However, this impact would be minimized by the implementation of a SWPPP, which would include measures to avoid the release of chemicals and sediment to drainages. Development and implementation of the SWPPP is required by law, and one will be developed and implemented as part of the proposed project. See LRDP Impact HYD-3 in Volume II for more information regarding SWPPPs.

IIP-SW Impact BIO-4: Construction of storm water drainage improvements would not result in potential degradation of habitat via alterations in hydrology for special-status cave invertebrates (Santa Cruz telemid spider, Dollof Cave spider, Empire Cave pseudoscorpion, or Mackenzie's Cave amphipod).

Significance: Less than significant

IIP-SW Mitigation: Mitigation not required

Residual Significance: Not applicable

The campus contains suitable habitat for four special-status cave invertebrate species: Santa Cruz telemid spider, Dollof Cave spider, Empire Cave pseudoscorpion, and Mackenzie's Cave amphipod are likely associated with the karst system (i.e., caves, sinkholes, fissures, cracks, and crevices) underlying the Baskin Tributary of Moore Creek, the main stem of Jordan Gulch, and all three forks of Jordan Gulch. All of these species are federal species of concern. The only cave known to support these species at UC Santa Cruz is Empire Cave, which would not be affected by the Infrastructure Improvements Project. Therefore, there would be no direct impacts on known occupied habitat for special-status cave invertebrates from the proposed project.

Suitable habitat for these invertebrates may be present within subterranean caves or karst features such as fissures, cracks, and underground caverns that are present in the marble bedrock of the central campus and lower campus. These features may provide suitable microhabitats for these species, but their occupancy would depend on underground physical connections with occupied caves such as Empire Cave. Researchers in central Texas, where karst systems and karst invertebrates are common, determined that caves or voids less than 1.5 meters (4.9 feet) below the surface, less than 2 meters (6.6 feet) wide and 1 m (3.3 feet) high, or highly dissimilar in morphology to occupied caves are unlikely to contain suitable habitat for special-status invertebrate species (Veni and Reddell 2002). These guidelines have been adopted by the USFWS for central Texas karst invertebrates (USFWS 2004) and may also be applicable to the karst system at UC Santa Cruz. Direct impacts to these features would not occur, as no improvement is proposed that would result in the filling of a suitable void more than 1.5 meters below the surface.

The proposed storm water drainage improvements would not add new impervious surfaces that could increase runoff volumes or peak flow rates or increase the discharge of other pollutants into the karst system. Rather, with the proposed improvements, runoff would be infiltrated and dispersed at several locations and peak flows would be reduced. To the extent that there are some changes in the hydrology of the underlying karst system as a result of the storm drainage improvements, the changes would be within the range of the natural fluctuation in water levels that results from large storms. Furthermore, these cave invertebrate species have evolved in a dynamic environment where underground flows are highly variable and likely shift from place to place over time. In some cases, the increase of flow may be beneficial to the species because it could create a more favorable microclimate (e.g., increase underground humidity).

For the above reasons, impacts to these four invertebrate species, should they occur, would be less than significant, and no mitigation is required.

IIP-SW Impact BIO-5:	Construction of storm water drainage improvements could result in temporary direct and indirect impacts to movement habitat for California red-legged frog in the east fork and west entrance fork of the Moore Creek drainage.
Significance:	Significant
IIP-SW Mitigation BIO-5:	The Campus shall implement LRDP Mitigation BIO-9.
Residual Significance:	Less than significant

Suitable habitat for movement of California red-legged frog is present within the east fork and west entrance fork of the Moore Creek drainage. Suitable movement and upland aestivation habitat is also present between and near these drainages (EcoSystems West 2004b, Jones & Stokes 2004a). Construction of storm water drainage improvements in the east and west entrance forks of Moore Creek could result in temporary direct and indirect impacts to high-quality movement habitat due to temporary ground disturbance during the construction of projects and by equipment using access routes to the work sites. California red-legged frogs are expected to use the Moore Creek drainage only sporadically because most frogs likely will remain within the immediate vicinity of the Arboretum Pond, which has high-quality upland aestivation habitat. Therefore, impacts on California red-legged frogs from construction activities are expected to be minimal.

Once the drainage improvements are constructed within these two drainages, the project would not result in additional direct impacts to the species, but could result in ongoing indirect impacts to red-legged frog habitat associated with a change in hydrology and from new impediments to movement. As described in Section 4.8, *Hydrology and Water Quality*, the drainage improvements are designed to reduce peak flows through creeks on campus, including Moore Creek and its tributaries. This reduction in peak flow is not expected to adversely affect movement habitat for California red-legged frog or adversely affect the high-quality breeding habitat in the Arboretum Pond. The quality of water is expected to improve as a result of the storm water drainage improvements primarily through reductions in sediment loads due to reduced erosion. These changes may benefit the movement of and breeding habitat for California red-legged frogs in Moore Creek and its tributaries. Thus, no significant adverse effects are expected as a result of changes in water quality and/or quantity. Proposed improvements would result in new structures in the east fork of Moore Creek, but these structures would not be large enough (i.e., greater than 4 feet high) to create impediments to movement of California red-legged frog.

Indirect impacts to movement could occur during the construction of improvements and access routes. Thus, IIP-SW Mitigation BIO-5 is proposed to minimize direct and indirect impacts to the species during periods in which they would be expected to be in the vicinity of proposed storm water drainage improvements. For projects requiring permits from the ACOE, consultation with USFWS is required, and additional mitigation measures may be required by these agencies in conjunction with the federal permit.

In compliance with IIP-SW Mitigation BIO-5, UC Santa Cruz shall implement the following measures in conjunction with the construction of Items 83-87, 88, 89, 90, 91, 92, 93, 94, 98, 99, 99.5, 100, 101, 102, 103, 104, 105, 107, 109, and 110 to avoid and minimize temporary direct and indirect adverse impacts to California red-legged frog habitat.

Initial ground disturbing activities including grading and vegetation removal will occur after June 1 and before October 15, when CRLF are most likely to be in or near aquatic environments and not dispersing.

A qualified biologist shall examine the project area 24 hours before project activities begin and during any initial vegetation, woody debris, tree removal, or other initial ground disturbing activities. If a CRLF is observed at any time before or during project activities, all activities will cease. The Campus will coordinate with the appropriate agencies to develop avoidance measures before commencing project activities.

Initial construction activities (including vegetation removal and grading) shall not occur when it is raining.

Implementation of this mitigation would reduce the impact to a less-than-significant level.

IIP-SW Impact BIO-6:	Construction of storm water drainage improvements could result in the loss of nesting and roosting habitat for special-status raptors, and disturbance to active nests or roosts.
Significance:	Significant
IIP-SW Mitigation BIO-6:	The Campus shall implement LRDP Mitigation BIO-11.
Residual Significance:	Less than significant

Six special-status bird species, sharp-shinned hawk, golden eagle, northern harrier, loggerhead shrike, Cooper's hawk, and white-tailed kite, use the campus grasslands as foraging habitat. The proposed storm water drainage improvements and associated access routes would temporarily impact approximately 13,500 square feet (0.81 acres) of grassland area within which special-status birds have been observed foraging, with 3,000 square feet (0.07 acres) of grasslands being permanently lost to the footprints of the actual storm water drainage improvements. However, the majority of grasslands in the Great Meadow (roughly 90 acres) and the East Meadow (roughly 80 acres) would remain largely undisturbed. Therefore, the loss of foraging habitat potentially used by special-status birds is considered a less-than-significant impact.

The six species of special-status raptors listed above could nest or roost in forested riparian areas where improvements are proposed. Development of the proposed drainage projects would result in the temporary disturbance of understory habitat from access routes and the construction of drainage projects, but no large, suitable nesting trees would be physically removed during project construction or during the construction and use of access routes. The temporary disturbance of potential nesting or roosting habitat is considered a less-than-significant impact because of the abundance of similar habitat on undeveloped portions of the campus and on extensive adjacent public lands (e.g., Wilder Ranch State Park and Henry Cowell Redwoods State Park).

Raptors could be impacted during construction due to disturbances from noise and activity on the ground near active roosting or nesting locations. If disturbance is prolonged, these species may abandon roosts or nests. Construction activities associated with infrastructure improvements and access routes, and construction-related noise, which results in the loss or abandonment of active nests of special-status bird species would be a potentially significant impact.

LRDP Mitigation BIO-11 (conduct pre-construction nest surveys for raptors and construction exclusion zones around active nests) would be implemented to reduce the potential impact of the proposed project on active nests of these six species of special-status raptors, or other birds of prey, to a less-than-significant level.

IIP-SW Impact BIO-7:	Construction of storm water drainage improvements could result in the loss of western burrowing owl habitat and potential direct and indirect impacts to owls from construction.
Significance:	Potentially significant
IIP-SW Mitigation BIO-7:	The Campus shall implement LRDP Mitigations BIO-12A and 12B.
Residual Significance:	Less than significant

Western burrowing owls are known to occur on campus within the East Meadow and grasslands in the southwestern corner of the campus (Linthicum 2005). Suitable habitat for Western burrowing owls also remains in the Great Meadow (Pelc 1995; Beyer 2001) and could be affected by storm water drainage improvements along the Great Meadow Tributary of Jordan Gulch.

The storm water drainage improvements in this area would permanently remove very limited areas (> 0.1 acres) of suitable habitat for the western burrowing owl and would temporarily impact up to 1 acre of habitat due to access route development. Construction of these projects has the potential to kill or injure western burrowing owls that occupy nests at certain project sites (see Table 2-6). Impacts to individuals in occupied nests would be considered potentially significant. LRDP Mitigations BIO-12A (conduct pre-construction surveys for western burrowing owl) and BIO-12B (establish construction exclusion zone or passive relocation of birds for active nests that cannot be avoided) would be implemented to reduce the potential for impacts to individual western burrowing owls to a less-than-significant level.

IIP-SW Impact BIO-8:	Construction of storm water drainage improvements could result in temporary disturbance of suitable foraging habitat for pallid bat, Pacific Townsend's big-eared bat, western red bat, long-eared myotis, fringed myotis, long-legged myotis, yuma myotis, and greater western mastiff bat.
Significance:	Less than significant
IIP-SW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

Eight special-status bat species—pallid bat, Pacific Townsend's big-eared bat, western red bat, long-eared myotis, fringed myotis, long-legged myotis, Yuma myotis, and greater western mastiff bat—have been observed foraging throughout the campus. Riparian areas in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch provide high quality bat foraging habitat. Forested areas in the east fork of Moore Creek, the main stem of Jordan Gulch, the west fork of Jordan Gulch, and the middle fork of Jordan Gulch contain suitable bat foraging habitat that could be temporarily disturbed during construction of storm water drainage improvements through stream disturbance, brush clearing, and the activities of construction equipment and personnel. It is estimated that up to 84,800 square feet (1.95 acres) of suitable foraging habitat for special-status bats would be disturbed. However, construction activities associated with the proposed project would occur during daylight hours, when bats are least likely to forage. In addition, the impact is very small relative to the large extent of high-quality foraging habitat on campus that would not be affected by the proposed storm water drainage improvements or rest of the development under the 2005 LRDP (approximately 300 acres would remain undisturbed), and the impact would be temporary. Thus, impacts to bat foraging habitat are considered less than significant.

IIP-SW Impact BIO-9:	Construction of storm water drainage improvements would not result in the potential loss of San Francisco dusky-footed woodrat nests.
Significance:	Less than significant
IIP-SW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

Suitable habitat for San Francisco dusky-footed woodrat occurs in the riparian forest habitats within the north and central campus. Inhabited woodrat nests have been observed in the north campus drainages including the Kresge Tributary, the Baskin Tributary, and the west and middle forks of Jordan Gulch. (Bankie 2005), and woodrats were observed during surveys for the proposed projects within the east fork of Moore Creek (Ecosystems West 2004). While it has not been confirmed whether the subspecies with special status (San Francisco dusky-footed woodrat) is inhabiting these nests, it is highly likely that the subspecies comprises a portion of the population on campus. Therefore, for the purposes of this analysis, it is assumed that all woodrat nests are the San Francisco dusky-footed subspecies. Appropriate habitat occurs, to varying degrees, in all watersheds except the Great Meadow Tributary and the west fork of Moore Creek. Construction-related activities in proximity to nesting sites could cause adult woodrats to abandon their nests. However, no woodrat nests were observed within the direct footprint of proposed storm water drainage improvements or access routes. If nearby nests were abandoned as a result of project constructions, there is ample suitable habitat in the vicinity of the project in which nests could be reconstructed. This is a less-than-significant impact because of the lack of expected direct impact to the species and the availability of suitable habitat outside the project area.

IIP-SW Impact BIO-10:	Construction of storm water drainage improvements would not interfere with the movement of wildlife species or with established native resident or migratory wildlife corridors.
Significance:	Less than significant
IIP-SW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

Existing wildlife corridors such as those provided by the east fork of Moore Creek, the lower main stem of Jordan Gulch, middle fork of Jordan Gulch, and the Kresge Tributary provide cover to a variety of species on campus. Wildlife is likely to continue to use these riparian corridors to avoid vehicle traffic and minimize interaction with humans. Construction of check dams and drop structures, as well as placement of rock, concrete, and wood, could impede wildlife movement through these corridors. However, none of the proposed storm water drainage improvements would be substantial enough to create a real barrier to movement through the existing riparian corridors (i.e., wildlife could always move around or over the new structures). Temporary disturbance of wildlife movement is expected during construction of drainage improvements. No temporary and permanent impacts are expected to significantly alter wildlife movement patterns throughout campus. Thus, this impact is considered less than significant and no mitigation is required.

Cumulative Impacts

As the proposed Infrastructure Improvements Project will have no impacts on the Ohlone tiger beetle, the project would not contribute to cumulative, biological impacts identified at the LRDP level.

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2.4.5 Cultural Resources

2.4.5.1 Environmental Setting

Section 4.5, *Cultural Resources* (Volume I), presents the cultural resource setting for the entire UC Santa Cruz campus. Significant cultural resources may include archaeological resources, historic buildings, structures and sites, human remains, paleontological localities, and unique geological resources. CEQA criteria that define significant cultural resources are presented in Section 4.5.1.5 of that document.

This section presents an evaluation of the potential for the proposed Phase 1 and Phase 2 Infrastructure Improvements Project to affect significant cultural resources that may be present within the areas of that could be affected by implementation of the proposed improvements.

Cultural Resources Inventory of the Campus

Consistent with LRDP Mitigation CULT-1A, the Campus determined the area of potential effects within which cultural resources would be affected by implementation of the proposed Infrastructure Improvements Project. As detailed in Section 2.3, *Project* Description, above, the Infrastructure Improvements Project consists of a series of improvements to several elements of the campus infrastructure. The proposed storm water drainage improvements have the potential to result in impacts to cultural resources, because many of these improvements would include ground disturbance and would require temporary access routes for heavy equipment. Proposed storm water improvements include a variety of water control, dispersion and diversion features, and various stream bank-armoring features; many of these would be located in Jordan Gulch and its tributaries. Because the majority of these improvement sites are within steep-sided drainages, most are inaccessible from existing paved areas and would require the establishment and use of heavy equipment routes for work at the site.

Other proposed improvements with a potential to affect cultural resources include a short segment of domestic water pipeline and the proposed College Eight natural gas pressure-reducing station, both of which would be located south of the Family Student Housing complex in areas that are presently undeveloped; and the proposed new cooling tower option near the Earth and Marine Sciences Building. The remaining improvements have little or no potential to affect cultural resources because they would be implemented within existing utility corridors in already developed areas (mostly within campus roadways), on located on sites that are already completely developed.

<u>Archaeological Inventory</u>. Consistent with 2005 LRDP Mitigation CULT-1C, -1D and –1E, the campus retained a qualified archaeologist to complete intensive archaeological survey of each of the project areas that would be affected by the proposed Infrastructure Improvements Project, including the improvements described above, and of all associated off-road access routes. Cultural resources that were identified within the potentially affected areas are described below. The archaeologist also assessed the significance of each resource and identified measures to avoid significant resources (Pacific Legacy 2005).

The archaeological records search and survey identified two prehistoric archaeological sites and five historic archaeological sites within areas that could be directly or indirectly affected by construction or heavy equipment access to the proposed storm water drainage improvement sites (Pacific Legacy 2005).

A description of each of the identified resources is provided below, along with an assessment of site integrity and significance.

CA-SCR-142: A prehistoric archaeological site consisting of a sparse lithic scatter (chipped stones tools and stone tool manufacturing debris), which may include a subsurface deposit. Exposed portions of the site are in fair to good condition. The site is assumed to be a significant cultural resource with potential to yield information about local prehistory.

CA-SCR-181: A prehistoric archaeological site consisting of a dense lithic scatter, which may include a subsurface deposit. The previously recorded site could not be relocated in 2005, and it is presumed to have been obscured either by the growth of dense brush in the area, or possibly by erosion or earth moving. The site is assumed to be a significant cultural resource for its potential to yield information about local prehistory.

CA-SCR-182H: An assemblage of railway and quarry features related to the 19th century lime processing operations at Cowell Ranch, located in the Jordan Gulch Main Stem drainage. The site includes all of the railway elements in Jordan Gulch Main stem, including the railway bed (with some railway ties still in place), a south terminus trestle near the main entrance to the campus, and a limestone and earth railway causeway foundation in Jordan Gulch; three limestone quarries; and an historic wood fence along a quarry access road.

For purposes of management of the resource, the railway alignment and features were recorded and mapped as segments, which vary in historic and physical integrity. Segment mapping is on file with the archaeological technical report at the campus for use in future management of the site. Technical report mapping is held on campus as a confidential document for the protection of the resource. The segments of the railway alignment that lack historic or physical integrity are not now considered as contributors to the historic significance of the site; their recordation has preserved the significant information they represent and physical alteration of these segments therefore would not alter the significance of the site. Other segments include significant features and possess substantial integrity, and are considered to be significant site elements. The quarry elements of this site complex are also considered to be significant cultural resources. The wood fence does not provide additional significant information beyond what has already been recorded, and is not considered to be a significant element of the site.

CA-SCR-183H: A complex of historic features closely associated with SCR-182H, above. It consists of a railway alignment in Jordan Gulch Middle Fork; three limestone quarries in upper Jordan Gulch; two lime kilns; and an historic road segment and associated tailing dump. Within one of the quarries is a natural sinkhole, previously interpreted as an earthen and rock dam, flanked by a limestone drywall retaining wall. One of the kilns has partially collapsed and has trees growing through it, but is still considered to be a significant element of the resource because it may expand the period of lime processing represented in the site overall. The intact portions of the railway alignment, quarries, kilns and rock dump road components of this site have been provisionally assessed as significant cultural resources.

CA-SCR-186H: Several historic water troughs, and a historic fence line. One of the water troughs is marked “Mt. Diablo Cement”, which indicates that it was produced by a company owned by the Cowell’s, which operated in Contra Costa County in the first decade of the 1900s; thus this features is associated with the Cowell Ranch, which is historically significant. However, there is no other archaeological evidence representing the Cowell Ranch in the immediate vicinity. This site does not appear to be a significant cultural resource because the information represented by the site features has been fully recorded and they have little further potential to provide important historic information.

CA-SCR-UCSC-001H. A complex of previously-unrecorded historic water control features, including the Arboretum Reservoir and Arboretum water tower; East Dam and West Dam; the Arboretum Dam; and the associated spillway. The site appears to be a significant cultural resource.

UCSC-CA-SCR=004H: The Elf Land Kiln, a lime-processing kiln believed to date from the beginnings of the lime production industry in Santa Cruz County. The east wall of the kiln has partially collapsed and there are trees growing out of walls. The site is a significant cultural resource.

Six of the identified archaeological or historic resources are considered to be significant, as noted above. No historic buildings are present in the areas that would be affected by the proposed project. The proposed improvements that potentially would affect each of the significant resources are identified below.

Paleontological Review. Consistent with LRDP Mitigation CULT-5A, the Campus consulted the most recent Campus Soils and Geology map (see Figure 4.6-4, *Site Geologic* Map, Volume I of this EIR) to review the locations of all proposed infrastructure improvements that would involve ground disturbance. No paleontologically sensitive formations were identified within areas that would be affected by the proposed project.

Unique Geological Resources. CEQA also provides consideration of unique geologic resources. These are presumed to comprise geological features that are "unique" under the criteria listed above. The only geologic features considered to be unique on the UC Santa Cruz campus are the limestone caves in Cave Gulch and Wilder Creek. These will not be affected by the proposed Infrastructure Improvements Project and are not discussed here.

2.4.5.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.5 (Volume I) for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.5, Volume I, for analytical methods relative to cultural resources impacts. Impacts to archaeological deposits and human remains most often occur as the result of excavation, grading, or other physical disturbance within the vertical or horizontal boundaries of an archaeological site. Archaeological deposits may also suffer impacts as the result of project activity that increases erosion or increases the accessibility of a surface resource, and thus increases the potential for vandalism or illicit collection.

Significant impacts to built-environment features (buildings, bridges, kilns and railway features) may result from demolition or physical alteration of the feature, or from excavation, grading or traffic in the vicinity that may cause erosion or vibration, which can result in indirect effects to the feature. Significant impacts also may occur if the setting of a historic structure or feature is altered by the introduction of incompatible elements, in cases where the property retains integrity of setting and the setting of the resource contributes to its significance.

The analysis that follows addresses the potential impacts of these improvements upon identified significant cultural resources. For the purposes of impact evaluation for this EIR, a resource is assumed to be a significant cultural resource if it retains or appears likely to retain physical integrity. Isolate historic features for which historic context cannot be established (that is, for which there is no evidence or documentation of date or origin) are not considered, here, to be significant cultural resources, because they have little information potential or historic significance beyond the location and description documented through archaeological survey. In cases where some features of a significant historic site have been destroyed or altered, or portions of an archaeological deposit have been disturbed, that portion of the resource may not contribute to the significance of the resource. No resources that appear likely to meet the definition of unique paleontological resources or unique geological resources were identified within any of the areas that would be affected by the proposed Infrastructure Improvements Project.

Table 2-7, *Summary of Infrastructure Improvements Cultural Resources Impacts and Avoidance Measures,* below, identifies and briefly describes the elements of each identified significant cultural resource that could be affected by the proposed project, and identified the infrastructure improvements that potentially would affect the resource, the potential impact, and the measures required to avoid impact avoidance.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The proposed project would not alter any historic buildings in the Cowell Ranch Historic District or elsewhere, and no additional analysis of this resource is required.

Project-Specific Impacts and Mitigation Measures

IIP-SW Impact CULT-1:	Proposed infrastructure improvements could damage or destroy portions of significant cultural resources CA-SCR-181, CA-SCR-182H, CA-SCR-183H, CA-SCR-142, CA-SCR-UCSC-001 and CA-SCR-UCSC-004, or other undiscovered resources or human remains, as a result of grading, excavation, other ground-disturbing activity, or other project development activities associated with the improvements or related access routes.
Significance:	Potentially significant
IIP-SW Mitigation CULT-1A:	Pursuant to LRDP Mitigation CULT-1E, the campus shall ensure that the final design of each improvement avoids impact to significant cultural resources, as identified in Table 2-7. The Campus shall also consult confidential cultural resources mapping and the project archaeologist, as needed, to delineate each resource and resource element on construction plans as avoidance areas, and shall implement the resource avoidance measures identified in Table 2-7, below. Table 2-7 is appended to this measure by reference.
IIP-SW Mitigation CULT-1B:	If the measures identified in Table 2-7, or other measures to avoid impacts to significant resource elements, are not feasible for any of the identified significant cultural resources, the Campus shall implement the research design and data recovery provisions of LRDP Mitigation LRDP CULT-1F and, for a prehistoric resource, CULT-4B. In the event that these measures, in the professional judgment of a qualified archaeologist in consultation with the campus, cannot mitigate the impact to a less-than-significant level, the Campus shall implement LRDP Mitigation CULT-3A and 3B, as applicable.
IIP-SW Mitigation CULT-1C:	The Campus shall implement LRDP Mitigation CULT-1G, CULT-4C and CULT-4D, as pertinent.
IIP-SW Mitigation CULT-1D:	The Campus shall implement LRDP CULT-1B.
Residual Significance:	Less than significant

Several proposed infrastructure improvements and access routes have the potential to affect identified significant cultural resources, and could affect undiscovered cultural resources that may be present at or near the proposed work locations. Improvement work and use of access roads have the potential to result in both direct and indirect or incidental impacts. Direct impacts are those that result from actual alteration of the historical resource or unique archaeological resource through excavation, removal or movement of features, heavy equipment crushing, and related soil disturbance. Indirect and incidental impacts may result from heavy equipment vibrations, erosion that results from project activity, unauthorized collection of historic or archaeological materials, and incidental movement of people and vehicles within the boundaries of the identified cultural resource site.

Table 2-7 lists proposed improvements that could affect identified resources or resource elements, describes the potential for direct, indirect and incidental impacts, and specifies measures to avoid impacts to resources or resource elements identified as significant or potentially significant. Only those improvements that potentially would result in effects to identified significant cultural resources are listed here. The referenced segments of the railway sites, SCR-182H and 182H are illustrated in the confidential technical report prepare by Pacific Legacy (2005), on file with UC Santa Cruz Physical Planning and Construction. Under IIP SW Mitigation CULT-1, the Campus will implement the avoidance measures identified in this table. Implementation of these measures would reduce the impact on identified resources to a less-than-significant level.

Table 2-7
Summary of Infrastructure Improvements Cultural Resources Impacts and Avoidance Measures

IIP or Access Route	Potential Impact(s)	Mitigation(s)
Phase 1 Improvements		
Improvement 23	Erosion damage repairs to northwest slope of quarry could impact railway Section 3 segment, CA-SCR-182H.	Contractors shall be directed to stay within previously disturbed slope of hillside when working in this area.
Improvement 44	Improvement work adjacent to Bridge Kiln, CA-SCR-183H could indirectly affect kiln.	Contractors shall be directed to stay outside of existing fencing around Bridge Kiln.
Improvement 45	Work in streambed just downstream of the Upper Quarry Kiln, CA-SCR-183H could indirectly affect kiln.	Campus shall ensure that Upper Quarry Kiln is fenced prior to construction activity in this area and shall inform contractor of avoidance requirements.
Improvement 105	Installation of dissipation manifolds on slope below Family Student Housing could expose or disturb prehistoric site CA-SCR-142.	Campus shall retain a qualified archaeologist to monitor the placement of the dissipation manifolds to ensure that placement does not disturb the archaeological deposit.
Improvement 106	Work adjacent to CA-SCR-142 could result in direct impacts to buried portions of deposit.	Campus shall ensure that the resource area as mapped is designated as environmentally sensitive on construction maps and on the ground prior to construction, and shall inform contractors that area must be avoided by heavy equipment.
Phase 2 Improvements		
Improvement 8	Work near Elf Land Kiln, UCSC-004, could result in indirect impacts from incidental construction traffic, slope disturbance or vibration.	Campus shall ensure that kiln is fenced prior to construction activity in the area, and shall inform contractors to avoid use of heavy equipment on slope where the kiln is located.
Improvement 26, 27, 28	Improvement could result in direct impact to railway alignment, Section 6, CA-SCR-182H. Integrity of segment very poor and it does not contribute to significance of resource.	No mitigation needed.
Improvement 29	Channel work may directly impact railway alignment, Section 6, CA-SCR-182. Integrity of railway feature very poor impact and this segment does not contribute to significance of resource.	No mitigation is needed.

Table 2-7
Summary of Infrastructure Improvements Cultural Resources Impacts and Avoidance Measures

IIP or Access Route	Potential Impact(s)	Mitigation(s)
	Work down slope could incidentally affect fence just north of pocket quarry, Section 5, CA-SCR-182H	Campus shall inform contractor to avoid any alterations of historic fence line down gulch slope to south.
Improvement 30	Work near railway alignment Section 5, with *in situ* railroad ties and rock causeway, CA-SCR-182H, could directly or indirectly impact significant features.	Campus shall ensure that improvement design provides avoidance of area of *in situ* railway ties on west side of channel and rock causeway. Campus shall instruct contractor avoid use of heavy equipment and any alteration of features on east bank of channel. All work in this area shall be performed during dry weather.
Improvement 31	Channel work near limestone pocket quarry and berm in center of gulch floor, Section 5, CA-SCR-182H could indirectly or incidentally impact features.	Campus shall instruct contractor to avoid any alterations to quarry, associated rock debris piles on quarry floor, and earth berm. Campus shall ensure that pocket quarry and berm are fenced prior to construction. The campus shall ensure that work is confined within the eastern channel. All work in this area shall be performed during dry weather.
Improvement 32	Work near stone railway causeway, Section 5, CA-SCR-182H, could indirectly or incidentally impact feature.	Campus shall ensure that improvement design avoids alteration of causeway; and that causeway is fenced prior to construction. Campus shall inform contractor to avoid heavy equipment use near causeway and along railway alignment leading from foundation ends, and that work must be confined to channel. All work in this area shall be performed during dry weather
Improvements 33, 34, 35	Work adjacent to railway bed alignment, Section 4, CA-SCR-182H could result in direct or indirect impacts to historic features.	Campus shall instruct contractor to avoid use of heavy equipment on railroad alignment and that work must be confined to channel. All work in this area shall be performed during dry weather
Improvement 36	Work on sinkhole adjacent to railway alignment, Section 4, CA-SCR-182H could result in indirect impacts to historic features.	Campus shall inform contractor to avoid railroad alignment and that work must be confined to channel. All work in this area shall be performed during dry weather
Improvement 37	Installation of logs or other embanking material in channel and on creek bank could disturb or destroy CA-SCR-182H railway grade alignment along channel.	Campus shall retain a qualified archaeologist to perform a final field review of plans, to ensure that placement will not disturb the railway alignment.
Improvement 43	Sinkhole improvements are in the center of Bridge Quarry feature, CA-SCR-183H and could result in direct impacts to historic features.	Campus shall ensure that design of improvements will not alter retaining wall on east side of sinkhole, west quarry face, and north and south stone faces of the sinkhole. Campus shall ensure that retaining wall is fenced prior to construction.

Table 2-7
Summary of Infrastructure Improvements Cultural Resources Impacts and Avoidance Measures

IIP or Access Route	Potential Impact(s)	Mitigation(s)
Improvement 94	Work around East Dam, CA-UCSC-001H could directly or indirectly alter the historic feature, which has moderate historic integrity.	Campus shall ensure that improvement design does not substantially alter structure or appearance of dam or cut into berms. Campus shall instruct contractor to use access road across dam only when soil is dry.
Improvement 98	Work in vicinity would indirectly or incidentally affect CA-SCR-142, which could include a buried component that extends into the project area.	Campus shall notify the contractor that site and a 50 ft. buffer around it is environmentally sensitive, and instruct contractor to avoid any heavy equipment operations in area.
Improvement 110	Improvement adjacent to West Dam, UCSC-001H, could directly alter the historic feature.	Campus will ensure that improvement design does not materially alter earthen dam or cut into berms, and that dam access road is used only when soils are dry.
Access Route 12	Route crosses East Dam, UCSC-001H, on existing dirt road that has already altered dam; use could further alter dam. Heavy equipment use of dirt road adjacent to reported location of CA-SCR-181 could impact undiscovered portions of deposit.	Campus shall inform contractor to use access road only in dry weather. Campus shall inform contractor to stay on dirt roads and shall identify appropriate access route to creek on contractor maps that will ensure avoidance of site area.
Access Route 13	Route crosses West Dam, UCSC-001H, on existing dirt road that has already altered dam; use could further alter dam.	Campus shall inform contractor to use access road only when soils are dry.
Access Route 16A	Use of route past Bridge Kiln, iron ring feature in redwood stump, Upper Quarry Kiln, and railway bed alignment, CA-SCR-183H, could result in indirect or incidental impacts to features and direct impacts to railroad alignment.	Campus shall designate the area as environmentally sensitive on contractor maps and inform contractor to avoid. Campus shall instruct contractor to avoid kiln areas with heavy equipment, not to alter the alignment of railway bed, and to access area only when soils are dry. Campus shall ensure that the iron ring feature is flagged for avoidance.
Access Route 16B	Use of route along slope near Bridge Quarry retaining wall, CA-SCR-183H, could result in indirect impacts to features.	Campus shall fence off and avoid retaining wall on east slope near sinkhole.
Access Route 20A	Route runs in vicinity of Elf Land Kiln, UCSC-004H, which could be indirectly affected by heavy equipment.	Campus shall inform contractor to avoid use of heavy equipment on slope where the kiln is located. Campus shall ensure that kiln is fenced prior to construction.
Access Route 23	Use of route may result in direct impacts to railway alignment Section 6, CA-SCR-182H. Integrity of segment very poor, and impact would not be significant.	No mitigation needed.

Table 2-7
Summary of Infrastructure Improvements Cultural Resources Impacts and Avoidance Measures

IIP or Access Route	Potential Impact(s)	Mitigation(s)
Access Route 24	Use of access route, which ends at railway causeway, railway alignment Section 5, CA-SCR-182H, could result in direct impacts to causeway feature.	Campus shall ensure that road route is designated to avoid crossing or altering intact portions of causeway. Campus shall inform contractor of environmental sensitivity and shall ensure that vehicles accessing site are no more than 8 feet wide and that they cross causeway only via existing gap.
Access Route 25	Use of access route along railway alignment Section 4, CA-SCR-182H and could directly impact alignment.	Campus shall inform contractor to avoid any alterations to the railroad bed and to use the route only in dry weather.

In the event that the nature of the proposed improvement or access route will not permit avoidance of a significant site or feature, the research design and data recovery provisions of LRDP Mitigation CULT-1F will be implemented. This measure provides for detailed recordation and other data recovery to reduce unavoidable impacts to historical resources to a less-than-significant level. If data recovery excavations are carried out on a prehistoric site, the Campus will implement LRDP Mitigation CULT-4A to ensure that a local Native American has the opportunity to monitor the excavation. With rare exceptions, these measures will reduce the impact to a less-than-significant level. The Campus will also consult with a qualified archaeologist on the efficacy of the mitigation. In the rare case that the significance of the impact cannot be reduced through data recovery and other documentation, the Campus will implement LRDP Mitigation CULT-3A and 3B, but the impact will, nevertheless, be significant and unavoidable. It would be premature to assume that this situation will arise for the proposed project at this time.

In addition to the identified improvements proposed in the vicinity of known archaeological or historical resources, several of the infrastructure improvements would involve excavation of trenches for utility pipelines and excavations to construct foundations and pads for new facilities. These ground disturbing activities would in most part occur in areas where there existing utility lines are already in place and therefore the areas have been previously disturbed. However, any ground disturbing activity has the potential to encounter and disturb unknown subsurface archaeological resources or historic features. The campus will implement LRDP Mitigation CULT-1G to address any archaeological discoveries during construction, and LRDP Mitigations CULT-4B and -4C to address any discoveries of human remains. The implementation of these measures would reduce the impact to previously undiscovered cultural resources to a less-than-significant level.

The campus will also implement LRDP Mitigation CULT-1B to ensure that the construction contractor is informed of the cultural resource issues for the project and is aware of the required avoidance measures and emergency discovery procedures described above. The implementation of these mitigation measures would reduce impact of the proposed project on significant cultural resources to a less-than-significant level.

Cumulative Impacts

Cumulative impacts on cultural resources from campus development under the 2005 LRDP, including the Infrastructure Improvements Project, are adequately addressed under LRDP Impact CULT-7. The cumulative impact of development upon significant cultural resources is considered less than significant because both the Campus and the City have protections in place to avoid and minimize impacts to such resources. Because the mitigation measures included in the proposed 2005 LRDP EIR (Section 4.5.3) would reduce the impacts of campus development to a less-than-significant level, the contribution of the campus to this less-than-significant cumulative impact is not cumulatively considerable. The proposed project would not contribute to any impacts on historic building or on unique paleontological or geological resources.

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2.4.6 Geology, Soils, and Seismicity

2.4.6.1 Environmental Setting

Section 4.6, *Geology, Soils, and Seismicity* (Volume I), presents the environmental setting for geology, soils, and seismicity for the entire UC Santa Cruz campus.

2.4.6.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.6 in Volume I for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.6 for analytical methods relative to geology, soils, and seismicity.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The project site is not located within an Alquist-Priolo Earthquake Fault Zone. The closest known active faults include the San Gregorio fault zone, which is about 7 miles offshore, and the Monterey Bay-Tularcitos fault, which is about 4 miles to the south of the campus. Furthermore, the proposed project does not involve the construction of new structures that would be occupied by people. Therefore, implementation of Infrastructure Improvements Project would not expose people to potentially substantial adverse effects resulting from rupture of a known earthquake fault or to effects from ground shaking, liquefaction and settlement. No septic or alternative wastewater disposal systems are proposed. No additional analysis relative to these issues is necessary.

However, the proposed project would involve ground disturbing construction activities that could result in erosion. The impact related to construction-phase erosion is addressed in Section 2.4.8, *Hydrology and Water Quality*.

Project-Specific Impacts and Mitigation Measures

IIP-ALL Impact GEO-1:	Proposed improvements could be located on a geologic unit or soil that would become unstable as a result of the project and result in a potential risk to life or property.
Significance:	Potentially significant
IIP-ALL Mitigation GEO-1:	The Campus shall implement LRDP Mitigation GEO-1.
Residual Significance:	Less than significant

Most of the proposed storm water drainage improvement structures under the Infrastructure Improvements Project, such as check dams, flumes and detention basins that would be constructed would be small, unoccupied structures; therefore, impacts from unstable soil or ground conditions would not be a major concern. All of the domestic water system, cooling water system, heating water system, natural gas and electrical system improvements involve underground pipeline improvements or replacement of valves and switches and therefore unstable soil conditions are not a concern for these improvements. The one exception is the new cooling tower, which is an element of the campus core cooling water system improvements. Construction of the new cooling tower on unstable soil or ground could result in a significant risk to life and property. To the extent that adequate information is not available from previous investigations, the Campus shall, in compliance with LRDP Mitigation GEO-1, conduct a geotechnical investigation of the site to determine the type of foundation that is appropriate for the site and the proposed cooling tower design. Therefore with mitigation, the impact would be less than significant.

Cumulative Impacts

The cumulative effects of the proposed project are adequately addressed in cumulative LRDP Impact GEO-6.

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2.4.7 Hazards and Hazardous Materials

2.4.7.1 Environmental Setting

Section 4.7, *Hazards and Hazardous Materials* (Volume I), presents the hazards and hazardous materials setting for the entire UC Santa Cruz campus, and includes definitions of appropriate terms, a brief summary of applicable regulations, and a discussion of potential hazardous materials and hazardous waste generated at the campus overall.

The proposed cooling tower is the only infrastructure improvement that would involve the use of hazardous chemicals. The types of hazardous chemicals used in the proposed cooling tower would be the same as those currently used in the three cooling towers near the Central Heating Plant and current handling practices would continue. Sulfuric acid, which would be added periodically and in controlled amounts to the water circulating in the cooling towers, is currently stored in a 55-gallon drum on the Central Heating Plant site. The three existing towers use approximately 110 gallons per month. Under Option 2, the new cooling tower at the Earth and Marine Sciences Building site would use approximately 100 gallons per month. Based on the amount of corrosion inhibitor currently used at the Central Heating Plant, it is expected that about 30 gallons would be used per month in the cooling tower. The chemicals would be stored in a new shed designed with secondary containment, adjacent to the new cooling tower. Little to no corrosive waste would be generated because the sulfuric acid is consumed in chemical reactions that control pH. Trace amounts of the scale/corrosion and biocide products remain in water that is discharged periodically to the City's WWTP. Unused or expired chemicals, including sulfuric acid, are occasionally disposed of as hazardous waste.

2.4.7.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.7 in Volume 1 for a discussion of applicable Standards of Significance.

Analytical Method. Analytical methods for assessment of potential hazards and hazardous materials impacts for the campus overall are detailed in Section 4.7. Hazardous substances include both hazardous materials and hazardous waste. For this EIR a substance is defined as hazardous if it appears on a list of hazardous substances prepared by a federal, state, or local regulatory agency or if it has characteristics defined as hazardous by such an agency.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. Impacts related to safety hazards associated with private and public airports or airstrips were determined not to be an issue applicable to the main campus in the 2005 LRDP Initial Study. Although some of the storm water drainage improvements would be within ¼ mile of an existing school, the proposed cooling tower, which is the only new emissions source included in the proposed project, would not located within ¼ mile of an existing or proposed school. None of the work sites would be located on or near sites with known contamination. The project would not involve the use of radioactive or biohazardous materials, nor would it involve operation by a non-UC entity. Therefore, no project level analysis of impacts related to these issues is required. The ability of existing emergency response capabilities to respond to an emergency involving the use of hazardous materials has been adequately addressed in LRDP Impact HAZ-8. Emergency Operations Plan has been adequately analyzed in the LRDP Impact HAZ-9. The Infrastructure Improvements Project would not result in a significant increase in hazards related to wildland fires, and so LRDP Impact HAZ-10 does not apply. No impacts would occur with respect to these issues, and therefore, no further analysis is required. Project-level impacts associated with transport, use, and disposal of hazardous chemicals and wastes at the proposed cooling tower and with contaminated building materials are addressed below.

Project-Specific Impacts and Mitigation Measures

IIP-CW Impact HAZ-1:	Construction and operation of the cooling tower would increase the routine use, transport, and disposal of hazardous chemicals and wastes on the campus, but would not create significant hazards to the public or the environment.
Significance:	Less than significant
IIP-CW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

Construction

Construction of the proposed project would involve the use of hazardous materials, including paints and solvents, adhesives and glues, and cleaning agents and degreasers. Fuels such as gasoline and diesel would be used in heavy equipment and other construction vehicles. These materials are routinely used in small quantities on construction projects, and construction procedures have been established to avoid releases of these materials into the environment. The project also would be required to comply with NPDES requirements designed to minimize the chances of release of hazardous materials to soil or groundwater.

Operations

Hazardous materials used in the operation of the proposed cooling tower include sulfuric acid, biocides, and other chemicals to control scale formation and corrosion. The use of chemicals as part of the proposed project would generate small quantities of hazardous waste that would be collected, transported and disposed off campus. Because the campus will continue to implement programs established to comply with regulatory requirements and campus policies, impacts from the use of hazardous chemicals at the new cooling tower would be less than significant. The campus would handle and dispose of hazardous waste through established campus programs that comply with state and federal laws and regulations; therefore, the impact from hazardous waste generation and disposal would be less than significant.

IIP-ALL Impact HAZ-2:	Construction of the cooling water, heading water and domestic/fire water improvements could potentially expose construction workers and campus occupants to contaminated building materials.
Significance:	Potentially significant

IIP-CW Mitigation HAZ-2A:	The Campus shall implement LRDP Mitigation HAZ-7.
IIP-CW Mitigation HAZ-2B:	Consistent with standard campus practices, EH&S will investigate whether chromium has been used in the cooling water system in the past and, if appropriate, will conduct testing. If testing reveals that the cooling tower debris is contaminated, it will be handled in accordance with applicable federal, state and local regulations.
Residual Significance:	Less than significant

Construction of the cooling water, heating water, and domestic/fire water improvements could involve removal and disposal of asbestos-containing insulation and/or asbestos cement piping. If chromium has been used as a treatment additive in the cooling water system, it is possible that the Cooling Tower #2, which, under one option for the cooling water system improvements, could be contaminated with chromium. As discussed in Section 4.7, *Hazards and Hazardous Materials*, Volume I, standard specifications included in all campus construction contracts require that contractors who disturb or potentially could disturb asbestos must comply with all federal, state and local rules and regulations regarding hazardous materials. LRDP Mitigation HAZ-7, which requires that the Campus shall survey buildings for potential contamination before any demolition or renovation work is performed, will be implemented. These measures would minimize the potential for exposure of workers to asbestos. In addition, the Campus would implement IIP-CW Mitigation HAZ-2B to address chromium in the cooling tower, and the impact would be reduced to a less-than-significant level.

Cumulative Impacts

The cumulative impacts of hazardous materials use and waste generation of campus growth under the LRDP including the Infrastructure Improvements Project are adequately addressed in LRDP Impact HAZ-12.

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2.4.8 Hydrology and Water Quality

2.4.8.1 Environmental Setting

Section 4.8, *Hydrology and Water Quality* (Volume I), presents the hydrology and water quality environmental setting for the entire UC Santa Cruz campus. It includes detailed information on all the drainages on the campus that would be affected by the proposed project.

2.4.8.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.8 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.8 for analytical methods relative to hydrology and water quality impacts.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The 2005 LRDP Initial Study identified that impacts related to hazards associated with levee or dam failure or inundation by seiche, tsunami, or mudflow would not occur under the 2005 LRDP. The campus is not located within the 100-year flood hazard area of any creek. Given that the proposed project consists primarily of small, localized improvements, the project would not significantly increase the extent of impervious surfaces, groundwater resources would not be affected, and no additional project-level analysis is needed.

Project-Specific Impacts and Mitigation Measures

IIP-CW Impact HYD-1:	Implementation of the Infrastructure Improvements Project would not result in wastewater that would violate wastewater discharge requirements.
Significance:	Less than significant
IIP-CW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

None of the proposed improvements would involve discharge of wastewater, except for the new cooling tower, which is an element of the cooling water system improvements. Under existing conditions, blow down from the existing cooling towers is discharged into the sanitary sewer system and conveyed along with the rest of the wastewater from the campus to the City's WWTP for treatment and disposal. The City has approved this discharge based on the chemicals used and their concentrations in the cooling towers, and pre-treatment is not required (Blunk 2005). With the construction and operation of the new cooling tower, additional blow down would be discharged. The existing City's WWTP has sufficient capacity to handle the expected increase in flow. Furthermore, the quality of discharge would be similar to the existing discharge. Therefore, the proposed project would not result in wastewater discharge that would violate waste discharge requirements.

IIP-ALL Impact HYD-2:	Implementation of the Infrastructure Improvements Project could result in storm water runoff during construction, which could violate water quality standards.
Significance:	Potentially significant
IIP-ALL Mitigation HYD-2:	The Campus shall implement LRDP Mitigations HYD-2B and 2C.
Residual Significance:	Less than significant

The proposed infrastructure improvements would involve ground-disturbing activities which could result in erosion and release of sediment into the campus drainages during construction. The concern would be greatest at the storm water drainage work sites as these would be in or near the campus drainages. Although each work site would be less than 1 acre in area, the project as a whole would involve about 6.79 acres of disturbance. Therefore, the project would be required to comply with NPDES requirements, and a SWPPP would be developed and implemented during each phase of the proposed project. Compliance with NPDES requirements and implementation of LRDP Mitigations HYD-2B and 2C would reduce the impact to a less-than-significant level.

IIP-SW Impact HYD-3:	Implementation of the storm water drainage improvements under the Infrastructure Improvements Project would alter drainage patterns and could result in erosion and siltation.
Significance:	Potentially significant

IIP-SW Mitigation HYD-3A:	The Campus shall monitor dispersion manifolds for evidence of erosion on an annual basis. If there is evidence that the dispersion manifolds are causing erosion, the Campus shall repair the erosion damage and implement any repairs or alterations to the design of the manifolds necessary to prevent further erosion.
IIP-SW Mitigation HYD-3B:	For improvements included in the Infrastructure Improvements Project that increase impervious surfaces (the new cooling tower and the College Eight natural gas pressure-reducing station), the Campus shall implement LRDP Mitigation HYD-3C and HYD-3D.
Residual Significance:	Less than significant

Storm water drainage improvements would affect four drainages on the campus – Cave Gulch, Moore Creek, Jordan Gulch, and some of the gullies that flow into the Pogonip-San Lorenzo watershed. The focus of Phase 1 of the project is to reduce peak flows in those sections of the creeks that are experiencing severe erosion by diverting, dispersing and detaining runoff in the upper portions of the watersheds. The focus of Phase 2 improvements is in-channel stabilization, armoring and repair. Table 2-8, below, lists the approximate number of improvements by watershed and types. Item number cited in subsequent text refer to the numbers by which improvements are identified in Table 2-2b, presented at the end of the chapter, which also describes each of the proposed improvements.

Table 2-8
Storm Water Drainage Improvements by Type

Drainage	Number of Upstream Peak Flow Reduction Improvements	Number of In-Channel Stabilization, Armoring, and Repair Improvements
Cave Gulch	0	2
Jordan Gulch	19	42
Moore Creek	19	31
San Lorenzo-Pogonip	1	3
Other	1	0
Total	**40**	**78**

As shown in the table above, about one-third of the improvements would reduce the peak flows that are discharged into the affected drainages. Some of the improvements would also reduce the total volume of runoff that reaches the active channels. The hydrological changes that would result are described below by drainage.

Cave Gulch. Item 2 would divert flow from Empire Grade that currently discharges into the Pump Station tributary of Cave Gulch for infiltration in native vegetation and reinforce the channel below the culvert outfall. The reduced flow rate, along with channel reinforcement, would reduce the potential for erosion in Pump Station Tributary.

Jordan Gulch**.** Item 18 would divert runoff from Chinquapin Road and Chinquapin Sinkhole overflow to Upper Quarry Sinkhole. This would reduce the potential for erosion in the east fork of Jordan Gulch. Similarly, Item 24 would divert water from the Music Center detention basin and would infiltrate it into the meadow, thus reducing the volume of runoff that is discharged into the Great Meadow Tributary. Other diversions within the Jordan Gulch watershed include Item 40 that would reduce flows into the main stem; Item 58, which would divert water away from the middle fork; and Item 64 which would divert flows from the west fork. All of these would be implemented in Phase 1 of the improvement project and would reduce the potential for erosion in Jordan Gulch.

The new cooling tower would add a small amount of impervious surface (less than 0.5 acre), which would result in a slight increase in runoff to Jordan Gulch. The Campus would implement LRDP Mitigations HYD-3C and 3D, requiring detention, retention, and/or infiltration of storm water runoff to ensure that post-development peak flow rates do not exceed pre-development rates and that the volume of runoff added to Jordan Gulch is minimized. The impact of all campus development in the Jordan Gulch watershed under the 2005 LRDP is considered significant and unavoidable because new buildings and other impervious surfaces would be constructed within the watershed before the Infrastructure Improvements Project storm water drainage improvements have been completed. However, the amount of impervious surface that would be added by the cooling tower is minimal and the project-level impact would be less than significant.

Moore Creek. Items 101 and 102 would divert runoff from east fork of Moore Creek to the west fork and Cave Gulch; Item 104 would divert runoff from College Eight dorms to a dispersion manifold for infiltration and reduce the volume of flow into West Entrance Fork Tributary; Item 105 would divert runoff from the south side of Family Student Housing to dispersion manifolds; Items 106 and 103 would divert runoff into a new detention basin to reduce peak flow rates into the drainage; Items 62, 69, 92, 93, 107, 91, 82, 72, and 73 would divert runoff from campus facilities and disperse it, thereby reducing the volumes of water that reach the tributaries including the East Fork, Kresge, and Science Hill tributaries to Moore Creek. All of these would be implemented in Phase 1 of the improvement project and would reduce the potential for erosion in Moore Creek.

San Lorenzo-Pogonip Drainage. Item 111 would divert runoff from East Remote parking lot and disperse it so that the volume is dispersed over a larger area within the watershed. This would reduce the erosion problem.

All of the above listed improvements would alter drainage patterns on the campus. However, because these diversions would help reduce existing erosion problems in the creeks, the impact on the creeks would be beneficial. Furthermore, Phase 2 of the project would make other improvements, mostly within the channels to arrest erosion at specific locations and reduce sedimentation. Therefore, overall, the proposed project would reduce erosion in all four watersheds on the campus.

However, subsequent to installation of dispersion manifolds, erosion could occur in areas where the water is dispersed for infiltration, if the manifolds are not properly designed and maintained. Because Phase 1 of the storm water drainage improvements relies heavily on diversion and dispersion of runoff, these activities could result in erosion associated with dispersion manifolds, and the impact would be potentially significant. The Campus will implement IIP-SW HYD-3A to reduce this impact to a less-than-significant level.

IIP-SW Impact HYD-4:	Implementation of the Infrastructure Improvements Project would alter drainage patterns but would not result in increased flooding on or off site.
Significance:	Less than significant
IIP-SW Mitigation:	Mitigation not required
Residual Significance:	Not applicable

As described above, storm water drainage improvements would alter drainage patterns by reducing peak flows compared to existing levels and potentially reducing the total volume of storm water that is discharged in certain reaches of the affected drainages.

As discussed in Section 4.8 in Volume I, flooding is a problem associated with a few sinkholes on the campus. 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 critical sinkholes that are showing signs of reaching capacity, which could increase the likelihood of spilling to downstream reaches and thus of flooding. The sinkholes that were identified include 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 in 2004 (Kennedy/Jenks 2004). Several of the storm water drainage improvements included in the Infrastructure Improvements Project are focused on the removal of sediment from these critical sinkholes to restore infiltration capacity. Therefore, even though the proposed project would alter drainage patterns on the campus, the project would reduce the potential for flooding on the campus by infiltrating more runoff in the upstream areas and improving infiltration at critical sinkholes.

Flooding has also occurred off-campus in the Moore Creek watershed near Highview Drive. However, adequate storage capacity is already available in the Arboretum Pond system, and the storm water drainage improvements would reduce peak flows in Moore Creek. Therefore, the potential for flooding would decrease compared to existing conditions. The impact would be beneficial.

Cumulative Impacts

Cumulative impacts from campus development under the 2005 LRDP, including the proposed project, are adequately addressed in LRDP Impacts HYD-7 and HYD-8.

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2.4.9 Land Use

2.4.9.1 Environmental Setting

Section 4.9, *Land Use* (Volume II), describes the land uses and applicable planning regulations for the UC Santa Cruz campus and the surrounding areas.

2.4.9.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.9 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.9 for analytical method relative to land use impacts.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. Analysis in the 2005 LRDP Initial Study concluded that the 2005 LRDP would not physically divide an established community nor would it result in any land use designation change that could conflict with any City or County land use plans. In addition, the LRDP-level analysis concluded that campus growth under the 2005 LRDP and the proposed land use plan would not conflict with any HCP. Therefore, no project-level analysis of these impacts is necessary. The proposed project would not involve development of new land uses which could be incompatible with existing and/or planned land uses, and therefore no project-level evaluation of this issue is necessary.

Project-Specific Impacts and Mitigation Measures

Not applicable

Cumulative Impacts

Cumulative impacts of campus development under the 2005 LRDP, including the proposed project, are adequately addressed in LRDP Impact LU-4.

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2.4.10 Noise

This section assesses the potential noise impacts of Infrastructure Improvements Project on adjacent noise sensitive land uses.

2.4.10.1 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.10 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.10 for analytical method relative to noise.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. Analysis in the 2005 LRDP Initial Study concluded that the campus is not located within an airport land use plan or within 2 miles of public airport or public use airport and therefore would not expose people working in the project area to excessive noise levels. The Initial Study also determined that the campus is not located within 2 miles of a private airstrip. Therefore, no impact would occur and no additional project-level analysis is needed. The noise impacts from construction activities and the operation of the new cooling tower are addressed below.

Project-Specific Impacts and Mitigation Measures

IIP-ALL Impact NOIS-1:	Construction activities associated with the Infrastructure Improvements Project would result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.
Significance:	Significant
IIP-ALL Mitigation NOIS-1:	The Campus shall implement LRDP Mitigation NOIS-1 for all improvements that are within 100 feet of an existing campus building or sensitive receptor.
Residual Significance:	Significant and Unavoidable

The proposed project would be constructed in two phases. The first phase would involve about one-third of the storm water drainage improvements, all of the domestic water system improvements and all of the campus core cooling water system improvements which include the construction of a new cooling tower. The second phase would involve the construction of the rest of the storm drainage improvements as well as improvements to the campus core heating water, electrical and natural gas systems. With the exception of the new cooling tower, all of the other improvements would involve minor construction activities and are therefore not expected to result in high levels of noise during construction, and the impact would be less than significant. To further reduce this impact, the Campus would implement LRDP Mitigation NOIS-1 at those work sites that are within 100 feet of a sensitive receptor or an existing campus building. The cooling tower project would however involve more substantial construction activities than the other improvements. Two options are under consideration for the cooling tower: the first one is to construct a new tower at the site of existing Cooling Tower #2 adjacent to the Central Heating Plant and the second is to construct a similar sized cooling tower at a site near the Earth and Marine Sciences Building. Under the first option, construction activities would include demolition of the existing tower, erection of the new tower, and finishing. Minimal foundation work would be necessary at this site as the new tower would be built on the pad of the existing tower. There would also be some ground clearing and grading locally for the placement of new utilities that would serve the new cooling tower. Similar activities would occur at the site near Earth and Marine Sciences Building under the second option, and in addition, a new foundation would be constructed. Construction activities would primarily take place during daytime hours (i.e., between the hours of 7:00 AM and 7:00 PM). Typical noise levels from these construction activities (with the normal number of pieces of equipment operating on the site and conservatively assuming a 10-hour typical workday) range from 75 to 86 dBA L_{eq} at a distance of 50 feet.

Noise levels from construction activities generally decrease at a rate of 6 dB per doubling of distance. Thus, at a distance of 100 feet from the center of construction activities, typical construction noise levels would range from 69 to 80 dBA L_{eq}. At the first location near the Central Heating Plant, although most of the other academic and residential buildings are more than 500 feet from the project site, the site would be less than 100 feet from the Lick Laboratories complex, and persons occupying these academic buildings would be considered sensitive receptors. However, because of the presence of other structures between the project site and the sensitive receptors, the noise levels at the receptors would be reduced below 80 dBA $L_{eq.}$ Furthermore, the Campus would implement LRDP Mitigation NOIS-1 in conjunction with the construction of the cooling tower. Therefore, the impact would be less than significant. Under the second option, although all other campus buildings would be more than 500 feet away, the Earth and Marine Sciences Building would be about 40 feet from the project site. Construction activities would result in noise levels in excess of 86 dBA L_{eq} at this receptor, which would constitute a significant impact. Although the Campus would implement LRDP Mitigation NOIS-1 in conjunction with the construction of this improvement, the noise levels during construction would not be reduced below 80 dBA L_{eq}, and the impact would be significant and unavoidable.

IIP-CW Impact NOIS-2:	Operation of the new cooling tower would result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
Significance:	Potentially significant
IIP-CW Mitigation NOIS-2:	The Campus shall achieve an exterior noise level of 70 dBA CNEL at the Earth and Marine Sciences Building adjacent to the new cooling tower by selecting a less noisy cooling tower or by design measures and operational changes.
Residual Significance:	Less than significant

The operation of the fans and pumps included in the proposed cooling tower would elevate noise levels in the vicinity of the cooling tower. Under the first option, even though the cooling tower would be in close proximity of academic buildings, intervening structures would reduce noise levels and nearby receptors in the academic buildings would at the most experience a small increase (less than 3 decibels) in noise levels, compared to levels that would exist without the proposed improvements.

Under the second option, the cooling tower would be within 40 feet of the Earth and Marine Sciences Building and there would be no intervening buildings between the cooling tower and this building. The operation of the cooling tower at this location would produce noise levels as high as 79 dBA L_{eq}, which would equate to about 86 dBA CNEL. This noise level would be in excess of the noise standard for academic buildings, which is 70 dBA CNEL. Even though the noise levels inside the building would be attenuated by the building shell, they would not be adequately reduced to provide a quiet working/learning environment. Therefore, the impact would be considered significant. To reduce this impact to a less-than-significant level, the Campus would implement IIP-CW Mitigation NOIS-2, which requires that the noise levels be reduced to an acceptable level by either selecting another less noisy cooling tower or including design measures such as enclosures and/or managing the operation of the cooling tower to reduce noise levels. With the implementation of this mitigation, the impact would be reduced to a less-than-significant level.

Cumulative Impacts

The cumulative impact of campus growth under the 2005 LRDP, including the proposed project, is adequately addressed in LRDP Impact NOIS-2.

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2.4.11 Population and Housing

2.4.11.1 Environmental Setting

Section 4.11, *Population and Housing* (Volume II), describes the population and housing conditions of the UC Santa Cruz campus and surrounding area as well as applicable planning regulations.

2.4.11.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.11 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.11 for analytical method relative to population and housing.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. Analysis of population and housing at the LRDP level took into account the entire projected increase in campus population and housing (LRDP Impacts POP-1 through POP-3). Implementation of the proposed project would not result in an increase in campus population above that accommodated by the 2005 LRDP. Therefore, no further analyses of project-related impacts related to population and housing are needed.

Project-Specific Impacts and Mitigation Measures

Not applicable.

Cumulative Impacts

The cumulative impacts on population and housing are adequately addressed under LRDP Impacts POP-1 and POP-3. The proposed project would not contribute to either cumulative impact.

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2.4.12 Public Services

2.4.12.1 Environmental Setting

Section 4.12, *Public Services* (Volume II), provides a description of existing public services that currently serve the campus.

2.4.12.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.12 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.12 for analytical methods relative to public services.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The LRDP-level analysis of public services impacts evaluated the effects of the entire campus population growth and facilities expansion under the 2005 LRDP (LRDP Impacts PUB-1 through PUB-7). The proposed Infrastructure Improvements Project would not increase the population of the campus or add buildings that could require services and, therefore, would not result in an impact on public services.

Project-Specific Impacts and Mitigation Measures

Not applicable.

Cumulative Impacts

The cumulative impacts of the 2005 LRDP are adequately addressed under LRDP Impacts PUB-5 through PUB-7. The proposed project would not contribute to any of these cumulative impacts.

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2.4.13 Recreation

2.4.13.1 Environmental Setting

See Section 4.13, *Recreation* (Volume II), for a discussion of existing campus and off-campus recreation facilities.

2.4.13.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.13 (Volume II) for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.13 for analytical method relative to impacts on recreational facilities.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The environmental effects of increased demand for recreational facilities and deterioration due to increased use associated with population growth under the 2005 LRDP are adequately addressed at the LRDP level. The proposed project would not increase the population of the campus. Additional project-level analysis is not required.

Project-Specific Impacts and Mitigation Measures

Not applicable.

Cumulative Impacts

The cumulative impact on regional recreational facilities from campus growth under the LRDP is adequately addressed under LRDP Impact REC-3. The proposed project would not contribute to the impact.

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2.4.14 Traffic, Circulation, and Parking

2.4.14.1 Environmental Setting

Section 4.14, *Traffic, Circulation, and Parking* (Volume II), describes the existing circulation system and parking for the UC Santa Cruz campus.

2.4.14.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.14 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. The Infrastructure Improvements Project would generate construction vehicle trips over a period of about 3 years (2006 through 2009). Because all the improvements would not be constructed simultaneously, the daily vehicle trips generated by the project were derived assuming that a certain number of improvement projects would be underway on a given working day during the 3-year period. For purposes of estimating construction traffic under reasonable worst case conditions, based on the schedule that is laid out in Section 2.3.10, it was assumed that during Phase 1 of the project, there would be simultaneous construction of three storm water drainage improvements, two domestic water pipeline improvements, and one cooling water system improvement. During Phase 2, up to six storm water drainage improvements, two heating water and one natural gas pipeline improvements could be underway simultaneously. Based on these assumptions, there could be up to 40 construction worker trips and up to 20 truck trips per work day, when construction is underway on the project.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. The proposed project would not increase campus population and would therefore not result in new daily vehicle trips. The impact from construction traffic is examined below.

Project-Specific Impacts and Mitigation Measures

IIP-ALL Impact TRA-1:	The proposed project would add vehicle trips to the study area transportation network.
Significance:	Less than significant
IIP-ALL Mitigation:	No mitigation required
Residual Significance:	Not applicable

As stated above, it is estimated that there would be up to 20 construction truck trips per day and up to 40 construction worker trips per day associated with the project. Because construction activity typically begins early in the mornings, and ends in mid-afternoon, most of these vehicle trips would occur outside the peak traffic hours. Furthermore, the number of peak-hour trips (no more than two truck trips and four construction worker vehicle trips during the peak hour) is too small to significantly affect the levels of service along the roadways. The impact from construction traffic would be less than significant.

Cumulative Impacts

The cumulative impact of the 2005 LRDP, including the proposed project, on the transportation network is adequately addressed in LRDP Impacts TRA-1 and TRA-2. Note that the LRDP-level traffic analysis took into account construction traffic that would be associated with ongoing construction on the campus over the life of the 2005 LRDP. The traffic associated with the Infrastructure Improvements Project is a subset of the construction traffic that was accounted for in the LRDP-level analysis.

Based on the construction schedules of the Infrastructure Improvements Project and the Family Student Housing Redevelopment Project, construction on both projects would be underway at the same time. However, as noted above, the number of peak-hour vehicle trips for the Infrastructure Improvements Project would be small, and even when combined with the construction vehicle peak-hour trips for the Family Student Housing Redevelopment Project (less than 20 peak hour trips), the combined trips would not result in a significant traffic impact. This is because the vast majority of construction vehicle movement typically occurs outside the peak commute hours.

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2.4.15 Utilities

2.4.15.1 Environmental Setting

Section 4.15, *Utilities* (Volume II), describes the existing utilities systems servicing UC Santa Cruz.

2.4.15.2 Impacts and Mitigation Measures

Standards of Significance. Refer to Section 4.15 in Volume II for a discussion of applicable Standards of Significance.

Analytical Method. See Section 4.15 for analytical method relative to impacts on utilities. Utility impacts are measured in terms of the adequacy of the available supply to meet the project demand, the availability of supply or service at the project's point of connection, and the environmental impacts from construction of utility connections or facilities.

Impacts Adequately Analyzed at the LRDP Level or Not Applicable to the Project. Analysis at the LRDP level of impacts related to the capacity of utility systems took into account the increase in demand from all the projected development and population growth under the 2005 LRDP. The proposed project would not increase campus population or the population-related increase in the demand for any utility. The proposed project would include the new cooling tower, as a result of which more domestic water would be cooled and used in the campus core cooling system. Note that the cooling water system is a closed loop system in which water is circulated. After the initial withdrawal of water that would be used in the new cooling tower, only small additional withdrawals of water would be needed to periodically replace the water lost due to evaporation in the new cooling tower or to replace that water that is discharged as blow down for cleaning purposes. The additional demand for cooling water is accounted for in the total projected demand for water under the 2005 LRDP, and the impact of that demand is evaluated at the LRDP level. No further project level analysis is necessary.

Project-Specific Impacts and Mitigation Measures

Not applicable.

Cumulative Impacts

The cumulative impacts of campus growth under the 2005 LRDP are adequately addressed under LRDP Impacts UTIL-9 and UTIL-10. The proposed project would contribute to these cumulative impacts.

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2.5 ALTERNATIVES TO THE PROPOSED PROJECT

CEQA requires an EIR to describe and evaluate a range of alternatives to a proposed project or alternatives to the location of the proposed project. The purpose of the alternatives analysis is to discuss ways that the objectives of the proposed project could be attained while reducing or avoiding significant environmental impacts of the proposed project. This process is intended to foster informed decision-making and public participation in the environmental process.

2.5.1 Project Objectives

Alternatives considered in the EIR should be feasible and should attain most of the basic project objectives. The primary goal of the Infrastructure Improvements Project is to upgrade existing utility systems. These upgrades are needed both to remediate inadequacies or inefficiencies in capacity or level of service in the existing systems. Storm water drainage system improvements are needed to correct existing erosion and sedimentation problems.

2.5.2 Significant Impacts of the Infrastructure Improvements Project

The alternatives analyzed for a project should focus on reducing or avoiding significant environmental impacts associated with the project as proposed. As described in Section 2.4, most of the improvements to the domestic water, cooling water, heating water, natural gas and electrical systems are minor improvements that would be located in areas that are already disturbed and developed and, therefore, significant environmental impacts from these improvements are not considered likely. A large number of storm water drainage improvements, because of their locations in creeks and drainages, the new cooling tower, and a few of the domestic water system and natural gas system improvements are the main elements of the proposed project that could result in environmental impacts. The analysis in Section 2.4 found that the proposed project would have potentially significant impacts mainly during the construction-phase and significant impacts from operations would be associated with only the cooling tower and no other infrastructure improvement. The potentially significant construction-phase impacts would be related to visual resources, biological resources, cultural resources, hydrology and water quality, and noise. The potentially significant operations-phase impacts would relate to the noise from the operation of the cooling tower under the second option. The evaluation that follows focuses on alternatives that would avoid or reduce these impacts. Furthermore, because practically all of the potentially significant impacts are associated with the storm water drainage improvements, the alternatives analysis below focuses mainly on that component of the proposed project.

2.5.3 Alternatives Considered but Rejected as Infeasible

This section discusses alternatives that were considered for the project but were rejected because they did not meet project objectives or were found to be infeasible for technical, environmental, or social reasons.

Because the proposed project comprises a large number of components or utility systems, alternative methods to achieve the objectives of improvements to individual utility systems were considered, rather than to the project overall. Note that because the proposed project is designed primarily to address problems in the existing utility systems on the campus, alternative locations were not considered.

2.5.3.1 Alternatives to Domestic/Fire Protection Water System Improvements

As discussed in Section 2.3.4, the campus domestic/fire protection water system cannot provide consistent, reliable service because of both inadequate water pressure under fire flow conditions due to undersized piping and the numerous pressure-reducing stations that are necessary on account of campus topography. The proposed project would replace undersized piping, and add or replace pressure-reducing valves.

A number of solutions to domestic water system issues were considered, including replacing the entire system; several combinations of replacing segments of undersized pipes; and multiple small-scale projects at several locations. It was concluded that entire system replacement or the combined cost of upgrades would have been significantly higher than the cost of improvements that would be implemented under the proposed project. Routing new connections over or through the natural drainage channels was also considered, but these were determined to be both too costly (because piping would have had to be carried on towers or other above-grade structures), and potentially disruptive to the habitats of endangered species. Therefore, all of these various alternative ways to address the problems were rejected and not carried forth for further analysis.

2.5.3.2 Alternatives to Cooling Water System Improvements

The proposed project includes the construction of a new cooling tower at the site at a site near the Central Heating Plant or the Earth and Marine Sciences Building in the central campus, and the installation of new piping between Sinsheimer Laboratories and the Earth and Marine Sciences Building to increase system flexibility. These improvements would increase the cooling water system capacity and would serve the new buildings that would be built in the campus core under the 2005 LRDP.

The alternatives to a centralized new cooling tower would be the construction and operation of a number of smaller cooling towers and associated individual building chillers or the use of individual air-cooled package chillers in the new buildings.

Stand-alone cooling towers for individual new projects would increase system costs because maintenance would be decentralized. Operating costs would be higher because water would be used less efficiently, and would have to be cooled during peak energy periods. Further, because central campus building space is scarce, it would be difficult to identify suitable locations for cooling equipment, which is noisy and emits spray. Air-cooled packaged chillers would not require a cooling tower and therefore would have lower demand for space, but such chillers would have significantly lower operating efficiency and consequently higher operational costs than the proposed project. Therefore, these alternatives were considered but rejected as they would be more costly and would also take up some of the limited land available in the campus core for new buildings.

2.5.3.3 Alternatives to Campus Core Heating Water System Improvements

As discussed in Section 2.3.6, the campus core heating water system has several deficiencies related to distribution piping that cannot handle water heated to design temperatures in the Central Heating Plant. Other problems are related to the operation of the campus Cogeneration Plant. The proposed project would replace low temperature pipeline segments with higher-rated pipelines that can convey water that is heated to 220 degrees Fahrenheit. Another improvement included in the project is the replacement of piping sections to better serve the Theater Arts Complex.

The alternative to this improvement would be to increase the pumping capacity of the entire hot water distribution system which would require excavating and replacing the entire concrete tunnel system throughout the campus core to replace the existing distribution mains, and to add a separate boiler to serve the buildings in the Theater Arts Complex. Excavating and replacing the entire tunnel system would be much more disruptive than the proposed project, prohibitively costly, and would not address the efficiency problems at the Cogeneration Plant. The alternative was therefore not carried forth for further evaluation.

2.5.3.4 Alternatives to Electrical System Improvements

The proposed project would replace oil-filled sectionalizing switches that are outmoded and potentially hazardous with solid dielectric switches and ground fault protection.

An alternative to replacing the existing switches would be to extend redundant electrical feeders to affected areas of the campus. While this alternative would limit the impacts of a power failure, it is much more costly and disruptive than the installation of new switches. Therefore, this alternative was rejected for further analysis.

2.5.3.5 Alternatives to Natural Gas Improvements

The proposed project includes replacement of a section of natural gas pipeline in Hagar Drive to provide more gas to a portion of the campus and the replacement of the College Eight pressure-reducing station.

Northern campus pressure problems could be addressed by adding new large gas lines to the upper campus area where loads are heaviest. This would require installing several miles of new gas piping from the base of campus to the northernmost developed areas. To be effective, this alternative would require improvements to increase pressure received from PG&E lines. It would not address issues related to existing constricted piping, and would be cost prohibitive. The alternative was therefore not carried forth for further evaluation.

2.5.4 Alternatives Evaluated in Detail

This section presents a qualitative evaluation of one alternative to the proposed storm water drainage system improvements and the No Project Alternative. Based on the evaluation in Section 2.5.3, it was determined that for all other components except the storm water drainage system improvements, alternatives would not be evaluated in detail because these other components of the proposed project would not result in significant environmental impacts, and furthermore, alternatives to the other components were found not to be feasible or effective.

Discussion for each alternative to the storm water drainage system improvements includes a brief description, an impact analysis, and a summary comparison with the proposed project. The alternatives were examined for their ability to meet project objectives, for their feasibility of implementation, and their ability to further reduce or avoid the significant impacts of the proposed project. Under each alternative, each of the resource areas with potentially significant project-related impacts is addressed under a separate subheading; all other resource areas are discussed under a single subheading.

2.5.4.1 Alternative 1: Convert to Conventional Piped Storm Drain System

Description

As described in Section 2.3.3.2, UC Santa Cruz uses the campus's natural drainages to convey runoff. Storm water runoff from the localized campus building clusters drains via a network of pipes, detention basins, and settling tanks to the tributaries and channels of primarily Jordan Gulch and Moore Creek, although some of the storm water is discharged into Cave Gulch and into gullies in the Pogonip that are tributary to the San Lorenzo River. The drainages that receive campus runoff are experiencing serious erosion problems which would be addressed by the series of improvements included in the proposed project. An alternative to implementing the proposed storm water system improvements would be to collect the water from the developed areas of the campus and convey it either into off-campus drainages or directly to the ocean. Such a system would require the construction of storm drains under all major roads on the campus, that would converge at or near the base of the campus at Bay and High streets.

The City of Santa Cruz does not have a piped system to receive campus runoff, so the campus piped system would have to discharge to creeks off campus, which are experiencing erosion issues similar to those on campus and would require extensive armoring to accommodate the additional flow from campus. For instance, from the intersection of Bay Street and High Street, the collected water would then be discharged into Bay Creek which runs in the median of Bay Street and finally discharges into Neary Lagoon. However, Bay Creek, which is culverted in certain areas, would likely have inadequate capacity to carry the entire flow so improvements along the corridor would be needed. Some of the water may need to be discharged into other drainages such as Arroyo Seco and the western tributary of Moore Creek. Alternately, campus runoff could be conveyed directly to the nearest point along the coast in a large new storm drain.

This alternative would require construction under major campus roads, through major utility alignments and possibly across the campus's steep drainages where access would be a construction challenge. Construction costs of this alternative would be high.

Impact Analysis

Aesthetics. As described in Section 2.4.1, the storm water drainage improvements sites, which are moderate to highly visible, would be restored following construction; therefore the project would not significantly affect the visual quality of the area around the sites (IIP-SW Impact AES-1). The storm drain system under Alternative 1 would generally be installed underground along existing roads; however, above-ground structures may be required where the piping crosses drainages, which could result in visual impacts.

Air Quality. Because the disturbed area associated with the proposed project would be small, the construction emissions would not be significant. Under Alternative 1, much more area would be disturbed and the emissions would, therefore, be greater but likely would not exceed the significance threshold because only a limited length of trench would be excavated at one time.

Biological Resources. The proposed project would require placement of fill in the waters of the US and the State as well as loss of riparian vegetation (IIP-SW Impacts BIO-1 and BIO-2). Similar, although less severe, impacts would occur under Alternative 1 as the piped system would involve creek crossings at certain locations on and off the campus where these resources could be affected. Similarly, impacts to water quality during construction could occur (IIP-SW Impact BIO-3) under Alternative 1. Because the piped system would not be located within the Lower Moore Creek watershed (except along the already disturbed Heller Drive corridor), construction of Alternative 1 would not affect CRLF (IIP-SW Impact BIO-5). The alternative could however result in significant reduction in the flows in the campus creeks, which could result in impacts to wildlife habitat, including the loss of riparian vegetation and pools that support CRLF in the Moore Creek drainage, which would be a significant impact. Impacts on nesting raptors from construction noise and activity (IIP-SW BIO-6) would occur both under the proposed project and under Alternative 1 and would require mitigation. Because Alternative 1 would likely not construct storm drain lines within the East Meadow and the Great Meadow, it would avoid the potentially significant impact of the proposed project on burrowing owls (IIP-SW BIO-7). Alternative 1 could result in a significant impact on springs and riparian vegetation in the creeks as the water that would normally have run off into creeks would no longer be discharged there and groundwater recharge could also be reduced.

Cultural Resources. While the construction activities under Alternative 1 would be located along existing roads and utility corridors, where it can be assumed that some level of ground disturbance has already occurred, the extensive excavation required for installation of a complete network of storms drains has moderate potential to encounter undiscovered archaeological deposits. Further, Empire Grade runs through a known archaeological site, and there may also be buried historic archaeological materials under roadways in the main entry area of the campus, around the central complex of the historic Cowell Ranch. The proposed project likely will be able to avoid all of the archaeological and historic features identified, while it might not be possible to avoid archaeological deposits within utility corridors. The alternative, this, has higher potential to affect archaeological resources, and possibly human remains (IIP-SW Impacts CULT-1 and CULT-2), that does the proposed project.

Hydrology and Water Quality. As discussed in Section 2.4.8, although the proposed storm water drainage improvements would reduce the existing erosion problems in the campus drainages, some erosion could still occur (IIP-SW Impact HYD-3). If all of the campus runoff were to be captured in storm drains and conveyed to downstream creeks or the ocean, erosion problems on the campus would be substantially reduced. However, the off-campus creeks into which the runoff would be discharged would likely experience increased erosion. Therefore, erosion problems may simply be transferred to another location. The increased flows could also result in flooding in off-campus creeks, an impact that would not occur under the proposed project. Furthermore, a system that conducted runoff away from the campus could have a significant adverse effect on local groundwater recharge.

Noise. Because some of the proposed storm water drainage and other improvements would be less than 100 feet from campus buildings, construction noise could exceed significance thresholds and mitigation would be required (IIP-ALL Impact NOIS-1). A similar impact could occur under Alternative 1 at some places where the storm drains would be constructed very close to campus buildings. However, because storm drain construction most likely would not involve major construction equipment such as large excavators, graders and loaders, it is likely that the noise thresholds would not be exceeded and the impact would be avoided.

All Other Resources. No project-specific significant impacts on other resources were identified for either the proposed project or the alternative.

Ability to Accomplish Project Objectives

The goals of the storm water drainage system improvements are to correct existing erosion problems, ensure water quality, and facilitate increased recharge of the groundwater aquifer. Alternative 1 would meet the first goal but, as described above, could potentially result in increased erosion off campus. The second goal would not be met because urban runoff is treated as it travels in vegetated channels whereas no treatment occurs when runoff is conveyed in piped systems. Therefore additional treatment of runoff before it enters the storm drain lines would likely be necessary under this alternative. Finally, this alternative would reduce the amount of water that would enter the groundwater aquifer at the site, and therefore not meet the third goal of the proposed storm water drainage improvements program.

2.5.4.2 Alternative 2: No Project

Description

As required by CEQA Guidelines, the No Project Alternative is analyzed below. Under the No Project Alternative no infrastructure improvements would be made on the campus to address the problems. The existing infrastructure would continue to serve its current users and functions, but it would not be upgraded or expanded to improve the adequacy of service or remediate deficiencies. Flooding would continue to occur at some of the sinkholes, and drainage erosion would be expected to accelerate.

Impact Analysis

Aesthetics. The No Project Alternative would avoid the significant impact of the proposed project on visual resources.

Air Quality. The No Project Alternative would avoid the minor increase in emissions during construction of the improvements.

Biological Resources. The No Project Alternative would avoid all of the significant impacts of the proposed project on biological resources. It would, however, result in a significant impact on CRLF because if the erosion in Moore Creek is not arrested, the Arboretum Pond could receive a significant amount of sediment, which would then degrade the pond as a breeding site for CRLF.

Cultural Resources. The No Project Alternative would avoid the potentially significant impacts of the proposed project on cultural resources.

Hydrology and Water Quality. The No Project Alternative would result in accelerated erosion in the drainages on the campus, resulting in the release of more sediment into the receiving waters. It would also result in the sedimentation of the Arboretum Pond and other detention facilities on the campus, and the flooding problems on and adjacent to the campus could potentially increase.

Noise. The No Project Alternative would avoid the significant noise impacts that would result from the proposed project during construction.

All Other Resources. No project-specific impacts were identified for either the proposed project or the alternative.

Ability to Accomplish Project Objectives

Under the No Project Alternative, none of the improvements would be made and, therefore, this alternative would not meet any of the goals and objectives of the proposed project.

2.5.5 Environmentally Superior Alternative

An EIR is required to identify the environmentally superior alternative from among the range of reasonable alternatives, which are evaluated. The proposed storm drainage improvement project would not have any significant and unavoidable impacts. Under the No Project Alternative, all of the impacts of the proposed project would be avoided; however, it would result in accelerated erosion in the campus drainages, resulting in the release of more sediment into the receiving waters and sedimentation of the Arboretum Pond and other detention facilities on the campus, and potentially could increase flooding problems on and off-campus. No mitigation would be available for this impact. Alternative 1 would avoid the potentially significant biological resource impacts of the proposed project. Although Alternative 1 would provide the benefit of substantially reducing erosion conditions on the campus, implementation of this alternative would likely result in increased erosion in off-campus creeks. Furthermore, Alternative 1 could have a significant adverse effect on local groundwater recharge and could result in flooding in off-campus creeks. Construction emissions would also likely be greater under this alternative than under the proposed project because a larger area of land would be disturbed. Therefore, the proposed project is considered the environmentally superior alternative.

2.6 GROWTH INDUCING IMPACTS

As required by the CEQA Guidelines, an EIR must discuss ways in which a potential project could induce growth. A project may be growth inducing if it directly or indirectly fosters economic or population growth or the construction of new housing, removes obstacles to population growth, or requires or encourages the construction of new facilities. According to CEQA Guidelines Section 15126.2(d), "it must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment."

The issue of removal of obstacles to growth relates directly to the removal of infrastructure limitations or regulatory constraints that could result in growth that was not planned at the time of project approval. The proposed Infrastructure Improvements Project consists of improvements to existing infrastructure facilities on the UC Santa Cruz campus. With the exception of the proposed cooling water system improvements, none of the components of the proposed project provide additional infrastructure capacity or extend services to areas outside those already served by existing utilities. The proposed improvements to the electrical, natural gas, heating water and storm water drainage systems address existing operational and safety concerns and existing erosion conditions in campus drainages. The proposed cooling water system improvements would provide additional capacity to serve a portion of the development that would be constructed within the existing campus under the proposed 2005 LRDP. The potential growth-inducing impacts of this development are analyzed in Section 6.0, *Other CEQA Considerations* in Volume 1 of this EIR.

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Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
2	CG-PST-R1-1	Cave Gulch	Pump Station Tributary	Below pump station driveway	Current demand exceeds current outfall design resulting in erosion and channel incision.	Divert flow coming down Empire Grade – Reinforce 40 ft of shoulder and install 200 SF rock lining off Empire Grade. Install 2 diversion structures each 2' Wx 6' L and anchored to channel. Protect receiving channel below culvert outfall with rock energy dissipation apron (15' long x 4' wide)	1
18	JG-EF-J	Jordan Gulch	East Fork	Chinquapin sinkhole, Chinquapin Drive, JG and MS.	Runoff from Chinquapin sinkhole overflow and Chinquapin Drive contributes to erosion in JG MS.	Divert runoff from Chinquapin sinkhole overflow and Chinquapin Drive to Upper Quarry sinkholes. Provide 150 LF culvert to divert water at Chinquapin/McLaughlin intersection. Provide pipe diversion devices to redirect upper quarry flow to expanded armor. Re-grade 1000 SF adjacent to intersection and add 200 SF of rock lining at inlet and 500 SF at outlet.	1
19	JG-MS-GMT-R1-3 to 4	Jordan Gulch	GMT	Sites 1A and 1B	Sinkhole and channel entrance eroding. High flow and unprotected channel (Hydromodification)	Install buried storm drain pipe with rock stilling basin and rock-lined channel to connect to sinkhole. Banks (but not bottom) of the sinkhole will be lined with filter fabric	1
20	JG-MS-GMT-R1-5	Jordan Gulch	GMT	Site 2	High flow and unprotected channel created 3" high knickpoint. (Hydromodification)	Install rock chute drop structure.	1
21	JG-MS-GMT-R1-8	Jordan Gulch	GMT	Site 3	Paved bike trail threatened by bank erosion.	Install gabion retaining wall.	1
22	JG-MS-GMT-R1-9	Jordan Gulch	GMT	Sites 4A and 4B	High flow and unprotected bank/channel created 4.5" high knickpoint.	Install rock chute drop structure.	1
23	JG-MS-GMT-R1- 12 to 13	Jordan Gulch	GMT	Site 6	High flow and unprotected bank/channel created a steep eroding gully.	Install buried storm drain pipe, a concrete stilling box at the pipe outlet, and a grouted-rock channel to connect to the existing storm drain system	1

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
24	JG-MS-GMT-A	Jordan Gulch	GMT		Runoff from Arts areas is piped to JG GMT and contributes to erosion.	Divert Music detention water 450 LF to the northeast to sheet flow across meadow for infiltration and treatment. Provide 200 LF armored channel from dew line depression to JG-MS-GMT-R1-4 sinkhole.	1
25	JG-MS-GMT-B	Jordan Gulch	GMT		Runoff from Visual Arts painting studio contributes to erosion in JG GMT	Divert multiple (approx. 800 LF total) downspout connections to storm drain piping to splash block distribution to promote infiltration on hill/slope below painting studio	1
38	JG-MS-A	Jordan Gulch	Main Stem		Discharges (oils/grease) from parked cars impact JG-MS water quality.	Install 6.0 cfs Vortechnics Storm water Treatment System.	1
40	JG-MS-B	Jordan Gulch	Main Stem		Hahn Student Services parking runoff creating erosion and poor water quality.	Divide flow at 8" culvert at south end of parking lot with coir logs. Assume 3 20 LF coir logs, 1 hour labor time, 2 laborers to stake coir logs.	1
42	JG-MS-D	Jordan Gulch	West Fork		Discharges (oils/grease) from parked cars impact JG-West water quality.	Revegetate parking lot islands for water quality. Assume 300 LF x 10 ft wide = 3,000 SF revegetate area. 3 drop inlets and manifold	1
44	JG-MF-R1-7a (NEW)	Jordan Gulch	Middle Fork		Runoff from culverts at intersection of McLaughlin Dr. and Science Library Road is released onto slope creating a small brook.	Convey discharge from 2 culverts via 240 LF pipe to Middle Fork. Construct energy dissipation apron.	1
45	JG-MF-R1-9	Jordan Gulch	Middle Fork		Shallow swale at end of asphalt diverts flow to east over face of quarry wall. Berm is too low.	Increase height of berm w/ concrete to about 1-ft hight for 15 ft.	1
58	JG-MF-I	Jordan Gulch	Middle Fork		Runoff from Colleges 9/10 causes Health Center sinkhole to overflow which contributes to channel erosion.	Install a larger culvert (assume 48") under McLaughlin Dr. and armor the channel between McLaughlin Dr. and the Health Center sinkhole (about 175 LF).	1
59	JG-WF-CO-R1-1 (NEW)	Jordan Gulch	West Fork	Downstream of CFAO detention basin.	High flow and unprotected channel causing channel incision on about 20% of the slope.	Install approximately 5 check dams (4 ft wide x 1 ft high).	1

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
60	JG-WF-CO-R1-2 (NEW)	Jordan Gulch	West Fork	Open space vegetated w/ grasses as well as some redwood, underlain by schist		Install retention/detention basin upstream of sinkhole. Redirect Kerr Hall Flow to new detention basin. Extend existing Kerr Hall pipe to carry outflow to sinkhole. (Assume existing Discharge pipe to McHenry Library)	1
64	JG-WF-A	Jordan Gulch	West Fork		Runoff from Academic Research Center contributes to erosion in JG-WF	Divert runoff to sheet flow for increased infiltration. Annex building downspouts to be diverted toward JG GMT with regrading and a diversion structure. Other existing storm water pipes to be diverted to 3 separate surface manifolds that discharge to hill/slope to the north of ARC. Assume 500 LF.	1
68.2	MC-EF-BT-A	Moore Creek	Baskin Tributary	South of Bus Stop on Heller Drive	Concentrated road runoff causing poor water quality and erosion. Impacting critical sinkhole downstream.	Install new drainage turn-out in east side curb of Heller Drive, just south of bus stop. Convey water 150 LF in 18" CMP on surface to hillside where 100 LF of 18" surface water spreader manifold can be used.	1
68.4	MC-EF-BT-B	Moore Creek	Baskin Tributary	V-ditch south of Bus Stop on Heller Drive	Concentrated road runoff causing poor water quality and erosion. Impacting critical sinkhole downstream.	Modify existing drainage turn-out on east side of Heller Drive south of MC-EF-BT-A by redesigning to capture all street flow from curb. Use coir logs to spread water below the V-ditch outlet.	1
69	MC-EF-BT-C	Moore Creek	Baskin Tributary		Runoff from Thimann Lab and Lecture Hall contributes to erosion and overflow of MC EF BT sinkhole.	Divert storm piping from Thimann Lecture and East side of Thimann Labs to new culvert that discharges in surface manifolds south of Steinhart. Assume 200 LF 24-inch culvert.	1
69.5	MC-EF-BT-D	Moore Creek	Baskin Tributary	18" CMP culvert from Steinhart Way located SW of Thimann Building	Concentrated road runoff causing poor water quality and erosion. Impacting critical sinkhole downstream.	Modify culvert outlet to be a water spreader manifold on hillside above Baskin Tributary	1
72	MC-EF-BT-SHT-A	Moore Creek	Science Hill Tributary	Thimann Labs	Runoff from loading dock creating erosion and poor water quality.	Install ~300 LF 12-inch piping to redirect runoff from southern Thimann Lab to new detention basin (see JG-WF-CO-R1-2 (NEW)).	1

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
73	MC-EF-BT-SHT-B	Moore Creek	Science Hill Tributary	Thimann Labs	Runoff from loading dock creating erosion and poor water quality.	E end of T. Labs building will be dispersed and detained at proposed Sector 67 DB (see project JG-WF-CO-R1-2 (NEW) above); In-ground vault for parking and Sinsheimer Lab Parking above	1
82	MC-EF-KT-A	Moore Creek	Kresge Tributary	North Remote Parking Lot	Runoff from parking causing erosion.	Install pipe to capture flow from parking at either Camper Park road or at Kresge Road Bridge and redirect to CG.	1
91	MC-EF-A	Moore Creek	East Fork	North of Meyer Drive and East of Heller Drive	Downstream erosion	Install detention basin and overflow structure.	1
92	MC-EF-B	Moore Creek	East Fork		Runoff from College Eight Apartment #2 is piped to MC EF and contributes to erosion	Divert piped storm water runoff from College Eight Apartment #2 downspouts (5 locations) to surface dissipation manifolds. Assume 200' pipe staked to ground.	1
93	MC-EF-C	Moore Creek	East Fork		Runoff from Arts areas is piped to MC EF and contributes to erosion	Modify overflow catch basin near Performing Arts entry drive to divert water to JG GMT rather than MC EF.	1
96	MC-MF-A	Moore Creek	Middle Fork	Sand filter only	Runoff from parking lot causing poor water quality and downstream erosion.	Divert flow from sand filter for eastern 1/3 of parking lot (or replace sand filter with swale) and disperse on hillside to south. Assume 450 LF 12-inch culvert, 350 LF flow dispersion.	1
101	MC-WEF-A	Moore Creek	West Entrance Fork Tributary		Runoff from Porter College parking lots is piped to MC EF and contributes to erosion	Divert flow from 50% of Porter parking lots to landscaped areas to promote infiltration. Assume 300 LF 12-inch shallow trench pipeline, 200 LF 8-inch flow dispersion pipeline.	1
102	MC-WEF-B	Moore Creek	West Entrance Fork Tributary		Runoff from Porter College Academic Buildings is piped to MC EF and contributes to erosion	Divert piped storm water runoff from south portion of Porter College Academic Building to surface dissipation manifold for infiltration toward Cave Gulch (requires deep trench). Assume 350 LF deep trench 12-inch pipeline to parking lot dispersion manifold.	1

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
103	MC-WEF-C	Moore Creek	West Entrance Fork Tributary		Runoff from FSH and Heller Dr is piped to MC WF and contributes to erosion	Widen V ditch along western side of Heller Drive. Divert water from existing eastern flowing culvert crossing to keep runoff in V ditch. Provide series of turnouts to new Heller drive detention basin. Assume 1000 LF V ditch work, 1 ft. excavation, 4 ft.	1
104	MC-WEF-C	Moore Creek	West Entrance Fork Tributary		Runoff from College Eight A Dorms is piped to MC WF and contributes to erosion	Divert piped storm water runoff from A L and Garden dorms to surface dissipation pipe for infiltration. Assume cut and cap culvert. 100 LF total 8-inch dissipation pipeline	1
105	MC-WEF-D	Moore creek	West Entrance Fork Tributary		Runoff from FSH and Heller Dr is piped to MC WF and contributes to erosion	Divert piped storm water runoff from south east side of Family Student Housing to two surface dissipation manifolds. Assume 2 diversion manifolds, 200 LF total per manifold.	1
106	MC-WEF-E	Moore Creek	West Entrance Fork Tributary	North of Heller Drive/Empire Grade intersection	Downstream erosion	Detention at existing depression for flow from Empire Grade and for potential reroute of flow from Family Student Housing. Assume 800 LF 8" pipe and 200 LF dissipation manifold.	1
107	MC-WEF-E	Moore Creek	West Entrance Fork Tributary		Runoff from Performing Arts Buildings A,B,C is piped to MC EF and contributes to erosion	Divert piped storm water runoff from south portion of Performing Arts (Building A, B, C) to surface dissipation manifold for infiltration. Assume 130 LF total dispersion pipeline.	1
109	MC-WEF-G	Moore Creek	West Entrance Fork Tributary		Runoff from West Remote Parking is piped to MC WF and contributes to erosion and vehicle contaminant pollution	Install vegetated swale in parking lot median. Install catch basin and pipe water to dissipation manifold to the south (3 locations). Requires deep trench. Sheet flow to encourage infiltration and treatment.	1
111	GC-A	San Lorenzo-Pogonip Drainage	Gully C	E. end of parking lot	Runoff from East Remote parking causing poor water quality and downstream erosion.	Redirect flows from outlet to south of parking area and disperse.	1

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
1	CG-PT-R2-1	Cave Gulch	--		Reach between two sinkholes eroding/incising.	Recontour 50 ft of roadway and replace drop inlet. Add new concrete drop structure. Grade out headcut and create rock-lined channel inside gully, 20' wide x 50' long. Add additional drop structure midway down channel. Install 100 LF 24" pipe under road crossing to connect upper sinkhole to rock-lined channel. Uphill of upper sinkhole, place 3 waterbars along NW-SE trending road.	2
3	JG-EF-R2-1	Jordan Gulch	East Fork	Sloping knickpoint, 4' drop	Channel unable to handle storm water flow resulting in knickpoints.	2 check dams and redwood planting - plant seedlings in riparian zone.	2
4	JG-EG-R2-3	Jordan Gulch	East Fork	2'-high knickpoint	Channel unable to handle storm water flow resulting in knickpoints.	1 check dam and redwood planting-plant seedlings in riparian zone	2
5	JG-EF-R2-4	Jordan Gulch	East Fork	Six- to eight-foot high root mass stabilizing roughly 100 feet of channel as well as large sediment stores upstream (JG-ER-R1-5)	High flow and unprotected channel	Armor 8' wide x 4' high knickpoint below root mass with large rock. Also reinforce root mass with 5 downstream checkdams: 2 would be 11 ft wide by 1.5 ft high, 3 would be 8 ft wide by 1.5 ft high.	2
6	JG-EF-R2-6	Jordan Gulch	East Fork	RW tree in channel, channel splits around	High flow and unprotected channel	Install 1-2 check dams or downed logs to divert flow away from RW tree. Check dams would be roughly 6 ft wide and 1.5 ft high.	2
7	JG-EF-R2-7	Jordan Gulch	East Fork		Shallow layer of sediment, may have originated from Spring Road, currently stabilized by annual vegetation.	Increase depth of Sinkhole by boring away sediments. Excavate 400 cu-ft of sediment, re-contour w/ 600 SF rock lining. Revegetate with sedges 100' long x 30' wide	2
8	JG-EF-R2-8	Jordan Gulch	East Fork	Sinkhole - with lots of clay from G.S. to 5' BGS (augured 12/03)	Sinkhole unable to accept storm water runoff.	Increase depth of Sinkhole by boring away sediments. Assume 6' deep sinkhole by 50' diameter. Excavate 3750 cu-ft of sediment, re-contour w/ 1000 SF of rock lining. Revegetate with sedges.	2
26	JG-MS-RI-1	Jordan Gulch	Main Stem	Channel scour at end of riprap apron.	Channel scour	Add rock stilling basin. Design outlet to protect downstream redwood clump.	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
28	JG-MS-R1-3	Jordan Gulch	Main Stem	Root mass stabilizing upstream reach	High flow and unprotected channel	Construct 1 - 2 check dams downstream of root mass. Check dam (s) to be 4 ft wide by 1.5 ft high	2
29	JG-MS-R1-4 to 6	Jordan Gulch	Main Stem	Root masses stabilizing upstream reach	High flow and unprotected channel	Construct 1 - 2 check dams downstream of each root mass: 4 ft wide by 1.5 ft high (2 - 4 total)	2
30	JG-MS-R1-7	Jordan Gulch	Main Stem		Ten to twelve foot high knickpoint migrating upstream (associated with railway?) ~ twenty-five foot drop over 50 feet	Construct large concrete drop structure with rock-lined berm or multiple concrete or rock check dams. Assumed 3 check dams.	2
31	JG-MS-R1-10	Jordan Gulch	Main Stem	Sloping knickpoint, 4' drop	Channel unable to handle storm water flow resulting in knickpoints.	Install 2 Check dams in channel (8 ft wide x 1.5 ft deep) drop structure and step pools.	2
32	JG-MS-R2-1	Jordan Gulch	Main Stem	Sloping knickpoint, 4.5' drop, broad channel bed downcutting	Channel unable to handle storm water flow resulting in knickpoints.	Construct log and boulder drop structure or concrete or rock chute drop structure. Construct in tandem with JG-MS-R1-10. (May benefit from project at JG-MS-R1-6a).	2
33	JG-MS-R2-2	Jordan Gulch	Main Stem		Large log jam in channel redirects stream flow toward bank. Poses threat to sanitary sewer line and support structures.	Reposition logs to armor bottom of bank. Field call about additional measures to take once the logs are removed. 1 day of equipment, operator, and 2 laborers.	2
34	JG-MS-R2-3	Jordan Gulch	Main Stem		Eroding bank caused by deflected stream flow immediately downstream of sanitary sewer. Sewer line and support structure in danger.	Reposition stones/boulders. 1 day of equipment, operator, and 2 laborers	2
35	JG-MS-R2-4	Jordan Gulch	Main Stem		Bank slip threatens sewer cradle foundation	Cut trees, reposition stones/boulders. 2 days of equipment, operator, and 2 laborers.	2
36	JG-MS-R3-3	Jordan Gulch	Main Stem	Sinkhole filled with sediment and debris, upstream of Village housing, auguring found 2.5 to 4.2' of sediment (coarse marble debris), cleaned w/in last few years.	Sinkhole unable to accept storm water runoff.	Enhance sinkhole capacity. Excavate 14,130 cu-ft (assume 5 ft. deep sediment, 60 ft. diameter.)	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
37	JG-MS-R3-5	Jordan Gulch	Main Stem		75 feet downstream of start of Reach 3: small scarp formed on inside of meander - start of bank failure	Stabilize toe of evolving bank failure by placing logs roughly 10 to 12 long. Logs would need to be secured into the bed and bank.	2
43	JG-MF-R1-7	Jordan Gulch	Middle Fork		Sinkhole unable to accept storm water runoff.	Construct berm (2' high by 50 LF) to increase sinkhole capacity. Stabilize channel and entrance to sinkhole with rock lining.	2
46	JG-MF-R2-2	Jordan Gulch	Middle Fork		Surface erosion downstream of footbridge crossing	Monitor effects of project at JG-MF-R1-9 and if necessary, extend the culvert outfall 75 LF to beneath the footbridge and construct a dissipation basin below footbridge	2
47	JG-MF-R2-3	Jordan Gulch	Middle Fork		Channel incision	Construct 2.5 ft. drop structure with dissipation apron.	2
49	JG-MF-R3-1	Jordan Gulch	Middle Fork	Sloping knickpoint, 3.0' drop	High flow and unprotected channel	Construct two drop structures, perhaps using rock from immediate area, wing wall may be constructed from compacted earth w/ filter fabric and rocks and logs for the drop structure (see GMT drawings for concept	2
63	JG-WF-R2-1 (new)	Jordan Gulch	West Fork		Erosion starting downstream of Learning Center discharge	Use concrete or rocks to build drop structure at existing knickpoint.	2
65	MC-EF-BT-R1-10	Moore Creek	Baskin Tributary	Sinkhole with down trees and loose rock and soil at risk of sliding in. Channel entrance is eroding 10- - 12 ft high knickpoint to be treated in conjunction with this (EF-BT-R1-8).	Sinkhole unable to accept storm water runoff.	Clear out down trees and other debris from immediate vicinity. Increase sinkhole capacity by building up berm downstream by 12"-18" high by 20'long with 30" long x 4" high concrete.	2
66	MC-EF-BT-R-1-2 to 4	Moore Creek	Baskin Tributary		Channel unable to handle storm water flow resulting in a series of knickpoints	From end of rock-lined section of Core West Parking Structure Bridge, pipe flow through buried 18 - 24 " dia pipe 200+-' feet to flat area OR customized "design and build" rock cascade channel and gradually step down	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
67	MC-EF-BT-R1-7	Moore Creek	Baskin Tributary		Channel unable to handle storm water flow resulting in a series of knickpoints and headcutting.	Grade stabilization structures - 4 - 5 checkdams. Checkdams to be 8 feet wide by 2 feet high.	2
68	MC-EF-BT-R1-8	Moore Creek	Baskin Tributary	Migrating knickpoint at head of sinkhole MC-EF-BT-RI-10, knickpoint has migrated 17 feet since 1999	High flow and unprotected channel (Hydromodification) / Natural process	20' of 24 in to 36 in dia. pipe under redwoods to carry water over headcut or rock chute or gabion drop structure	2
70	MC-EF-BT-SHT -R1-1	Moore Creek	Science Hill Tributary		Channel unable to handle storm water flow resulting in a series of knickpoints	2 -3 coconut fiber or simple check dams	2
71	MC-EF-BT-SHT -R1-3	Moore Creek	Science Hill Tributary		Actively incising reach roughly 180 feet in length, channel bed is devoid of large clasts or organic debris and is eroded to soil	10 +- check dams (similar to JG) or logs and rock channel lining, make improvement o Sinsheimer Lab and Parking Detention then evaluate need for in-channel improvements (checkdams would be 4 ft wide by 1.5 feet high)	2
74	MC-EF-KT-R1-1 to 3	Moore Creek	Kresge Tributary		Active channel incision and channel jumping under Heller Dr. Bridge due to pedestrians & mountain bikes.	Install 100 LF of channel / rock lining - 4 ft. wide - 30 CY	2
75	MC-EF-KT-R1-4	Moore Creek	Kresge Tributary		Mountain bike impacts	Install check dam	2
76	MC-EF-KT-R1-5	Moore Creek	Kresge Tributary		Active channel incision in area of high use from pedestrians and mtn. bikes	Install check dam	2
77	MC-EF-KT-R1-6	Moore Creek	Kresge Tributary		Active channel incision and headcut migration where footpath intersects channel	Install check dam	2
78	IMC-EF-KT-R1-7	Moore Creek	Kresge Tributary		Mountain bike impacts	Install check dam	2
79	MC-EF-KT-R2-3	Moore Creek	Kresge Tributary		Active channel incision occurring at redwood cluster - rw's in danger of undercutting and subsequent falling	Install check dam	2
80	MC-EF-KT-R3-1	Moore Creek	Kresge Tributary		5' headcut to North, field evaluation to ID whether flow goes to larger channel to left (north) which is R3-1	Install drop structure (rock or log with filter fabric and rock dissipation structure)	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
81	MC-EF-KT-R3-5	Moore Creek	Kresge Tributary		Sinkhole unable to accept storm water runoff.	Bore sinkhole to improve capacity. Assume 5 ft. deep, 30 ft. diameter	2
83	MC-EF-R1-3	Moore Creek	East Fork		Channel unable to handle storm water flow resulting in a series of knickpoints	Upstream of R1-3, demonstration for step -pool formation through material introduction to the channel along 25'- 30' length. 1 day of labor, 2 person crew.	2
84	MC-EF-R1-6 to R1-7	Moore Creek	East Fork		Channel bed downstream of bedrock control point MC-EF-R1-6 is incising into weathered schist	Construct ½ of 36" CMP flume to capture upstream flow down 25' plunge into large pool (20'x 40'), 4.5' wide channel at this location	2
85	MC-EF-R1-11 to 13	Moore Creek	East Fork		Two active knickpoints have migrated 7 feet since 1999	Install a series of concrete drop structures.	2
86	MC-EF-R1-14 to 16	Moore Creek	East Fork		Three active knickpoints totaling about 6 feet of elevation loss.	Install a series of wood or concrete drop structures.	2
87	MC-EF-R1-18 to 19	Moore Creek	East Fork		Two very important grade control points cumulative height of ~ 12 feet. Upper supported by roots lower by bedrock	Flume (supported on right bank) or rock check dams and armoring for upper knickpoint. Check with biologist for allowable modification of pool at base of upper knickpoint.	2
88	MC-EF-R2-1	Moore Creek	East Fork		Left bank below and adjacent to concrete dam actively eroding	Armor left bank with rip-rap or build up the height of the left dam wall to divert flow towards the center of the channel - armor outfall	2
89	MC-EF-R2-7 to 8	Moore Creek	East Fork		Active channel incision occurring below concrete sill, roughly 18 inches of bed scour below sill has occurred since 1999	6 - 7 checkdams about 4 - 11 ft. wide and 1.25 ft. high, excluding buried key dimensions.	2
90	MC-EF-R3	Moore Creek	East Fork		Two check dams in succession, the downstream check dam is failing and the bed below the failing dam has scoured ~ 3.5 feet.	Rebuild 2 existing check dams and add 2 - 3 more - 10 ft wide by 1.5 ft high - armor outfalls	2
94	MC-EF-D	Moore Creek	East Fork	North of Arboretum	Provide controlled overflow from East Dam	Controlled Overflow per 12/4/92 Rutherford and Chekene report (Ref 2-1), See also Johnson (ref 1-6) Red-legged frog habitat	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
95	MC-HV-R1-I	Moore Creek	Highview Drive Tributary		High flow directed at bank causing soil slump at Empire grade culvert	Fit end of existing Empire Grade culvert with angle to redirect flow, extend culvert to channel and construct dissipation basin, stabilize toe of bank failure if merited, advise homeowners (with County) that Highview Drive Culvert should be upsized.	2
97	MC-MF-B	Moore Creek	Middle Fork	Oakes College	Downstream erosion	Construct 10-ft. high by 70 ft. long earthen dam with riser manifold. Construct second riser manifold and excavate new detention basin. Redirect flow with 150 LF 12-inch culvert.	2
98	MC-WEF-R2-1 to 2	Moore Creek	West Entrance Fork Tributary		High flow directed at bank causing incising and widening channel at junction of WEF and 36" culvert draining Empire Grade and land below existing ball diamond	Install 50 LF of Rock on both sides of bank; 130 yards of site regrading and reconfiguration; 2000 ft2 of hydroseeding revegetation.	2
99	MC-WEF-R2-4	Moore Creek	West Entrance Fork Tributary	Large bank failure on west bank	Downstream erosion	100 LF of planting of willow cuttings on both sides of the bank and hydroseed 2000 ft2; 200 LF of coir logs.	2
99.5	MC-WEF-R2-7	Moore Creek	West Entrance Fork Tributary		Channel unable to handle storm water flow resulting in knickpoint advancing headward in channel.	Install concrete or rock chute drop structure and dissipation apron.	2
100	MC-WEF-R2-8	Moore Creek	West Entrance Fork Tributary		Center of ca. 200' segment of deeply incised channel with near-vertical banks	Install 400 LF of coir logs at toe of both sides of channel.	2
110	MC-WEF-H	Moore Creek	West Entrance Fork	West of Arboretum	Provide controlled overflow from West Dam	Armor pass-through pipe and other improvements per 12/4/92 Rutherford and Chekene report (Ref 2-1), see also Johnson (Ref 1-6)	2
114	GG-A	San Lorenzo-Pogonip Drainage	Gully G	Gully G Detention Basin Improvements	High flow and unprotected channel (Hydromodification)	Gully G- Detention basin improvements, install rip rap energy dissipation at end of pipe. See Bowman and Williams 1995 Ref 1-27.	2

Table 2-2a
Storm Water Drainage Improvements
(Phase 1 and 2)

Item	Project ID	Main	Tributary	Site Description	Problem	Project Description	Phase
116	GH-R1-1 (Gully H)	San Lorenzo-Pogonip Drainage	Gully H: Draining the Crown / Merrill Apartments		Runoff from Crown/Merrill apartments and associated parking causing erosion and affecting water quality.	Install detention vault in lower parking lot. Assume 50'x50' vault, 10 ft. deep. H20 Traffic-rated access hatch.	2
117	GH-R1-2 (Gully H)	San Lorenzo-Pogonip Drainage	Gully H: Draining the Merrill Apartments		Runoff from Merrill Doms and associated parking causing erosion and affecting water quality.	Extend 12 in dia culvert 200 ft down hill/slope and add energy dissipation apron at end	2

Drainageway Abbreviations: **BT** = Baskin Tributary, **CG** = Cave Gulch, **EF** = East Fork, **GMT** = Great Meadow Tributary, **JG** = Jordan Gulch, **KT** = Kresge Tributary, **MC** = Moore Creek, **MF** = Middle Fork, **MS** = Mainstem, **PG** = Porter Gulch Tributary, **SHT** = Science Hill Tributary, **WEF** = West Entrance Fork, **WF** = West Fork, **HV** = Highview

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
74	MC-EF-KT-R1-1 - 3	Rock lining of channel - for 100 LF. For treatment of two parallel gullies under bridge, a large rill under west side, and a 2.5'-high nickpoint.	Low: Visible only from sidewalks on bridge and west side of the adjacent portion of Heller Drive.	2500 (100 x 25 ft.)	AR-1	ST-1	Access is along channel which is in old road subject to much disturbance from mountain bikes. Equipment turnaround can occur under the Heller Drive bridge, and the same area may also serve as a secondary staging area.
75	MC-EF-KT-R1-4	Rock check dam. Effective height = 3 ft. To be keyed into bottom and sides. Estimate 8 CY of rock.	Low: Visible only from sidewalk on west side of the adjacent portion of Heller Drive.	400 (20 x 20 ft.)	AR-1	ST-1	Access is along channel for some distance, but channel is in heavily disturbed old roadbed.
76 and 77	MC-EF-KT-R1-5, 6	Two rock check dams to be located within a 150' segment of channel, from R1-5 site to 10' downstream of the R1-6 site. Effective height = 3 ft. To be keyed into bottom and sides. Estimate 8 CY of rock.	Low: Visible only from sidewalk on west side of the adjacent portion of Heller Drive.	400 ea. (20 x 20 ft.)	AR-1	ST-1	Access is along channel for some distance, but channel is in heavily disturbed old roadbed. Envelope of potential disturbance is 20' x 150', for a total of 3000 sq. ft.
78	MC-EF-KT-R1-7	Rock check dam within 50' long segment downstream of R1-7 point. Effective height = 3 ft. To be keyed into bottom and sides. Estimate 8 CY of rock.	Low: Visible only from sidewalk on west side of the adjacent portion of Heller Drive.	400 (20 x 20 ft.)	AR-1	ST-1	Access is along channel for some distance, but channel is in heavily disturbed old roadbed. Disturbance envelope is 20' x 50', for a total of 1000 sq. ft.
79	MC-EF-KT-R2-3	Wood check dam with rock dissipation apron. Effective height = 3 ft. To be keyed into bottom and sides.	Low: Visible from east edge of lot #147 and from pedestrian bridge.	300 (15 x 20 ft.)	AR-4	ST-4	Access route drops down the west side of canyon paralleling the pedestrian bridge, and then goes upstream along the disturbed channel.
80	MC-EF-KT-R3-1	Rock drop structure. Assume no more than 12 CY of rock. Special design needed as drop is too steep for a rock chute drop structure.	Low: Visible from east end of lot #147 and from pedestrian bridge, also possibly from one Porter College dorm.	625 (25 x 25 ft.)	AR-4 or AR-5	ST-4 or ST-5	Delivery of large rock to site will probably require use of dump truck which will require use of AR-5 and then traveling in the upstream direction on the existing trail in the canyon bottom.
81	MC-EF-KT-R3-5	Excavation of sediment from Kresge Tributary Sinkhole. Remove and haul off 131 CY of sediment from 30' diameter by 5' deep pit in sinkhole.	None: No permanent alteration other than deepening of sinkhole. Access road will be removed after work is done.	2400 (includes sinkhole and perimeter on 2 sides)	AR-5	ST-5	A hard-packed and graveled temporary road will be required for dump trucks to use. An excavator will be needed to dig out the sediment and load the trucks. Fill will be dumped at.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
66	MC-EF-BT-R1-2 to 4	Rock cascade. Customized "design and build" channel using boulders individually set into predetermined positions. Assume 100 CY of rock.	Moderate: Visible from pedestrian walkway and entrance road to Core West Parking Structure. A very small segment may be visible from Heller Drive.	4320 (250' L x 18' W)	AR-6 and AR-7	ST-6	Both access routes initially drop down 45% slope from Heller Drive, than continue along west edge of channel. Construction equipment will be positioned along west side of channel.
67	MC-EF-BT-R1-7	5 wooden check dams spaced along a 105-foot segment of channel running downstream from confluence with SHT tributary. Each dam to be 8' wide with a height of 2' and to have a rock dissipation apron of about 0.7 CY. Note: need for checkdams could be eliminated by extending pipe from R1-8 upstream.	None: Not clearly visible from any road, designated walkway, or building.	1250 (each 18' W x 14' L)	AR-7	ST-6	The area of possible disturbance is 2000 sq. ft. (19' W x 105' L). Actual area disturbed will be less, as it will extend only around each checkdam.
68	MC-EF-BT-R1-8	Pipe drop. Assume 36-inch RCP or CMP pipe with riser inlet, compacted earth inlet berm, and rock dissipation apron at outlet. Assume 30 LF of pipe and 5.5 CY of rock for apron. Trench will angle from surface down to floor of sinkhole, which is 12 ft. deep. Note: A longer pipe could also replace need for checkdams at R1-7.	None: Not clearly visible from any road, designated walkway, or building.	1000 (50' L x 20' W)	AR-7	ST-6	May need to import suitable fill material for inlet berm and pipe trench if excavated material from trench or sinkhole is unsuitable. Total needed = 32 CY. Note: If trench spoils are suitable, may also use to build berm in R1-10.
65	MC-EF-BT-R1-10	Woody debris removal from sinkhole and construction of 3-foot high earthen berm. Work to be done by excavator set up on the south side of the sinkhole.	None: Not clearly visible from any road, designated walkway, or building.	400 (20' x 20')	AR-9	ST-7	Woody debris to be cut and spread widely onto surrounding slopes. If sediment from pipe trench excavation at R1-8 or from sinkhole is unsuitable, may need to import 5 CY of suitable fill for construction of earth berm.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
70	MC-EF-BT-SHT-R1-1	3 small wood or log checkdams spaced within a 30-foot long section of channel.	Low: Check dams will be visible from the unofficial dirt path that crosses drainage and from Steinhart Way service road. Also likely visible from paved walkway that runs from parking structure to the east. Check dams will only extend slightly above the bank.	300 (15' L x 20' W)	AR-8	ST-8	Use of a backhoe or excavator is not necessary. Work may be done by manual laborers only.
71	MC-EF-BT-SHT-R1-3	10 small wooden check dams spaced along a 180-foot long segment of channel. Check dams to be 4' wide by 1.5' high and constructed by manual labor. Each to have a rock riprap apron (0.5 CY ea.)	Low: Slightly visible from designated walkway along south side of parking structure.	100 each (10' x 10')	None - AR-8 and AR-7 end nearby.	ST-8 or ST-6	No access for backhoe or excavator so work will need to be done by manual labor.
91	MC-EF-A	Detention basin construction at confluence of Kresge and Baskin Tributaries of the East Fork of Moore Creek. Improvements will likely include a riser pipe inlet and riprap armoring of McEnery Road fill on upstream side.	High visibility: Visible from Meyer and Heller Roads and associated sidewalks. However basin will be covered with grass so visual impact will be minimized.	500?	None (on road edge)	ST-9	If rock riprap needed, could be placed directly from Meyer Drive. Volume needed will depend on height of maximum design high-water elevation.
60	JG-WF-CO-R1-2	Detention basin construction southeast of Kerr Hall. Excavate to 4 - 6 feet deep and build compacted earth embankment 4 foot high by 150 feet long by 20 feet wide.	High visibility: Visible from Kerr Hall, east perimeter walkways, walkways to north and south, and Kerr Hall Circle. Assumed that basin will be kept in grass cover to minimize visual impact.	up to 30,625 (175' x 175')	AR-17B	ST-10	Assume basin excavation up to 120 CY. If excavated material is unsuited for fill it will need to be hauled away and up to 250 CY of material for embankment hauled in. Assume haul road will be removed after construction.
63	JG-WF-R2-1	1.5'-high concrete drop structure.	No or little visibility: May be slightly visible through trees from a portion of the Academic Resources Center parking lot.	300 (15' L x 20' W)	AR-18	ST-12	Assume concrete can be pumped down to site from cement truck positioned in ARC parking lot.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
43	JG-MF-R1-7	Middle Fork Sinkhole. Build an earthen berm 2' high x 50' long to capture more channel flow in sinkhole. Also stabilize about 60 feet of entrance channel with rock lining.	Low: Pedestrians on north side of bridge looking straight down will see site.	Berm: 1000 (50'L x 20'W) Channel work: 1500 (60'L x 25'W)	AR-16A and AR-16B (chute)	ST-13	Need to import up to 27 CY of soil for berm construction. Need up to 50 CY of rock for channel lining. It may be possible to slide materials to or very near to the site by constructing a temporary chute in the AR-16B access corridor.
44	JG-MF-R1-7A	New on-the-ground storm drainpipe. Install 18" pipe to collect runoff from intersection of McLaughlin and Science Library Roads and convey it 240 feet to the channel below. At the outlet have a loose rock velocity dissipater.	Moderate: Site is visible for a relatively short interval from McLaughlin Drive - Science Library Road intersection, both roads, and walkways along each road.	Pipe: 3750 (250' L x 15' W) Dissipater: 400 (20' x 20')	AR-16A	ST-13A	Pipe to parallel upper part of AR-16A.
45	JG-MF-R1-9	Increase height of existing asphalt/concrete berm to 12 inches high for a length of 15 feet.	None	225 (15' x 15')	AR-16A	ST-13A	
46	JG-MF-R2-2	Culvert extension. Extend the existing 48"-dia. culvert under Steinhart Drive an additional 75 feet to a point below the footbridge. Construct a rock-lined stilling basin at the outlet to slow water.	High visibility: Site may be within the viewshed of a portion of the Hahn Student Services building and definitely will be visible from the walkway between that building and McHenry Library. It will also be visible from the pedestrian bridge connecting the same two buildings.	Pipe: 1125 (75'L x 15'W) Basin: ca. 1825	AR-17A	ST-14	Assume 500 - 800 sq. ft. stilling basin up to 4 - 5 feet deep. Will need to excavate and haul up to 50 - 100 CY of soil and truck in up to 40 - 70 CY of rock. A truck road will need to be created for dump truck access.
47	JG-MF-R2-3	Install rock chute drop structure to treat a sloping nickpoint that has a 2.5-foot drop over a 20-foot length of channel.	Moderate: Site visible from pedestrian bridge connecting Hahn Student Services to McHenry Library.	600 (20'L x 30'W)	AR-17A	ST-14	Up to 16 CY of rock needed. Assume access route improved to allow dump truck use, then restored to natural conditions afterwards.
49	JG-MF-R3-1	Construct 2 concrete drop structures within a 60'-long channel segment	None	900 (60' L x 10-20' W)	AR-19	ST-13A	Assume cement pumped to site from a truck parked at the south end of the Hahn Student Services parking lot. Assume minimal or no impact from running hose down the slope.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
3 and 4	JG-EF-R2-1 and JG-EF-R2-3	Three wooden checkdams spaced within a 30' - long channel segment to treat two sloping nickpoints that are 4 ft. and 2 ft. high. Project also includes planting of redwood seedlings in the riparian zone.	None: Site is not visible from walkways or roads, and is unlikely to be visible from College 10 because of intervening trees.	300 (15' x 20') each	AR-20A	ST-15	Equipment should be set up on the west side of the channel.
5	JG-EF-R2-4	One 4-ft high rock chute drop structure and 5 wood checkdams. Two checkdams to be 11'w x 1.5' h and three to be 8'w x 1.5' high. All practices to be installed over a 165-foot length of channel.	None: Site is not visible from walkways or roads, and is unlikely to be visible from College 10 because of intervening trees.	Rock chute: 625 (25' x 25') Each ckdam 300 (15'L x 20'W)	AR-20A	ST-15	Equipment to be set up on west side of channel for excavation and rock placement.
6	JG-EF-R2-6	One wood checkdam in each of 2 channels surrounding redwood tree. Each to be about 6' wide x 1.5' high, and to function as a drop structure.	None or Low: Might be visible through trees from a back window of the fire station.	300 (15'L x 20'W) each	AR-20A	ST-15	Excavation needs to be carefully done to avoid damage to tree roots.
7	JG-EF-R2-7	Planting of native sedges (local ecotype) on sediment deposit.	None	3000 (100' L x 30'W)	AR-20A	ST-15	Need to find a seed source of local ecotype seed or else transplant propagules from a sedge population elsewhere on campus.
8	JG-EF-R2-8	Chinquapin Sinkhole. Excavate and haul away sediment from a 50' diameter area to a depth of 6 feet. Line sinkhole perimeter with 1000 sq. ft. of rock lining.	Moderate to high: Site is visible from McLaughlin Drive bridge and the lower end of Chinquapin Road.	4600 (includes sinkhole and 12' wide area on 3 sides)	AR-20A or AR-20B	ST-15	Need to haul away 140 - 240 CY of sediment. Need to haul in up to 560 CY of rock for lining sinkhole (18" thick). Haul out sediment by either improving AR-20A for truck use, or track walking up AR-20B, bucket by bucket.
26	JG-MS-R1-1	Construct rock stilling basin below end of riprap apron. Design to include protection of existing clump of redwoods now being undermined by stream flow.	Low: Site visible from pedestrian walkway above pipe outlet.	Max. 1825 feet for basin	AR-23	ST-14	Assume 500 - 800 sq. ft. basin up to 4 - 5 feet deep. Will need to haul away up to 50 - 100 CY of soil. Will need to import 40 - 70 CY of rock, via chute from pedestrian walkway, as there is no truck access.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
28 and 29	JG-MS-R1-3, 4, 5, and 6	Construct wood drop structure at R1-3, and checkdams or drop structures (up to 2 each) at each of 3 other nickpoints. Total to be 4 - 7 wood structures over a channel segment about 330 feet long.	Low: Site visible from pedestrian walkway above pipe outlet.	50 (each)	None	None	Each wood structure to include a small rock dissipation apron. Work to be done by labor crews only - no construction vehicle access to sites.
31	JG-MS-R1-7	Construct 2 wood checkdams (8'W x 1.5' deep) and one wood drop structure (4' high) to stabilize a sloping nickpoint and incising channel. Total to be 3 structures in a channel segment 160 feet long.	Low: Site visible from pedestrian walkway above pipe outlet.	70 (each)	None	None	Each wood structure to include a small rock dissipation apron. Work to be done by labor crews only - no construction vehicle access to sites.
30	JG-MS-R1-10	Construct a 12'-high concrete drop structure, perhaps with 2 - 3 steps. Also install rock-lined, compacted earth wingwalls at inlet.	None	3200 (80' long x 40' wide)	AR-24	ST-16	Use rock cobbles collected at or near site for rock lining of berm. Dump soil for berm from Hagar Drive via chute (22 CY). Pump cement via hose from truck parked on Hagar Drive.
31	JG-MS-R2-1	Concrete drop structure, 4.5 feet high. Construct in tandem with JG-MS-R1-10.	None	625	AR-24	ST-16	Pump cement from Hagar Drive via hose line.
33, 34, and 35	JG-MS-R2-2, 3, and 4	Three different and discrete projects. All involve repositioning boulders or logs in order to stabilize the bank.	None	300 (with excavator) 200 (by manual labor)	AR-24	ST-16	It is unlikely that construction equipment can reach R2-3 or R2-4 due to narrow passage, so manual labor is proposed for those sites.
36	JG-MS-R3-3	Clean out small sinkhole upstream of The Village. Excavate and haul away material from an area about 60' in diameter and to a depth of 5'.	None: except by hikers on sewer line access road, which is not an approved campus walkway.	4300	AR-25	ST-17	Haul away 150 - 300 CY of sediment. Truck access ends at the end of pavement in The Village.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
19	JG-MS-GMT-R1-3 to 4	Treat Music Center Sinkhole and eroding entrance channel with 120 LF of 18" dia. buried storm drainpipe with a compacted earth inlet berm. Also construct a rock stilling basin, 40 LF of rock-lined channel from the basin to the sinkhole, and rock lining of the sinkhole. Pipe and outlet basin will be located east of the channel. See Singer, Mills, and Nolan, 2004, Erosion Control Plan and Preliminary Design Report for the Great Meadow Tributary, job #02035-SC.	High: Visible from uphill lane of paved bicycle path.	5300 - assumes 17.5' wide strip along pipe and perimeter work space for all other components	AR-21	ST-18	Trench for pipe to be about 3' deep and 2.5' wide. Estimated volume of rock for all components = up to 112 CY. Access route follows bike path and is suitable for truck hauling. However a temporary covering will need to be replaced over bikepath to prevent damage to the asphalt.
20	JG-MS-GMT-R1-5	Install rock chute drop structure to treat a 3'-high nickpoint in channel.	High: Visible from uphill lane of paved bicycle path.	625	AR-21	ST-18	Up to 12 CY of rock needed.
21	JG-MS-GMT-R1-8	Construct 6'-high by 42'-long gabion retaining wall to protect bank supporting bike path.	High: Visible from uphill lane of paved bicycle path.	1150	AR-21	ST-18 and ST-19	35 CY of gabion rock will need to be hauled into the site. AR-21 provides suitable truck access.
22	JG-MS-GMT-R1- 9	Install two rock chute drop structures to treat 4.5' - high nickpoints on each of two parallel channels. Also construct compacted earth wingwall berms at head of rock chutes to direct flow into spillways.	High. Visible from uphill lane of paved bicycle path.	1800	AR-22B	ST-20 and ST-21	Up to 25 CY of rock needed which can be hauled by truck to ST-20 and transported from there by track loaders to the work site. By doing this no new truck roads will need to be constructed and no significant grading needed on the access route.
23	JG-MS-GMT-R1-12 to 13	Treat a steep eroding gully with installation of 150 LF of buried storm drain pipe, inlet berm and wingwalls of compacted earth, a concrete stilling box at the outlet, and a small grouted rock channel for box overflow.	High: Visible from uphill lane of paved bicycle path.	Inlet area: 50' x 35' = 1750 Pipe: 14' x 140' = 1960 Outlet area: 45' x 40' = 1800	AR-22A and/or AR-22B	ST-16 and/or ST-21	Only first 30 LF of pipe to be buried and that to a depth of 4.0' or less. Fill for construction of inlet berm can be hauled in by truck on AR-22B, without the need for any new grading or road construction.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
98	MC-WEF-R2-1 to 2	At location where 36" culvert empties into channel, reconfigure channel and install 50 LF of riprap bank protection on both banks. Hydroseed all disturbed soils	None: Project site is screened from Heller Drive by trees.	2500	AR-14B	ST-23	Up to 130 CY of material to be hauled away. Up to 90 CY of rock to be installed. Truck access is needed.
99	MC-WEF-R2-4	Install coir logs and willow live stakes on both sides of creek for 100 LF. Hydroseed all disturbed soils.	None: Site is hidden by dense riparian vegetation and oaks.	600	AR-15	ST-23	Work is to be done by manual labor, with workers in the channel and on the bank.
99.5	MC-WEF-R2-7	Install 5.5-foot high rock chute drop structure.	None: Site is recessed into landscape and screened from roads by vegetation.	625	AR-13	ST-24	Up to 15 CY of rock will need to be hauled into the site by truck on a temporary construction road.
100	MC-WEF-R2-8	Provide toe protection to both sides of 200 ft. length of channel by installing coir logs and willow stakes.	None: Channel is entrenched too deeply to be visible from roads or trails.	1200	AR-13	ST-24	Work is to be done by manual labor, with workers in the channel and on the bank.
106	MC-WEF-E	Construct new detention basin on northeast side of the Heller Drive/Empire Grade intersection. Improvements will likely include a riser pipe inlet and riprap armoring of Heller Drive on the uphill side.	High: Readily visible from both Empire Grade Road and Heller Drive.	700	None (on road edge)	ST-23	If rock needed, could be dropped into place from Heller Drive. Volume needed will depend on height of maximum design high-water elevation.
110	MC-WEF-H	Install 175 LF pipe spillway in West Dam with riser inlet and energy dissipater at outlet. Remove existing culvert.	High: Site is visible from Empire Grade.	Up to 3500	AR-13	ST-24	Good access off Empire Grade Road.
83	MC-EF-R1-3	Treat a 2.5'-high nickpoint by creating a step-pool formation out of loose rock.	High: Site borders a paved walkway from Oakes College.	450	AR-10D	ST-9	Assume up to 7.5 CY of rock needed. No road access to site, and access route ends just before reaching the site.
84 and 85	MC-EF-R1-6, 7, 11, 12, and 13	About 4 structures to be installed in a 400-foot long segment. Also one metal half-pipe flume and 3 concrete drop structures. Exact locations still to be determined.	High: Site borders a paved walkway from Oakes College.	550 sq. ft. for flume and 300 sq. ft. for each drop structure	AR-10C	ST-25	Assume construction equipment will be positioned on the west side of the channel.

Table 2-2b
In-Channel Storm Water Drainage Improvements
(Both Phases; Organized by Channel)

Item	Project ID	Project Type and Description	Visibility	Disturbed Area (sf)	Access Route ID	Staging Area ID	Other Issues - (export/import of soil, special equipment needs, trench dimensions, etc.)
86	MC-EF-R1-14, 15, and 16	Install about 3 - 4 concrete drop structures within 135-foot stretch of channel. Exact locations still to be determined.	Moderate to high: Site is visible from foot trail, but some intervening trees.	Up to 1200	AR-10A or AR-10C	ST-25 or ST-26	Assume construction equipment will set up on west bank and work from that side. One simple channel crossing is associated with AR-10A.
87	MC-EF-R1-18, 19	Install wood flume on west bank and accessory structures in channel.	None.	Up to 500	AR-10B	ST-25	Keep construction equipment on west bank.
88	MC-EF-R2-1	Build up east side of existing concrete dam and provide some rock armoring on bank.	None.	200	AR-11	ST-25	No construction vehicle access to this site. Assume manual labor crew will set up on west bank and work from that side.
89	MC-EF-R2-7 and 8	Needs 6 - 7 wood checkdams in a 50-foot long channel segment.	None.	Up to 1000 sq. ft.	AR-11	ST-27	No access by construction vehicles to this site. Assume construction crew will set up on west bank and work from that side.
90	MC-EF-R3-1b, 2	In a 225'-long channel segment, rebuild 2 existing wood checkdams and add 3 new ones.	None.	Up to 1500	AR-12	ST-28	Last portion of access route is pedestrian access only.
94	MC-EF-D	East Dam. Install 175 LF pipe spillway with riser inlet and energy dissipater.	Low to Moderate: Visible from dirt path that runs along north boundary of Arboretum.	Up to 3500	AR-12	ST-24	Good access off Empire Grade Road.
95	MC-HV-R1-1	Empire Grade road culvert and problem upstream of Highview Drive. Modify existing road culvert outlet and construct a rock-lined dissipation basin.	None, but low visibility if screening vegetation is removed.	TBD	TBD	TBD	

Drainage way Abbreviations: **BT** = Baskin Tributary, CG = Cave Gulch, **EF** = East Fork, **GMT** = Great Meadow Tributary, **JG** = Jordan Gulch, **KT** = Kresge Tributary, **MC** = Moore Creek, **MF** = Middle Fork, **MS** = Mainstem, **PG** = Porter Gulch Tributary, **SHT** = Science Hill Tributary, **WEF** = West Entrance Fork, **WF** = West Fork, **HV** = Highview

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-1	Kresge Tributary Sectors 58 and 50	MC-EF-KT-R1 -1, 2, 3, 4, 5, 6, and 7	255' to channel, addtl. 270' to R1-1 and 570' to R1-7	An abandoned, but passable dirt road. Starts at northeast corner of Lot #157 (Graduate Housing) and goes north and downhill to Kresge Tributary. It then follows the tributary to work sites both upstream and downstream. Max. slope = 20 - 25%.	Channel is old roadbed highly disturbed by mountain bike use. Only alternative route leaves Heller Dr. NE of the Porter College Dr. intersection and goes through woods to channel upstream of bridge. It would require cutting of many trees.
AR-2	Kresge Tributary Sector 58	Currently none. Possible replacement for AR-3 or AR-4 if needed	135' to channel, addtl. 420' to R2-3 and 525' to R1-7	Cross-country. Starts at southeast corner of lot #158 (Kresge East Housing) at handicapped parking space and goes straight down a 35 - 40 % slope to channel.	Route not preferred because it would damage native understory flora and be on a fairly steep slope.
AR-3	Kresge Tributary Sector 66	Currently none. Possible replacement for AR-4 to sites R2-3 and R3-1.	210' to channel, addtl. 135' to R2-3	Cross-country. Starts at truck turnaround area of lot #159 (Kresge East Housing) and angles southwest down the slope to the channel. May require cutting of one 4" dbh Douglas fir near top of slope. Max. slope = 40 - 45%.	Route not preferred because it would damage native understory flora and be on a fairly steep slope.
AR-4	Kresge Tributary Sector 66	MC-EF-KT-R2 - 3, and possibly to R3 - 1	150' to channel, addtl. 150' to R2-3 and 140' to R3-1	Cross-country. Starts at southeast end of lot #147 (Porter College) and angles down toward suspension bridge. Just before reaching the bridge, it turns east and parallels the bridge while going straight down slope to the channel. Then moves up or down canyon bottom to sites. Max. slope = 40%.	This route will destroy some native shrubs and herbs, but is shorter than AR-3 and probably less damaging.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-5	Kresge Tributary Sector 66	MC-EF-KT-R3 - 5 and perhaps R3-1	360' to R3-5, addtl. 270' to R3-1.	A previously used, still bare old vehicle path that angles around groups of trees to end at the north end of the Kresge Sinkhole. Starts on Porter College Road near the north-most satellite lot of parking lot #124 at Porter College. Route leaves road near the 15 MPH sign and proceeds downslope through small pile of down logs until reaching a sapling laurel tree. Here it angles about 45 degrees to the left for 105 feet. Then bear about 45 degrees to the right, passing to the right of 2 mature redwoods (1= live, 1= snag) and to left of large old stump. This is a narrow passage. Then head down slope toward the north end of the sinkhole. A wide unofficial mountain bike trail borders the sinkhole and allows movement upstream if desired.	This is the only route with a gentle enough slope to allow dump trucks to reach the sinkhole. Only minor grading, such as scraping off the duff layer and stockpiling it, will be necessary. A gravel course and some compaction may also be required, but nothing that would prevent removal of the road and restoration of the site later.
AR-6	Baskin Tributary Sector 58	MC-EF-BT-R1- 2 to 4	75	Cross-country. Starts on Heller Drive at a point 100 feet south of parking structure driveway and runs downhill at an angle to channel. Max. slope = 45%.	Route chosen because it doesn't require any tree cutting and seems to follow a previously used access route.
AR-7	Baskin Tributary Sector 58	MC-EF-BT-R1- 4, 7, 8, and MC-EF-BT-SHT-R1- 3	About 135 feet to channel and 330 ft. to north end of Baskin Sinkhole (BT-R1-8)	Cross-country. Starts on Heller Drive 50 feet south of the driveway to lot #158 (Kresge East Housing) on the opposite side of the road. Initially follows a narrow dirt foot trail at a 45% slope straight downhill. Halfway down the slope, the route veers to the southeast and the grade lessens. Then meets the channel and follows it downstream to the confluence with the Science Hill Tributary and beyond to sinkhole along east side of channel.	Some redwood saplings near the edge of Heller Drive will need to be removed to provide access. Overall, this route provides the path of least disturbance to the north side of the Baskin Sinkhole.
AR-8	Science Hill Tributary Sector 58	MC-EF-BT-SHT-R1- 1, also gets to within 100 feet of the upstream end of R1 -3.	150 feet to end	Cross-country. Starts off Steinhart Way at a point 60 feet west of, and across the road from the Thimann Lab building, at a small marble boulder near a lamp post. Follows an existing dirt footpath down to the channel, crosses the channel, and proceeds west on the north side of the channel until blocked by trees.	This route is preferred because it is the shortest route and crosses the channel at a point where it is already disturbed by the trail crossing.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-9	Baskin Tributary Sector 66	Baskin Sinkhole MC-EF-BT-R1-10	135 feet to channel and a total of 250 feet to north end of sinkhole	Cross-country. Starts on east side of Heller Drive at a point located 80 feet north of the lot #159 driveway and 62 feet south of a highway sign warning of a stop sign ahead. Proceeds directly down the slope to the channel, then follows the channel upstream to the sinkhole. This is the main access for any sinkhole work. Max. slope is 45 percent.	Route selected because no trees need to be cut except for one small laurel (< 10" dbh). The slope will be protected from vehicle damage in part by a pre-existing deep duff and litter layer under the redwood canopy. The "channel" is broad, poorly defined, and lacks riparian vegetation.
AR-10A	East Fork of Moore Creek Sectors 74 and 81	MC-EF-R1-14, 15, and 16.	About 1300' to R1-14	Alternate to AR-10C for access to R1-14, 15, and 16. Starts on bike path by Music Center and runs south on existing dirt road that runs along the west side of the Great Meadow. After traveling about 750 feet, it veers westerly toward a live oak tree with a broken-off top at the edge of the forest. It then enters the forest to the north of the tree, following a 25 - 30% unobstructed slope in a stand of Bay trees. Some prone Bays will need to be cut. The route enters a clearing near the creek just south of the fenced plant enclosure. Next it crosses the creek and goes upstream on a west-side terrace to R1-19.	This route avoids cutting of any mature upright trees. The first 750 feet is on an existing dirt road. It traverses gentler slopes than AR-10C does. It requires one channel crossing, but at a stable point with no or minimal vegetation disturbance.
AR-10B	East Fork of Moore Creek Sectors 80 and 81	MC-EF-R1-18 and 19	310' to R1-19	Cross-country route. Leaves Oakes Circle at north side of pipe outlet and runs parallel to the rock-lined channel. Continues downhill joining an existing large rill, reaching the channel after 200 feet. The route goes south on west side of channel, requiring the cutting of some horizontal live trees and 1 - 2 saplings.	This route avoids cutting of any mature, upright trees.
AR-10C	East Fork of Moore Creek Sector 80	MC-EF-R1-6, 7, 11, 12, 13, 14, 15, and 16	655' to R1-6	Access route follows pedestrian walkway, starting at north side of Oakes Circle. At about 225', first spur drops down a <50% slope for 135 feet to near site R1-3 (cross-country). At 585', a second spur goes cross-country down a 45% slope for 70 feet to the stream at the fence line near site R1-6.	This route was chosen because it does not require cutting of any trees.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-10D	East Fork of Moore Creek Sector 73	MC-EF-R1-3	525' to point where trees block further access	Route begins at intersection of Meyer Drive and road to Baskin Visual Arts. It continues cross county along pedestrian walkway across grassy area and continuing on west side of the channel.	This route allows the closest approach of equipment to the site.
AR-11	East Fork of Moore Creek Sectors 81, 87, and 88	MC-EF-R2-7 and 8, also MC-EF-R2-1	200' to stream and additional 200' to R2-8, or additional 210' to R2-1.	Pedestrian access only. Cross-country. Starts on service road between Oakes Provost House and Recycle Shed. Goes down a 40 - 45% slope for a distance of 200' to the channel. At the lower end is a steeper slope (55%) and a mudslide scar requiring extra care. At the westside terrace, a walk south for 200 feet will reach R2-8. To reach site R2-1, walk north after reaching the terrace.	This construction access route is potentially more damaging than most, due to the relatively steep, and relatively unstable slope, and the length of travel near the stream on an existing terrace. For these reasons, there will be foot access only to these sites and no entry by construction vehicles.
AR-12	East Fork of Moore Creek - Sectors 95, 96, & 88	MC-EF-R3 - 1b, 2	2460 feet, but all but last 560 feet on service roads	Service roads and cross-country. Starts on Empire Grade at West Dam Service Road Gate. Follows dirt road around north boundary of Arboretum for about 1425 feet. Then takes faint double track trail through grassland to north. After 300 feet leaves road to NW to descend gentle slope to channel. Runs upstream along east edge of channel for about 300 feet before ending at creek. Final 150' is by foot access only.	This is the preferred route because it maximizes the use of existing roads, minimizes damage to native vegetation, completely avoids any riparian vegetation, and avoids any steep slopes.
AR-13	West Entrance Fork of Moore Creek Sectors 94 and 95	MC-WEF-R2 - 7, 8, and R3 - 2	1150	Starts at West Dam service road on Empire Grade. Leaves service road after 360 feet, and heads west cross-country over broad grassy knoll towards the channel. Ends at WEF-R2 - 7.	This route preferred because it is the shortest, and does not disturb woody vegetation except for a few Coyote Brush shrubs.
AR-14A	West Entrance Fork of Moore Creek Sector 86	MC-WEF-R2 - 1, 2, 3	150 feet to R2 - 3.	Cross-country. Leaves Heller Drive, cutting through guard rail at a point 90 feet northeast of entrance kiosk and about 235 feet from the Empire Grade Road intersection. Goes downslope about 100 to channel and continues along west bank another 60 feet to R2 - 3.	This route is the preferred route because it is the shortest route to the site and will minimize collateral damage to trees.
AR-14B	West Entrance Fork of Moore Creek Sector 86	MC-WEF-R2-1 to 2	450	Leave AR-15 about 120 feet after gate by making a "u-turn" around a boulder field. Follow existing old vehicle tracks to the project site.	This route was chosen because it has gentle grades and will allow truck access.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-15	West Entrance Fork of Moore Creek Sector 86	MC-WEF-R2 -4, 5	370 feet to R2 - 5	Follows abandoned but passable dirt road through grassland. Road starts at gate on Heller Drive about 45 feet from the Empire Grade Road intersection. Each project site is reached by leaving the road and traveling cross-country downslope for a distance of about 80 feet.	This access way selected because it maximizes use of an old roadbed.
AR-16A	Middle Fork of Jordan Gulch Sectors 59 and 60	Middle Fork Sinkhole JG-MF-R1 - 7, 7a, and 9	525 feet to sinkhole, 870 feet to R1 - 9	Cross-country. Route leaves Science Library Road 75 feet from the McLaughlin Drive intersection. Go down the 30 % slope a distance of 270 feet to the channel, following the broad rill (R1 - 7a) for the lower half of the slope. Once in the channel travel upstream to the sinkhole or travel downstream to R1 - 9.	Route provides "least-steep" access to channel. 'Channel' has been previously disturbed by sewer line construction.
AR-16B	Middle Fork of Jordan Gulch Sector 59	Middle Fork Sinkhole JG-MF-R1 - 7, and R1-5	150 feet to sinkhole, additional 80 feet to R1-5	Alternate route to the Middle Fork Sinkhole. Cross-country. Begins at southwest corner of Lot #114, College 10. Proceeds west directly down a 50% slope to the channel.	This route is not the best route for vehicle access because it is the steepest. However, it is the shortest route for materials delivery.
AR-17A	Middle Fork of Jordan Gulch Sector 68	JG-MF-R2 - 2, 3, 4	800 feet to R2 - 5	Paved pedestrian trail and cross-country. Starts at east end of the pedestrian trail from Hahn Student Services Road to McHenry Library. Route follows the paved path for 300 feet, then drops into the channel and runs down the channel to R2 - 5.	This is the best access because slopes are gentle enough to allow truck access for transport of rock and soil. The 'channel' downstream has been used previously for sewer line construction.
AR-17B	West Fork of Jordan Gulch Sector 67	JG-WF-CO-R1-2 (new detention basin)	225 feet to center of proposed basin	Cross-country. Starts at Kerr Hall parking circle and goes east while paralleling an existing pedestrian walkway. A temporary truck road will need to be created to haul rock and/or soil.	This route is preferred because it is the shortest route and provides the most direct access from a paved road.
AR-17C	West Fork of Jordan Gulch Sector 67	JG-WF-R1-2 McHenry Library Sinkhole (south side)	about 60 feet	Route starts at Lot #120 (McHenry Lib. Parking) and follows sewer line west a short distance until a break in the trees allows it to drop cross-country to the north, to a position near the south side of the sinkhole.	This route was chosen because it is the most direct route that does not require tree removal. An excavator will use this route. Trucks hauling rock will not need any new access since they can use the existing paved road and parking lot.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-17D	West Fork of Jordan Gulch Sector 67	JG-WF-R1-1 and 2 McHenry Library Sinkhole (north side)	about 100 feet	Route starts on McHenry Library Road west of the library and goes cross-country directly down the slope toward the channel, then parallels the channel on the east side as it continues in the downstream direction.	This route is the one that minimizes slope steepness and does not require the removal of any trees > 10" dbh. This route will be for use by an excavator. Trucks hauling rock need not leave the library road, since it is close enough to the site.
AR-18	West Fork of Jordan Gulch Sector 75	JG-WF-R2 - 1	235	Cross-country, but follows previous construction access route over buried storm drainpipe for 115 feet to channel. Then follows channel downstream for 120 feet to project site. Access route begins in Academic Resources Center parking lot at the storm drain drop inlet.	This route selected because it traverses an area (old access route) that has already been disturbed.
AR-19	Middle Fork of Jordan Gulch Sectors 74 and 75	JG-MF-R3 - 1	1050	Service road, old road, and cross-country. Route starts at junction of Music Center graveled service road and McHenry Road. After 190 feet, the route bears to the northeast on a dirt road. At a wooden stairway over the fence, the route bears to the southeast for about 285 feet. Continue on old road until you see an oak sapling in a chicken wire enclosure to the left. Leave the road at this point, passing to the west of the oak and cutting through the fence line. Go straight down a 45 - 55 percent slope under a redwood forest canopy until arriving at the channel below. Travel upstream in the channel about 100 feet to the project site. Several down logs suspended in air over the channel will need to be moved, and 4 small laurels (< 5" dbh) near the fence line will need to be cut.	This route preferred because it is the only access over stable slopes less than 50% steepness and it does not require the removal of any trees > 8" dbh. Only 4 Laurel saplings will need to be cut. Cement can be pumped to the site via hose line from the south end of the Hahn Student Services Parking Lot (Lot # 101).

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-20A	East Fork of Jordan Gulch Sector 52	Chinquapin Sinkhole on East Fork of Jordan Gulch JG-EF-R2 - 8, also JG-EF-R2 - 1, 3, 4, 6, and 7. Note: This sinkhole sometimes referred to as McLaughlin Sinkhole or Jordan Gulch Sinkhole.	300 feet to channel. An additional 250' to sinkhole, and additional 450' to R2 - 1	This is the preferred route and is primarily an old dirt road. Enter old road at the west end of lot # 156 north of the Firehouse, cutting many small redwood saplings that have grown up on the old roadbed. After 300 feet the channel will be reached. Go upstream in and out of the channel, around a group of redwoods, cutting 2 < 8" diameter trees, then cross the creek and join an old road running along the west side to R2 - 1. To reach the sinkhole, proceed downstream from the point where the road first meets the channel.	Route possibly suitable for dump trucks if widened, compacted, and graveled. If loaded dump trucks can't make the grade, use AR-20B instead and carry soil to trucks parked on Chinquapin Road in bucket of a tracked loader.
AR-20B	East Fork of Jordan Gulch Sector 52	Chinquapin Sinkhole on East Fork of Jordan Gulch JG-EF-R2 - 8, also JG-EF-R2 - 1, 3, 4, 6, and 7	75 feet to channel and an additional 150 feet upstream to sinkhole	Alternate route (cross-country) to sinkhole. Starts about 75 feet north of the McLaughlin Drive and Chinquapin Road intersection and drops straight down the grassy hillside to the channel. Maximum slope steepness = 45%.	
AR-21	Great Meadow Tributary of Jordan Gulch - Sectors 74, 81, 82, and 89	JG-MS-GMT- R1 - 3, 5, and 8	About 1125' to site R1-8	Route follows uphill bike path lane, starting at Music Center. Slopes are gentle.	Existing terrain makes the bike path the only suitable access road for trucks that does not require grading.
AR-22A	Great Meadow Tributary of Jordan Gulch - Sector 89	JG-MS-GMT- R1 - 9, 12, and 13	165 feet to gully headcut	Route goes uphill on north side of gully, and in some cases requires movement over the gully site, after filling. Access route starts at the Village and goes uphill until it hits the old dirt road above the gully headcut. Max. slope = 18%.	Use of this route is necessary for trench digging and pipe installation.
AR-22B	Great Meadow Tributary of Jordan Gulch - Sectors 82, 89, and 97	JG-MS-GMT-R1-9, 12 and 13	About 2125 feet to R1-9. About 1840 feet to ST-20, all of which is on bike path or existing unpaved road.	Route starts at the southernmost parking lot in The Village (lot #168). It runs along the uphill land of the bike path initially, then veers off to the right on an existing dirt road. It follows the dirt road for about 950 feet, then veers off cross-country over the top of a grassy knoll and down the other side to the work site at R1-9. Max. slope = 18 - 20 percent.	This route is the only suitable route for truck hauling of rock into ST-20 for use at site R1-9. The only alternative route would require driving up the channel.

Table 2-3
Construction Access Routes to In-Channel Storm Water Drainage Improvements

ID	Location and Sector Number	Project Sites Served	Distance (ft.) to channel or site	Description of Route	Reason for Route Selection Alternative Routes - Other Access Issues or Concerns
AR-23	Main Stem of Jordan Gulch - Sector 68	JG-MS-R1-1, 2, & 3	130 feet to channel. An additional 35' upstream along west side of channel to R1-1. An additional 150' downstream in channel or on east side to R1-3.	Cross-country. This route begins at the junction of the pedestrian walkway with Hahn Road and to the north of a large Douglas fir. The route heads SE, passing to south of a pipe outlet. At a distance of 55' from the road, it veers 45 degrees to the left. The slope then steepens to 50% and the route continues for 75 feet to the channel.	The steepness of canyon side slopes makes this access route the only feasible approach without traveling down a drainage swale, which would be problematic.
AR-24	Main Stem of Jordan Gulch Sector 75	JG-MS-R1-10 and to JG-MS-R2-1. Also provides vehicle access part way to JG-MS-R2-3 & 4, also JG-MS-R1-7.	About 365' to channel. Site R1-10 is about 75' upstream over eroded historic railroad bed on west side. Site R2-1 is about 100' downstream via travel in the channel.	Cross-country. Start at SE portion of lot #101 (Hahn Student Services). Beginning point is north of lamp-post #75-25 and midway between it and a clump of redwoods further to the north. Proceed downhill (SE) for 60', passing to the left of a 3-trunked Laurel. Continue downhill and in another 45' pass to right of an 18"-diameter Douglas-fir. Continue downhill 68' to a large redwood clump and pass to the right of it. Go another 65' toward a 2-trunked Laurel and pass to the left of it. Go another 60' downhill to a strongly-bowed redwood tree (16" dbh) that extends to the right. Pass to the right and follow the finger of this ridge down to the confluence of the Main Stem with the Middle Fork, a distance of about 65'. Maximum slope = 45%.	Side slopes along the Main Stem of Jordan Gulch are generally unsuitable for construction vehicle access because of their steepness and the presence of unstable soil conditions. This was the only suitable access route that I could find. The strongly-bowed redwood tree cited in the description will need to be cut to allow vehicle access.
AR-25	Main Stem of Jordan Gulch Sector 90	JG-MS-R3-3	About 150 feet to site from the end of asphalt pavement.	Route follows the existing sewer line access road. First 100' of route is on top of gabion blankets, so a protective cover must be laid down before traversing. Also access is limited to vehicles with a width of no more than 8 feet.	This route was selected because it is the only feasible approach. The site cannot be approached by vehicles from the north because of numerous narrow "choke points" along the sewer line access road.
AR-26	Lower Moore Creek Sector 104	MC-HV-R1-1 (Highview Drive Tributary)	TBD	TBD	TBD (Note: TBD = to be determined)

Environmental Constraints Used During the Selection of Access Routes - With a few exceptions (noted in the table) selected construction access routes do not entail: (1) Cutting of trees of 10" dbh or larger, (2) traversing slopes greater than 50% (2h:1v), or (3) traversing unstable slopes (such as slopes with springs or seeps, slopes with swales or drainages, slopes with colluvial hollows, or slopes with old landslide scars). **Road Width:** Width of access routes and temporary roads will be 12 feet or less. **Final Condition:** It is assumed that any temporary access route surfacing materials will be removed and that all routes will be erosion-proofed, revegetated and/or mulched after construction is complete.

Table 2-4
Special-Status Plants Species with the Potential to Occur in Project Area

Species Common Name[a]	USFWS Listing[b]	State Status[c]	CNPS Status[d]	Habitat Type[e]	Flowering Period	Distribution by County[f]	Potential for Occurrence in Project Areas
Species with habitat in the project area							
Amsinckia lunaris bent-flowered fiddleneck	None	None	2-2-3 List 1B	Cismontane woodland, valley and foothill grassland, coastal bluff scrub	Mar–Jun	ALA, CCA, COL, LAK, MRN, NAP, SCR, SHA, SIS, SMT, SON	Grassland habitat present. Reported from campus in Buck (1986), but no specific location given and no occurrences currently known
Anomobryum filiforme moss without common name	None	None	3-2-1 List 2	Broadleaf upland forest, lower montane coniferous forest, North Coast coniferous forest, on damp rocks and soil on outcrops	N/A	HUM, MPA(?), SCR, Oregon	Potential habitat present in mixed evergreen forest. identified in 2002 surveys.
Campanula californica swamp harebell	None	None	2-2-3 List 1B	Moist places: bogs and fens, closed-cone coniferous forest, coastal prairie, meadows, freshwater marshes and swamps, North Coast coniferous forest	Jun–Oct	MEN, MRN, SCR*, SON	Potential habitat in redwood forest. Not identified in 2002 surveys.
Elymus californicus California bottlebrush grass	None	None	1-1-3 List 4	Cismontane woodland, North Coast coniferous forest, broadleafed upland forest, riparian woodland	May–(Nov)	MNT?, MRN, SCR, SMT, SON	Habitat present in project area. Reported from campus in Buck (1986), but no specific location given and no occurrences presently known
Fissidens pauperculus Moss without common name	None	None	2-2-3 List 1B	North Coast coniferous forest in damp soil	N/A	HUM, MNT, MRN, SCR	Potential habitat present in redwood forest
Hoita strobilina Loma Prieta hoita	None	None	2-3-3 List 1B	Moist sites in chaparral, cismontane woodland, riparian woodland , usually serpentinite soil	May–Oct	ALA*, CCA*, SCL, SCR	Riparian woodland present. Not observed in 2005 surveys of project area.
Pedicularis dudleyi Dudley's lousewort	None	R	3-2-3 List 1B	Maritime chaparral, North Coast coniferous forest, valley and foothill grassland	Apr–Jun	MNT, SCR*, SLO, SMT	Redwood forest present. Not observed in 2002 surveys.

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Species Common Name[a]	USFWS Listing[b]	State Status[c]	CNPS Status[d]	Habitat Type[e]	Flowering Period	Distribution by County[f]	Potential for Occurrence in Project Areas
Penstemon rattanii var. *kleei* Santa Cruz Mountains beardtongue	None	None	3-2-3 List 1B	Chaparral, lower montane coniferous forest, North Coast coniferous forest, often in sandy soil	May–Jun	SCL, SCR	Redwood forest and mixed evergreen forest present. Not observed in 2002 surveys.
Polygonum hickmanii Scotts Valley polygonum	PE	None	3-3-3 List 1B	Grassland in mudstone or sandstone	May–Aug	SCR	Grassland present. Not observed in 2002 surveys.
Sidalcea malachroides maple-leaved checkerbloom	None	None	2-2-2 List 1B	Broadleafed upland forest, coastal prairie, coastal scrub, North Coast coniferous forest, often in disturbed places	Apr–Aug	DNT, HUM, MEN, MNT, SCL, SCR, SON, Oregon	Redwood forest present. Not observed in 2002 surveys.
Species without habitat in the project area							
Arctostaphylos andersonii Santa Cruz manzanita	None	None	2-2-3 List 1B	Chaparral; openings in and edges of broadleafed upland forest and north coast coniferous forest	Nov–Apr	SCL, SCR, SMT	Not present.
Arctostaphylos pajaroensis Pajaro manzanita	None	None	2-3-3 List 1B	Chaparral in sandy soils	Dec–Mar	MNT, SCR*	Not present
Arctostaphylos silvicola Bonny Doon manzanita	None	None	2-2-3 List 1B	Inland marine sands in chaparral, closed-cone coniferous forest, sand parkland, sandhill ponderosa pine forest	Feb–Mar	SCR	Not present
Arenaria paludicola marsh sandwort	E	E	3-3-2 List 1B	Freshwater marshes, bogs, and fens	May–Aug	LAX*, MEN, SBD*, SCR*, SFO*, SLO, Washington*	Not present
Carex comosa bristly sedge	None	None	3-3-1 List 2	Marshes and swamps, lake margins, valley and foothill grasslands	May–Sep	CCA, LAK, MEN, SBD*, SCR*, SFO*, SHA, SJQ, SON, Idaho, Oregon*, Washington, other states	Not present
Carex saliniformis deceiving sedge	None	None	2-2-3 List 1B	Coastal prairie, coastal scrub, meadows, coastal salt marshes	June	HUM, MEN, SCR*, SON	Not present

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Special-Status Plants Species with the Potential to Occur in Project Area

Species Common Name[a]	USFWS Listing[b]	State Status[c]	CNPS Status[d]	Habitat Type[e]	Flowering Period	Distribution by County[f]	Potential for Occurrence in Project Areas
Chorizanthe pungens var. *hartwegiana* Ben Lomond spineflower	E	None	2-3-3 List 1B	Inland marine sands in chaparral, closed-cone coniferous forest, sand parkland, sandhill ponderosa pine forest	Apr–Jul	SCR	None, habitat not present.
Chorizanthe robusta var. *hartwegii* Scotts Valley spineflower	E	None	3-3-3 List 1B	Meadows, grasslands in sandy or mudstone soil (Purisima outcrops)	Apr–Jul	SCR	Not present
Chorizanthe robusta var. *robusta* robust spineflower	E	None	3-3-3 List 1B	Coastal dunes, coastal scrub, openings in cismontane woodland, in sandy or gravelly soil	Apr–Sep	ALA*, MNT, SCL*, SCR, SMT*	Not present
Collinsia multicolor San Francisco collinsia	None	None	2-2-3 List 1B	Closed-cone coniferous forest, coastal scrub sometimes in serpentinitic soil, broadleafed upland forest	Mar–May	MNT, SCR, SCL, SFO, SMT	Not present
Cupressus abramsiana Santa Cruz cypress	E	E	3-2-3 List 1B	Closed-cone coniferous forest, sandhill ponderosa pine forest on sandstone or granitic substrate	N/A	SCR, SMT	Not present
Eriogonum nudum var. *decurrens* Ben Lomond buckwheat	None	None	3-3-3 List 1B	Inland marine sands in chaparral, closed-cone coniferous forest, sand parkland, sandhill ponderosa pine forest	Jun–Oct	SCR, ALA	Not present
Erysimum teretifolium Santa Cruz wallflower	E	E	2-3-3 List 1B	Inland marine sands in chaparral, closed-cone coniferous forest, sand parkland, sandhill ponderosa pine forest	Mar–Jul	SCR	Not present
Grindelia hirsutula var. *maritima* San Francisco gumplant	None	None	2-2-3 List 1B	Coastal bluff scrub, coastal scrub, valley and foothill grassland, in sandy or serpentine soil	Aug–Sep	MNT, MRN, SCR, SFO, SLO, SMT	Not present
Holocarpha macradenia Santa Cruz tarplant	T	E	3-3-3 List 1B	Coastal prairie, valley and foothill grassland, often in clay soils	Jun–Oct	ALA*, CCA*, MNT, MRN*, SCR	Not present.
Horkelia cuneata ssp. *sericea* Kellogg's horkelia	None	None	3-3-3 List 1B	Openings in closed-cone coniferous forest, maritime chaparral, coastal scrub, coastal prairie, in sandy or gravelly soil	Apr–Sep	ALA*, MRN*, MNT, SBA, SCR, SFO*, SLO, SMT	Not present

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Special-Status Plants Species with the Potential to Occur in Project Area

Species Common Name[a]	USFWS Listing[b]	State Status[c]	CNPS Status[d]	Habitat Type[e]	Flowering Period	Distribution by County[f]	Potential for Occurrence in Project Areas
Horkelia marinensis Point Reyes horkelia	None	None	3-2-3 List 1B	Coastal dunes, coastal prairie, coastal scrub in sandy soil	May–Sep	MEN, MRN, SCR, SMT	Not present.
Linanthus grandiflorus large-flower linanthus	None	None	1-2-3 List 4	Coastal scrub, coastal bluff scrub, closed-cone coniferous forest, cismontane woodland, coastal dunes, coastal prairie, valley and foothill grassland, usually in sandy soil	Apr–Aug	ALA, KRN, MAD, MER, MNT, MRN, SBA*, SCL, SCR, SFO, SLO, SMT, SON	Not present
Malacothamnus arcuatus arcuate bush mallow	None	None	2-2-3 List 1B	Chaparral	Apr–Sep	SCL, SCR, SMT	Not present
Microseris paludosa marsh microseris	None	None	2-2-3 List 1B	Moist places in closed-cone coniferous forest, cismontane woodland, coastal scrub, valley and foothill grassland	Apr–Jun	MEN, MNT, MRN, SCR, SFO*, SLO, SMT*, SON	Not present. Reported from lower campus in mima mound/coastal prairie
Mielichhoferia elongata Moss without common name	None	None	2-2-1 List 2	Cismontane woodland on metamorphic rock, usually vernally wet	N/A	FRE, MPA, SCR, TRI, TUL, widespread outside California	Potential habitat not present
Mimulus rattanii ssp. decurtatus Santa Cruz monkeyflower	None	None	1-2-3 List 4	Gravelly places on the margins of chaparral and lower montane coniferous forest	May-Jul	MNT, SCR	None, habitat not present.
Pentachaeta bellidiflora white-rayed pentachaeta	E	E	3-3-3 List 1B	Valley and foothill grassland, coastal scrub, coastal prairie	Mar–May	MRN*, SCR*, SMT	Not present
Plagiobothrys chorisianus var. *chorisianus* Choris' popcornflower	None	None	2-2-3 List 1B	Mesic areas in chaparral, coastal scrub, and coastal prairie	Mar-Jun	SCR, SFO, SMT	No occurrences currently known on campus
Plagiobothrys diffusus San Francisco popcornflower	None	E	3-3-3 List 1B	Coastal prairie; valley and foothill grassland	Mar–Jun	ALA, SCR, SFO*	Not present in project areas. Known to occur in Marshall Field
Silene verecunda ssp. *verecunda* San Francisco campion	None	None	3-2-3 List 1B	Coastal bluff scrub, chaparral, coastal prairie, coastal scrub, valley and foothill grassland, generally in sandy or rocky soil	Mar–Aug	SCR, SFO, SMT	Not present

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Special-Status Plants Species with the Potential to Occur in Project Area

Species Common Name[a]	USFWS Listing[b]	State Status[c]	CNPS Status[d]	Habitat Type[e]	Flowering Period	Distribution by County[f]	Potential for Occurrence in Project Areas
Stebbinsoseris decipiens Santa Cruz microseris	None	None	2-2-3 List 1B	Open areas in broadleafed upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub	Apr–May	MNT, MRN, SCR	Not present
Trifolium buckwestiorum Santa Cruz clover	None	None	3-3-3 List 1B	Coastal prairie, broadleafed upland forest, cismontane woodland	Apr–Oct	MNT, SCR, SON	Not present

Notes:

[a]Nomenclature follows Hickman (1993) and CNPS (2001)

[b]U.S. Fish and Wildlife Service E = Endangered; PE = Proposed Endangered; T = Threatened

[c]Section 1904, California Fish and Game Code. California Department of Fish and Game. E = Endangered; R = Rare

[d] CNPS On-Line Inventory of Rare Plants, 6th Edition (Database as of September 28, 2001)

Top line: CNPS R-E-D (Rarity-Endangerment-Distribution) code. Rarity: 1 = Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time; 2 = Occurrence confined to several populations or to one extended population; 3 = Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported. Endangerment: 1 = Not endangered; 2 = Endangered in a portion of its range; 3 = Endangered throughout its range. Distribution: 1 = More or less widespread outside California; 2 = Rare outside California; 3 = Endemic to California.

Bottom Line: CNPS List. List 1B: Rare, Threatened, or Endangered in California and elsewhere. List 2: Rare, Threatened, or Endangered in California, more common elsewhere. List 3: Plants about which more information is needed. List 4: Plants of limited distribution: a watch list.

[e]Thomas (1961), Munz and Keck (1973), Hickman (1993), CNPS (2001b), and unpublished information.

[f]California Native Plant Society On-Line Inventory of Rare Plants, 6th Edition (Database as of September 28, 2001); counties abbreviated by a three-letter code (below); occurrence in other states as indicated.

ALA: Alameda
AMA: Amador
BUT: Butte
CCA: Contra Costa
COL: Colusa
DNT: Del Norte
FRE: Fresno
GLE: Glenn
HUM: Humboldt
KRN: Kern
LAK: Lake
LAX: Los Angeles
MAD: Madera
MEN: Mendocino
MER: Merced
MNT: Monterey
MOD: Modoc
MPA: Mariposa
MRN: Marin
NAP: Napa
NEV: Nevada
ORA: Orange
PLA: Placer
PLU: Plumas
SAC: Sacramento
SBA: Santa Barbara
SBD: San Bernardino
SBT: San Benito
SCL: Santa Clara
SCR: Santa Cruz
SCZ: Santa Cruz Island (SBA Co.)
SDG: San Diego
SFO: San Francisco
SHA: Shasta
SIE: Sierra
SIS: Siskiyou
SJQ: San Joaquin
SLO: San Luis Obispo
SMT: San Mateo
SOL: Solano
SON: Sonoma
SRO: Santa Rosa Island (SBA Co.)
STA: Stanislaus
TEH: Tehama
TRI: Trinity
TUL: Tulare
TUO: Tuolumne
VEN: Ventura
YUB: Yuba
* Presumed extinct in these counties or states.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
Ohlone tiger beetle *Cicindela ohlone*	FE	--	Coastal prairie and open grassland on Watsonville loam soils with barren areas for foraging and thermoregulation	*Low Potential*: Known to occur in grasslands in Marshall Field and the southwestern corner of the Campus not near Infrastructure Improvement projects, access routes.
Santa Cruz rain beetle *Pleocoma conjungens conjungens*	FSC	--	Associated with sandy soils, especially in sand parkland habitat. The Waddell Creek collection was in coastal sage scrub and redwood forest habitat	*Not expected*: Suitable habitat not present within footprint of Infrastructure Improvement projects, access routes.
Monarch butterfly *Danaus plexippus*	--	S3	Roosts located in wind-protected tree groves (eucalyptus, Monterey pine, and cypress) with nectar and water sources nearby.	*Not expected*: Suitable habitat not present within footprint of Infrastructure Improvement projects, access routes.
Stohbeen’s parnassian butterfly *Parnassius clodius strohbeeni*	Former Candidate	--	Associated with riparian forests, especially redwood riparian areas. Once found throughout the Santa Cruz Mountains.	*Not expected*: Believed to be extinct. Suitable habitat exists in Cave Gulch.
San Francisco lacewing *Nothochrysa californica*	FSC	--	Associated with riparian areas, oak woodlands, and coastal scrub habitats.	*Low potential*: not observed field surveys); last documented near USSC campus in 1965 (BUGGY Data Base 2003); unlikely to occur in project areas despite presence of suitable foraging and breeding habitat.
Unsilvered fritillary butterfly *Speyeria adiaste adiaste*	FSC	--	Grasslands in or near redwood forests or in oak woodlands. Larval food plant is yellow pansy (*Viola pedunculata*).	*Not expected*: Suitable habitat not present within footprint of Infrastructure Improvement projects, access routes. Not known to occur on or within 15 miles of the UC Santa Cruz campus (CNDDB 2005).
Santa Cruz telemid spider *Telemid* sp.	FSC	--	Known only from Empire Cave	*Low Potential*: suitable habitat potentially accessible via karst features in drainages throughout campus, but presence in such features unknown.
Dolloff Cave spider *Meta dolloff*	FSC	--	Known from Empire and Dolloff Caves	*Low Potential*: suitable habitat potentially accessible via karst features in drainages throughout campus, but presence in such features unknown.
Empire Cave pseudoscorpion *Microcraegris imperialis*	FSC	--	Known only from Empire Cave	*Low Potential*: suitable habitat potentially accessible via karst features in drainages throughout campus, but presence in such features unknown.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
MacKenzie's cave amphipod *Stygobromus mackenze*	FSC	--	Known only from Empire Cave	*Low Potential*: suitable habitat potentially accessible via karst features in drainages throughout campus, but presence in such features unknown.
California red-legged frog *Rana aurora draytonii*	FT	SSC, CP	Permanent water sources such as ponds, lakes, reservoirs, streams and adjacent riparian woodlands; may aestivate in rodent burrows or cracks during dry periods.	*High Potential*: High likelihood of species movement into the East Fork Moore Creek and West Fork Moore Creek drainages from known population at Arboretum Pond. Not expected outside of the Moore Creek Drainages.
California tiger salamander *Ambystoma californiencse*	--	SSC CP	Grasslands and lowest foothill regions and breeds in long-lasting rain pools. Dry, hardpan soils are necessary within one mile of breeding areas for refuge sites.	*Not expected*: Suitable habitat not present within footprint of Infrastructure Improvement projects, access routes.
Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum*	FE	CE, CFP	Moist burrows among riparian vegetation, willow thickets, coastal scrub, or coast live oak. Breeding is done at temporary pools or semi-permanent ponds.	*Not expected*: Suitable habitat not present within footprint of Infrastructure Improvement projects, access routes or FSH.
California horned lizard *Phrnosoma coronatum frontale*	FSC	SSC CP	Grasslands, brushlands, woodlands, and open coniferous forest with sandy or loose soil; requires abundant ant colonies for foraging.	*Low Potential*: suitable habitat present within grasslands in some access routes that are not too densely vegetated.
Southwestern pond turtle *Clemmys marmorata pallida*	FSC	SSC	Associated with Woodlands, grasslands, and open forests; aquatic habitats, such as ponds, marshes, or streams, with rocky or muddy bottoms and vegetation for cover and food	*High Potential*: Potential habitat in the East Fork of Moore Creek in and near Arboretum Pond; CNDDB lists an adult turtle in Moore Creek just south of the campus. No known population on Campus.
Cooper's hawk *Accipiter cooperii*	--	SSC	Forages and nests in dense woodlands, preferably near riparian areas.	*High Potential*: one CNDDB record of nesting near Henry Cowell Redwood State Park approximately 3 miles from the study area. Foraging habitat available in grasslands near the Great Meadow Tributary.
Sharp-shinned hawk *Accipiter striatus*	--	SSC	Forages over dense chaparral and scrublands. Breeds in dense coniferous or deciduous forests, usually within 90 meters of water.	*High Potential*: known to nest near the Applied Sciences building approximately 1.6 miles from the project site (Ecosystems West 2001). Foraging habitat available in grasslands near the Great Meadow Tributary.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
White-tailed kite *Elanus leucurus*	--	CFP	Open vegetation and uses dense woodlands for cover. Nests in riparian woodlands where it uses oak trees and sycamore trees for nest sites.	*High Potential*: one adult observed foraging north of the arboretum in the meadow (Jones & Stokes 2003); one recent breeding record for Santa Cruz County (Suddjian 2000). Foraging habitat available in grasslands near the Great Meadow Tributary.
American peregrine falcon *Falco peregrinus anatum*	--	CE, CFP	Nests in caves, potholes and ledges of high cliffs preferably overlooking a large body of water such as a lake, river, or the ocean.	*Not expected*: Suitable nesting and foraging habitat not present within footprint of Infrastructure Improvement projects, access routes.
Northern harrier *Circus cyaneus*	--	SSC	Open grasslands, meadows, and emergent wetlands, where it nests on the ground in shrubby vegetation.	*High Potential*: suitable nesting and foraging habitat available in grasslands near the Great Meadow Tributary.
Loggerhead shrike *Lanius ludovicianus*	FSC	SSC	Grasslands with scattered shrubs, trees, fences or other perches. Nesting habitat includes coastal scrub.	*High Potential*: Foraging habitat available in grasslands near the Great Meadow Tributary and FSH. nesting habitat available in riparian corridors.
Ferruginous hawk *Buteo regalis*	SC	SSC	Open terrain in plains and foothills where ground squirrels and other prey are available.	*Low Potential*: does not nest in California; is an uncommon winter visitor in Santa Cruz County (Suddjian 2000). May forage in grasslands near the Great Meadow Tributary and FSH.
Golden eagle *Aquila chrysaetos*	BGEPA	SSC CFP	Cliffs and escarpments or tall trees for nesting; annual grasslands, chaparral, and oak woodlands with plentiful medium and large-sized mammals for prey.	*High Potential*: no records of nesting in campus area; suitable foraging habitat present near the Great Meadow Tributary.
Bald eagle *Haliaeetus leucocephalus*	FT	CE	Nests in coniferous forests within one mile of a lake, reservoir, stream, or Ocean.	*Not Expected*: no known nests in project areas; no suitable foraging or nesting habitat within the project areas.
Vaux's swift *Chaetura vauxi*	--	SSC	Nests in hollow, burned out tree trunks in large conifers.	*Low Potential*: may forage over grasslands on campus; unlikely to nest there because of lack of suitable nesting habitat.
Western burrowing owl *Athene cunicularia hypugea*	FSC	SSC	Forages and nests in grasslands and open scrub with small mammal burrows.	*High Potential*: Previously documented in Great Meadow grasslands. Grassland habitat within the Great Meadow considered high quality because of the abundance of ground squirrel burrows and short vegetation.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
Yellow-breasted chat *Icteria virens*	--	SSC	Nests in dense riparian habitats dominated by willows, alders, Oregon ash, tall weeds, blackberry vines, and grapevines	*High Potential*: Birds have been observed in Lower Moore Creek (EcoSystems West 2002). Suitable habitat not present in other areas of campus
California yellow warbler *Dendroica petechia brewsteri*	--	SSC	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders or in mature chaparral; may also use oaks, conifers, and urban areas near streamcourses	*Low Potential*: Suitable nesting habitat along the east fork of Moore Creek; however, no records of birds nesting in that area or elsewhere at UC Santa Cruz.
Marbled murrelet *Brachyramphus marmoratus*	FT	CE	Old-growth conifer (especially redwood and Douglas-fir) forests near the coast	*Low Potential*: No known nesting documented on campus; unlikely to nest on campus due to lack of mature redwoods with large lateral branches suitable for nesting platforms
Tricolored blackbird *Agelaius tricolor*	FSC	SSC	Cattail and tule marshes; open valleys and foothills	*Low Potential*: No suitable nesting habitat on campus; occasional use of lower campus grasslands near the Great Meadow Tributary by foraging birds is possible
Black swift *Cypseloides niger*	--	SSC	Nests in moist crevices or caves on sea cliffs above the surf, or on cliffs behind or adjacent to waterfalls in deep canyons	*Low Potential*: Historically a common nester on ocean-facing cliffs and caves between Davenport and Santa Cruz (CNDDB 2002); no breeding has been documented at known nesting localities from surveys in 2001 and 2002 (Suddjian 2002)
Willow flycatcher *Empidonax trailii*	FSC	CE	Riparian areas and large wet meadows with abundant willows. Usually found in riparian habitats during migration	*Low Potential*: Rare spring and fall migrant, does not nest along the California coast (Suddjian 2002)
Long-eared owl *Asio otis*	--	SSC	Nests in abandoned crow, hawk, or magpie nests, usually in dense riparian stands of willows, cottonwoods, live oaks, or conifers.	*Not Expected*: one recent breeding record for Santa Cruz County (Suddjian 2002), but no records of this species on campus. Potentially suitable nesting habitat within the mixed evergreen forest in all drainages; grasslands provide marginal foraging habitat.
Short-eared owl *Asio flammeus*	--	SSC	Open areas, including grasslands, prairies, dunes, meadows, irrigated lands, and saline and freshwater emergent wetlands. Known to nest on dry ground, concealed by vegetation.	*Low Potential*: no recent breeding records in Santa Cruz County (Jones & Stokes 2003); known to winter roost near the East Field on Lower Campus (EcoSystems West 2001), but not within the Great Meadow. Grasslands within the project boundaries provide suitable nesting and foraging habitat.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
Pallid bat * *Antrozous pallidus*	FSC	SSC	Occurs in a variety of habitats from desert to coniferous forest. Most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California and oak woodland, grassland, and desert scrub in southern California. Relies heavily on trees for roosts	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Pacific Townsend's (Western) big-eared bat *Corynorhinus townsendii townsendii*	FSC	SSC	Roosts in caves, tunnels, mines, and dark attics of abandoned buildings; very sensitive to disturbances; may abandon a roost after onsite visit	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Western red bat* *Lasiurus blossevillii*	FSC	--	Found primarily in riparian and wooded habitats. Occurs at least seasonally in urban areas. Day roosts in trees within the foliage. Found in fruit orchards and sycamore riparian habitats in the Central Valley	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Long-legged myotis* *Myotis volans*	FSC	--	Most common in woodlands and forests above 4,000 feet, but occurs from sea level to 11,000 feet	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Yuma myotis *Myotis yumanensis*	FSC	--	Roosts colonially in a variety of natural and humanmade sites including caves, mines, buildings, bridges, and trees; in northern California, maternity colonies are usually in fire-scarred redwoods, pines, and oaks; forages for insects over bodies of water	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.

Table 2-5
Special-Status Wildlife Species With the Potential to Occur in the Project Area

Common and Scientific Name	Status		Habitat Requirements	Potential Occurrence at Project Sites
	Federal	State		
Fringed myotis *Myotis thysanodes*	FSC	--	Forages in open woodlands; roosts in buildings, mines, caves, bridges, conifer snags, and caves	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Long-eared myotis *Myotis evotis*	FSC	--	Forages in woodlands; roosts in a variety of habitats including mines, buildings, caves, bridges, and rock crevices	*High Potential*: Riparian areas in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch provide high quality foraging habitat. No roosting habitat is present in or in the vicinity of proposed projects.
Greater western mastiff bat *Eumops perotis californicus*	FSC	SSC	Roosts and breeds in deep, narrow rock crevices; may also use crevices in trees, buildings, and tunnels; forages in a variety of semiarid to arid habitats	*Low Potential*: not detected during any surveys. May forage at project sites in the east fork of Moore Creek, the Mainstem of Jordan Gulch, the west fork of Jordan Gulch, and the Middle Fork of Jordan Gulch. No suitable roosting habitat found at proposed project sites.
San Francisco dusky-footed woodrat *Neotoma fuscipes annectens*	--	SSC	Occurs in a variety of habitats from desert to coniferous forest. Most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California and oak woodland, grassland, and desert scrub in southern California. Relies heavily on trees for roosts	*High Potential*: EcoSystems West (2002) observed three woodrat nests in the north campus. One nest recorded adjacent to the east fork of Moore Creek during 2002 survey (Jones & Stokes 2004).

Notes:

*Listed by the Western Bat Working Group as a "High Priority" species.

Sources: *BUGGY Data Base* 2003; CNDDB 2002, 2005; Ecosystems West 2001, 2002; Jones & Stokes 2003; Suddjian 2000, 2002.

Status Key:

Federal

- FE Federally Endangered
- FT: Federally Threatened
- FC: Federal Candidate for listing as threatened or endangered
- FSC: Federal Species of Concern
- FPE: Federally Proposed Endangered
- BGEPA: Federally protected under Bald and Golden Eagle Protection Act

State

- CE: California Endangered
- CT: California Threatened
- CFP: California Fully Protected
- CP: California Protected
- SSC: Species of Special Concern
- S3: Restricted range and considered rare in California (CNDDB)

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
East Fork Jordan Gulch											
JG-EF-R2-1 and JG-EF-R2-3	LTS	LTS w/LRDP MM BIO-4C		LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
JG-EF-R2-4	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
JG-EF-R2-6	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
JG-EF-R2-7	--	--	--	--	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
JG-EF-R2-8	--	--	--	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-20A	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-20B	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
Great Meadow Tributary											
JG-MS-GMT-R1-3 to 4	--	--	--	LTS	LTS	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
JG-MS-GMT-R1-5	LTS	--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
JG-MS-GMT-R1-8	LTS	--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
JG-MS-GMT-R1-9	LTS	--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
JG-MS-GMT-R1-12 to 13		--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
AR-21	--	--	--	--	LTS	--	LTS	--	--	--	LTS
AR-22A	--	--	--	LTS	LTS	--	LTS	LTS	--	--	LTS
AR-22B	--	--	--	LTS	LTS	--	LTS	LTS	--	--	LTS
Mainstem Jordan Gulch											
JG-MS-R1-1	LTS	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MS-R1-2	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
JG-MS-R1-3,4,5, and 6	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	--	--	LTS
JG-MS-R1-10	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MS-R1-7	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MS-R2-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MS-R2-2,3, & 4	--	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MS-R3-3	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-23	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-24	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-25	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
Middle Fork Jordan Gulch											
JG-MF-R1-7	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R1-7A	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R1-9	--	--	--	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R2-2	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R2-3	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R2-4	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-MF-R3-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-16A	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
AR-16B	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-17A	--	LTS w/LRDP MM BIO-4C	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-19	--	LTS w/LRDP MM BIO-4C	--	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
West Fork Jordan Gulch											
JG-WF-CO-R1-2	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-WF-R1 and JG-WF-R1-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
JG-WF-R2-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-17B	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-17C	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-17D	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
AR-18	--	LTS w/LRDP MM BIO-4C	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
Baskin Tributary and Science Hill Tributary											
MC-EF-BT-R1-10	LTS	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--			
MC-EF-BT-R1-2 to 4	LTS	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--			
MC-EF-BT-R1-7	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--			
MC-EF-BT-R1-8	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--			
MC-EF-BT-SHT-R1-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-BT-SHT-R1-3	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-6	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
AR-7	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-8	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-9	--	LTS w/LRDP MM BIO-4C	--	LTS w/ MM WQ-XA &XB	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
Kresge Tributary											
MC-EF-KT-R1-1 - 3	LTS	--	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-KT-R1-4	LTS	--	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-KT-R1-5,6	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-KT-R1-7	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-KT-R2-3	LTS	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
MC-EF-KT-R3-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
MC-EF-KT-R3-5	--	--	--	LTS	LTS	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-1	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-2	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-3	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-4	--	LTS w/LRDP MM BIO-4C	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-5	--	--	--	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
East Fork Moore Creek											
MC-EF-R1-3	LTS w/MM	--	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-R1-6, 7, 11, 12, and 13	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

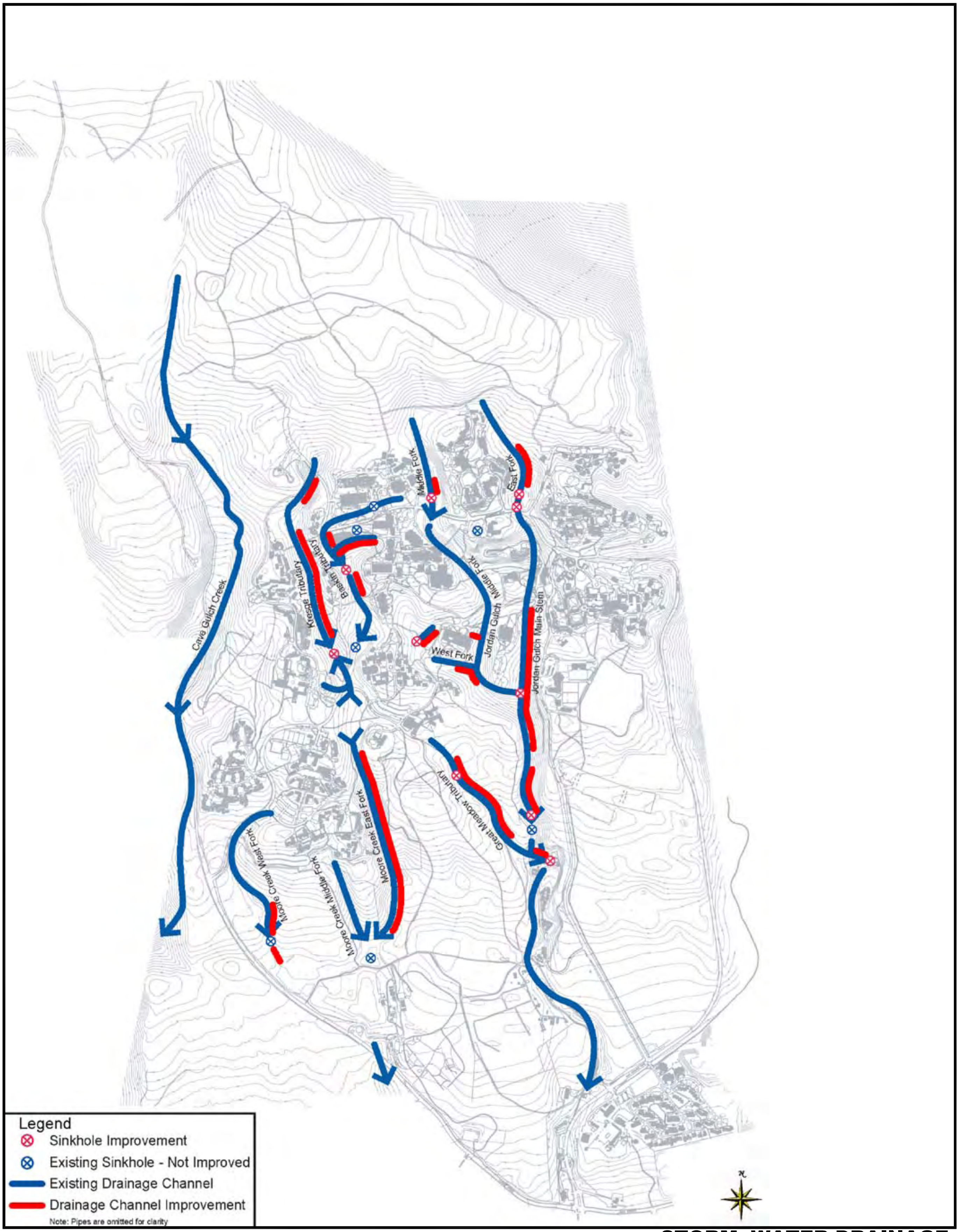
	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
MC-EF-R1-14, 15, and 16	LTS	--	--	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-R1- 18, 19	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-R2-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-R2-7 and 8	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-R3-1b, 2	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-A	--	--	--	--	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-EF-D	--	LTS w/LRDP MM BIO-4C	--	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-HV-R1-1	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-10A	--		--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
AR-10B	--	LTS w/LRDP MM BIO-4C	--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-10C	--	LTS w/LRDP MM BIO-4C	--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-10D	--	LTS w/LRDP MM BIO-4C	--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-11	--	--	--	--	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-12	--	--	--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
AR-26	TBD	TBD	TBD	TBD	--	LTS w/ LRDP MM BIO-10	--	--	--	LTS	LTS
West Fork Moore Creek											
MC-WEF-R2-1 to 2	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-WEF-R2-4	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS

Table 2-6
Summary of Biological Resource Impacts by Storm Water Drainage Improvements

	IIP-SW Impact BIO-1	IIP-SW Impact BIO-2	IIP-SW Impact BIO-2	IIP-SW Impact BIO-3	IIP-SW Impact BIO-4	IIP-SW Impact BIO-5	IIP-SW Impact BIO-6	IIP-SW Impact BIO-7	IIP-SW Impact BIO-8	IIP-SW Impact IO-9	IIP-SW Impact BIO-10
Project	**Fill in Waters of US and State**	**Riparian (Temporary)**	**Riparian (Permanent)**	**Water Quality-Erosion and Toxins**	**Cave Invertebrates**	**California red-legged frog**	**Special-Status Raptors**	**Western burrowing owl**	**Special-Status Bats**	**San Francisco Dusky-footed woodrat**	**Wildlife Movement**
MC-WEF-R2-7	LTS	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-WEF-R2-8	--	--	--	--	--	--	LTS w/ LRDP MM BIO-11	--	LTS	LTS	LTS
MC-WEF-E	--	--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
MC-WEF-F	--	--	--	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
MC-WEF-H	--	LTS w/LRDP MM BIO-4C	LTS w/MM BIO-4A & 4B	LTS	--	--	LTS	LTS w/ LRDP MM BIO-12A & 12B	--	--	LTS
AR-13	--	--	--	--	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-14A	--	--	--	LTS	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-14B	--	--	--	--	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS
AR-15	--	--	--	--	LTS	LTS w/ LRDP MM BIO-10	LTS w/ LRDP MM BIO-11	--	LTS	--	LTS



STORM WATER DRAINAGE SYSTEM IMPROVEMENTS

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UC Santa Cruz LRDP EIR
Santa Cruz, California

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FIGURE 2-1

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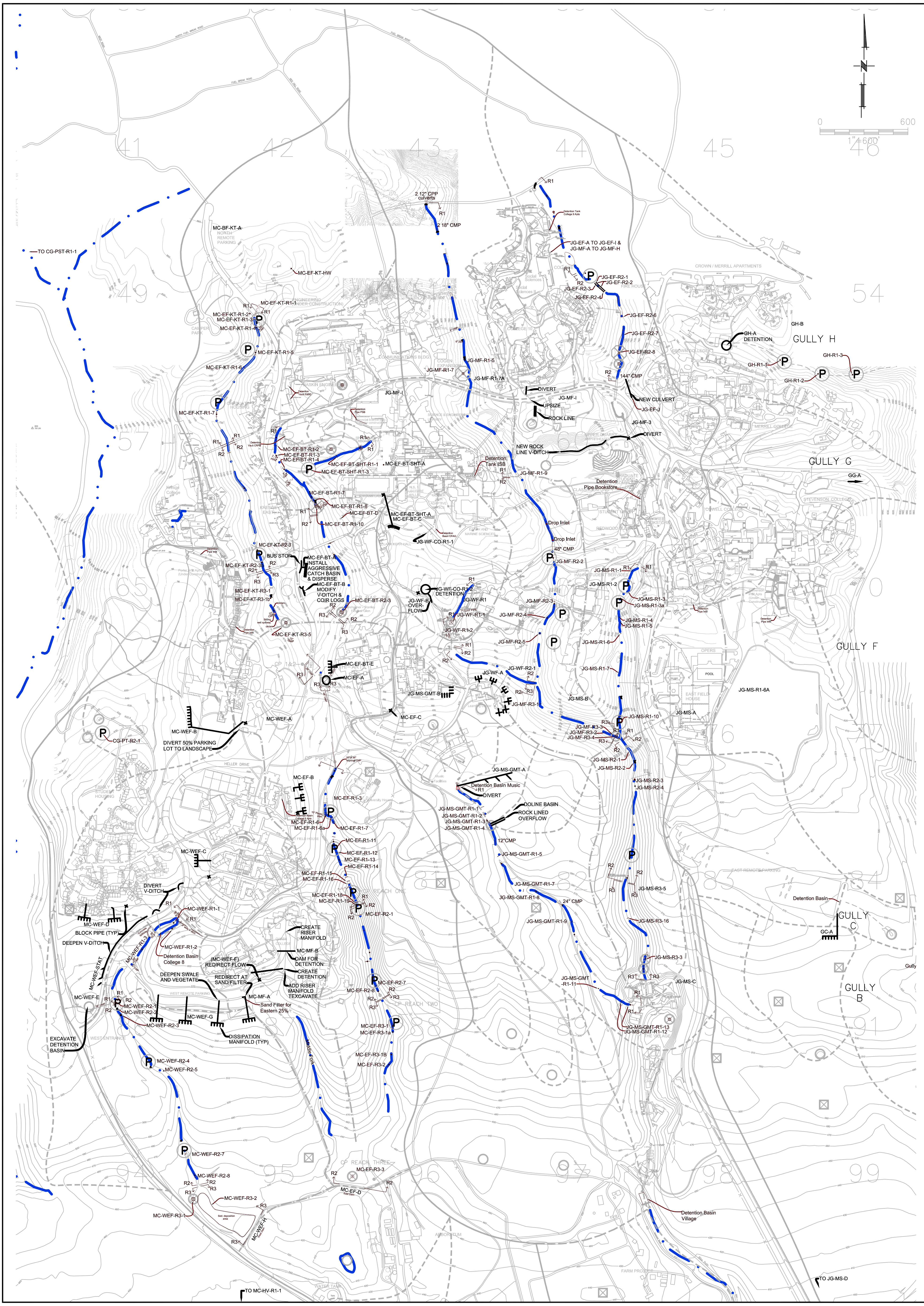

Basin Boundary
Sub-basin Boundary
Redirected Basin Boundary
Drainage Divide
Priority Sites
Priority Sinkhole to Monitor
Identified Sinkhole
Assumed Sinkhole Location or Depression Location
Possible Location

Source: Kennedy/Jenks Consultants

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STORM WATER DRAINAGE SYSTEM IMPROVEMENTS (DETAILED)

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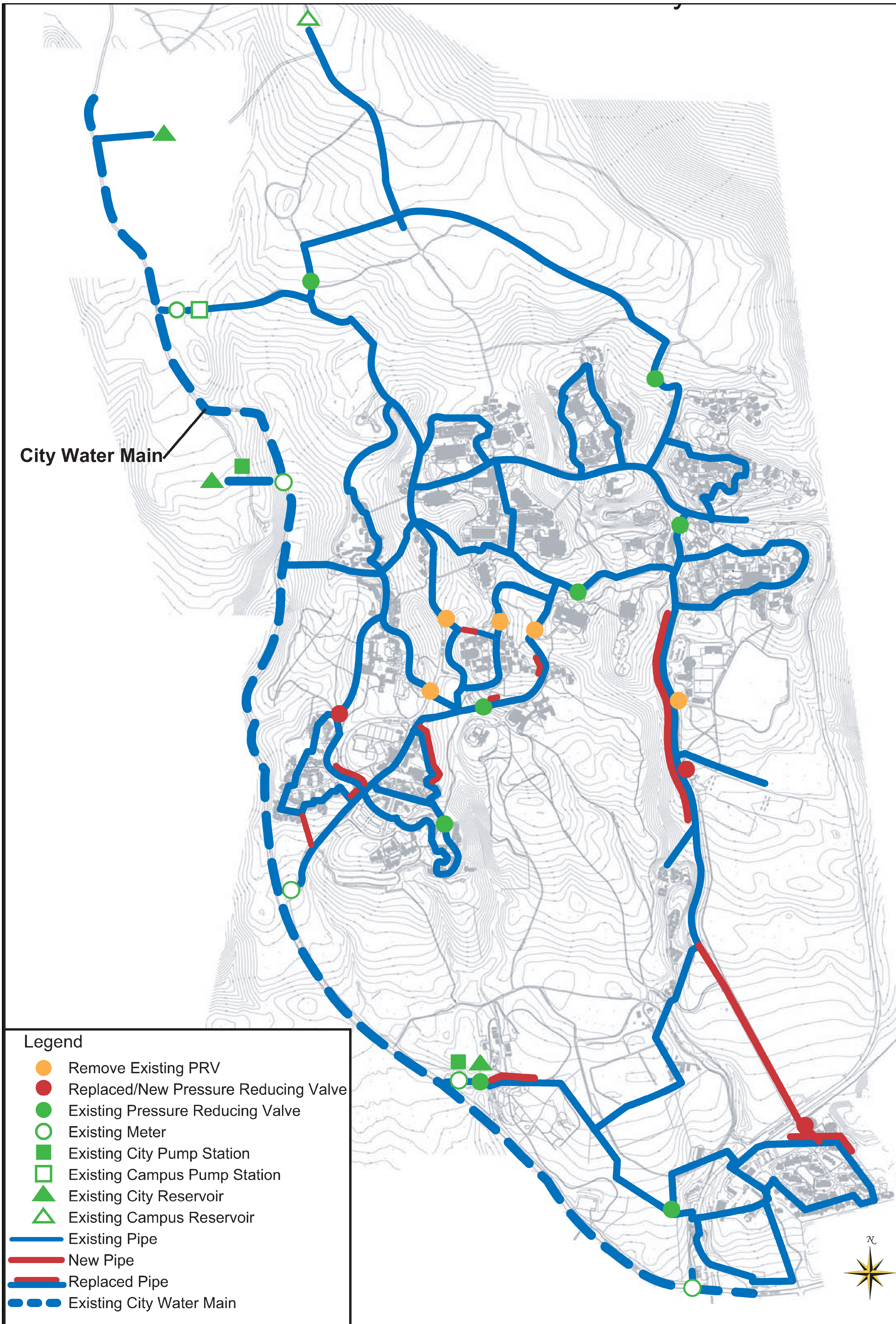
Figure 2-2



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DOMESTIC/FIRE PROTECTION
WATER SYSTEM IMPROVEMENTS

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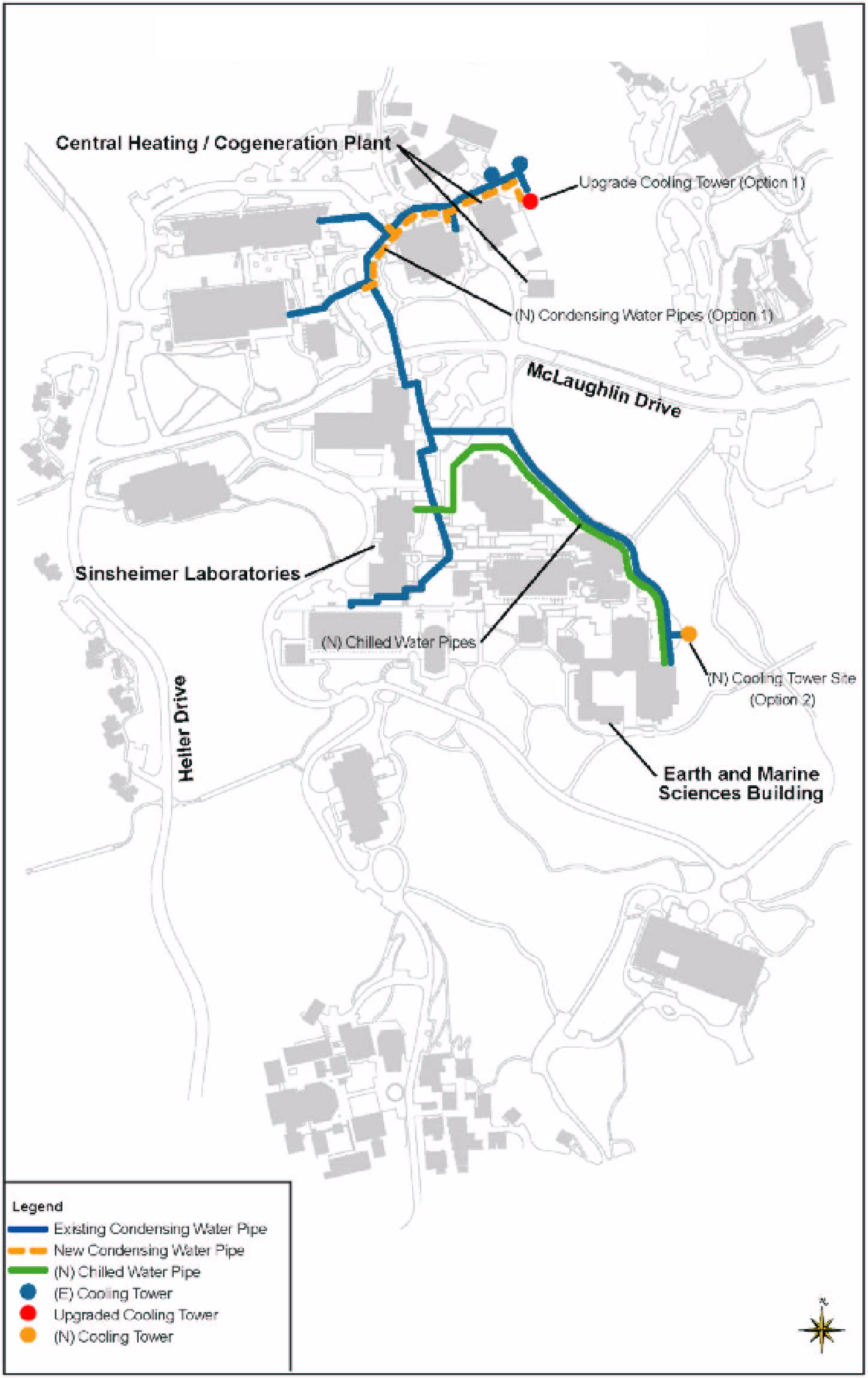
FIGURE 2-3



CAMPUS CORE COOLING WATER SYSTEM IMPROVEMENTS

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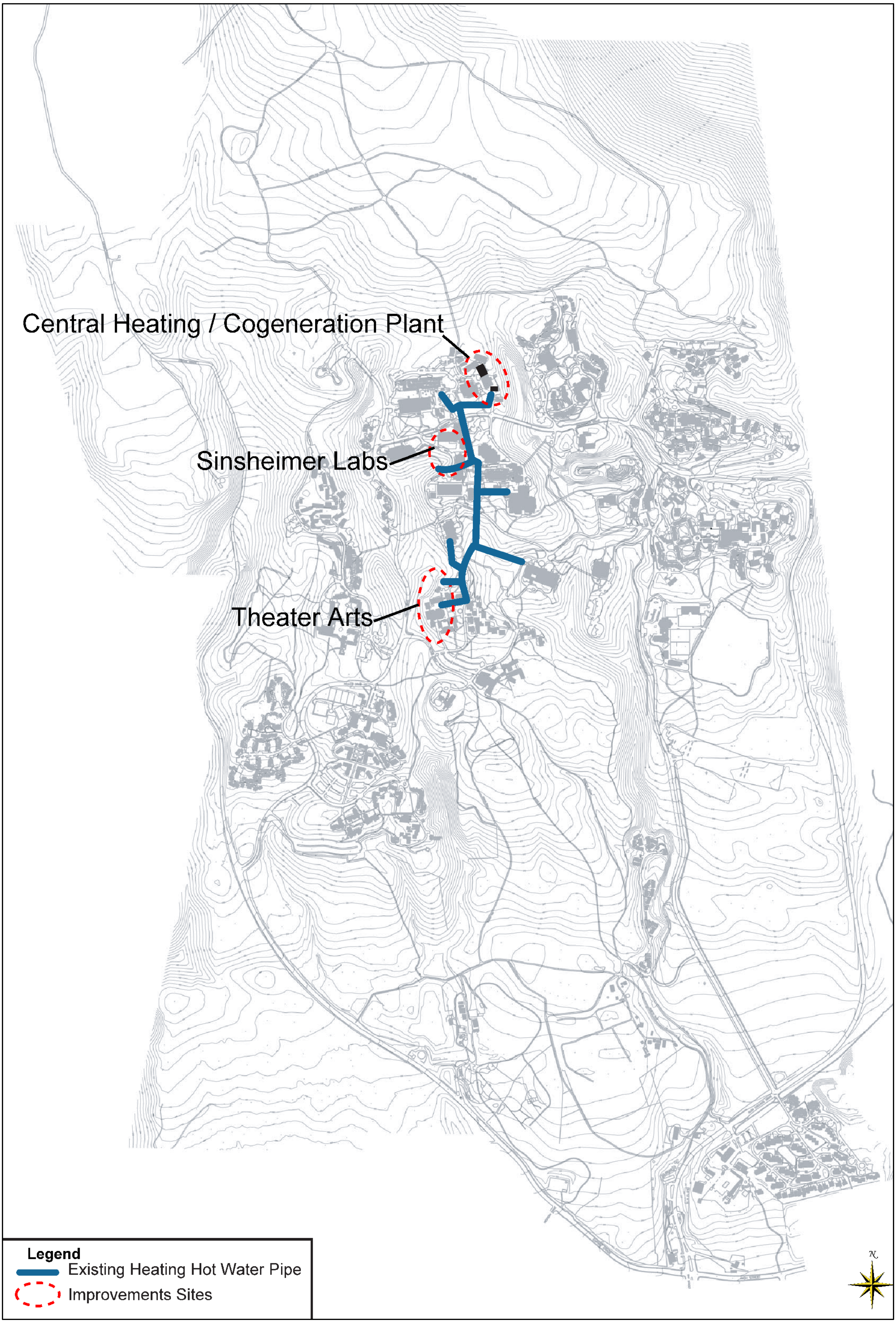
FIGURE 2-4



CAMPUS CORE HEATING WATER SYSTEM IMPROVEMENTS

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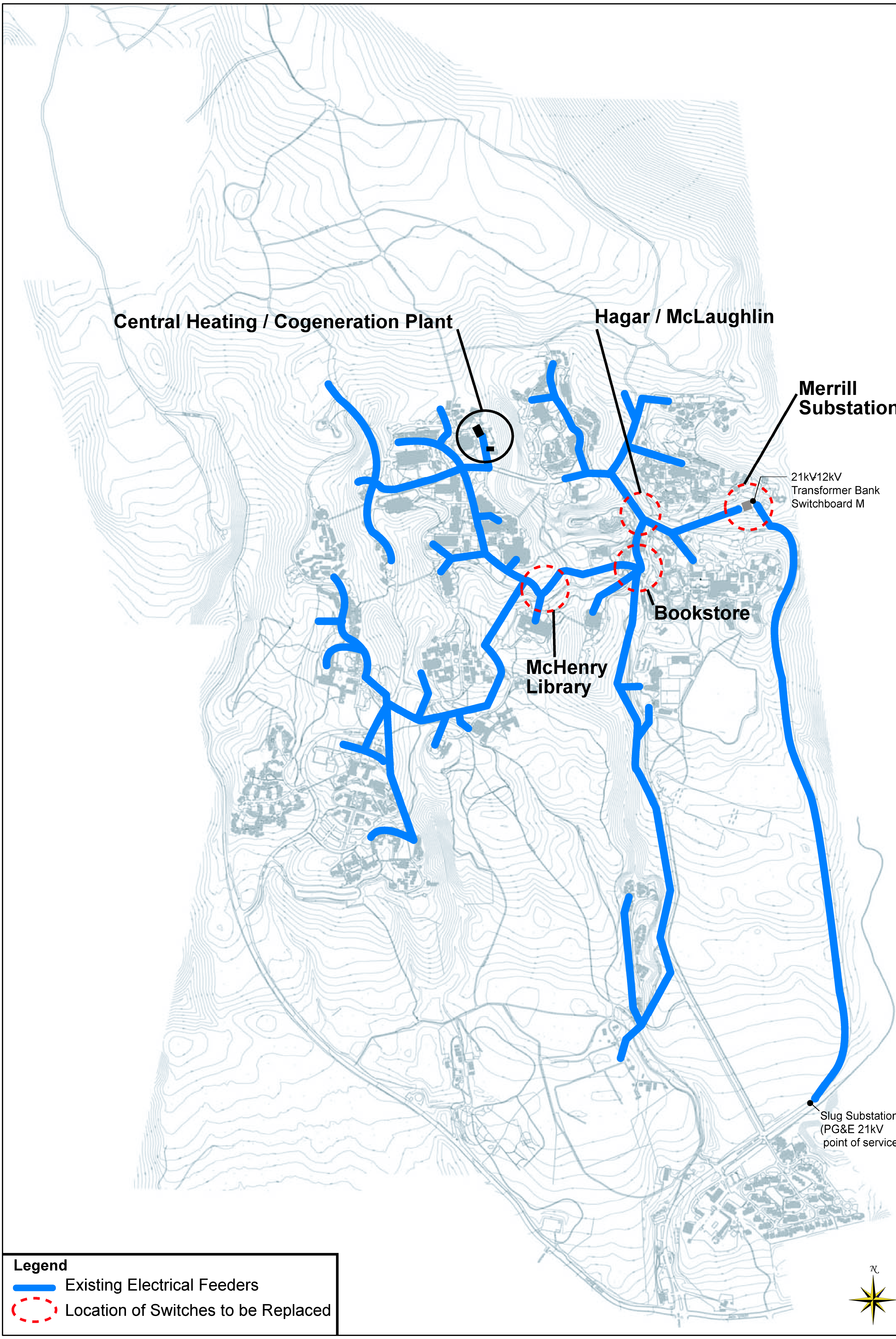
FIGURE 2-5



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ELECTRICAL SYSTEM IMPROVEMENTS

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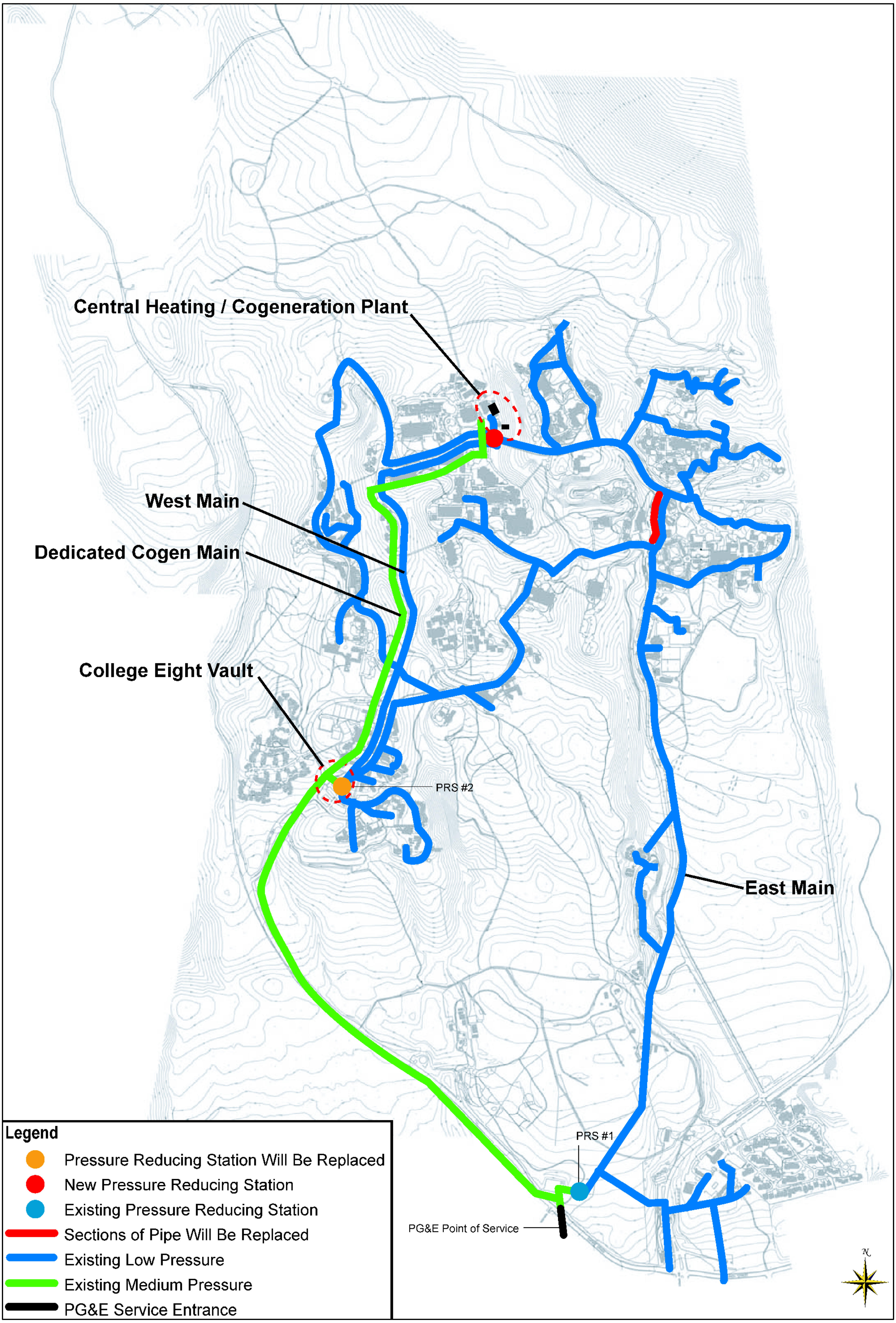
FIGURE 2-6



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NATURAL GAS SYSTEM IMPROVEMENTS

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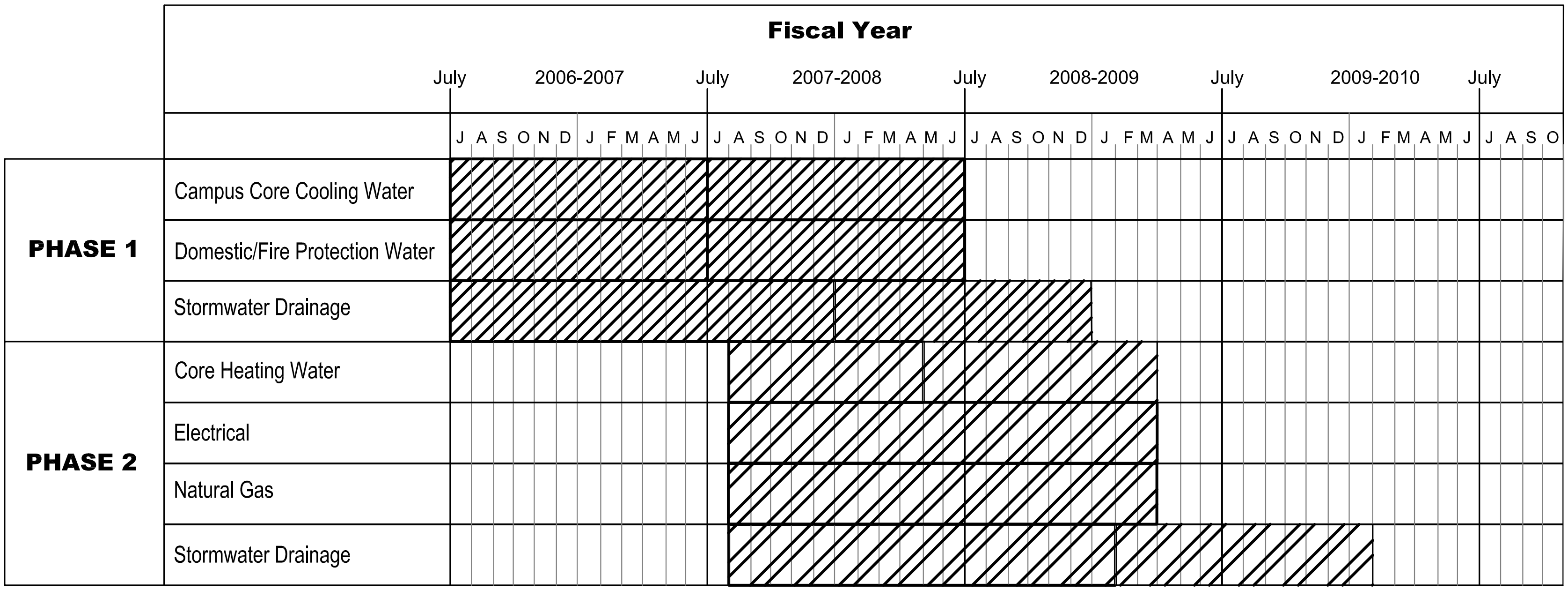
FIGURE 2-7



INFRASTRUCTURE IMPROVEMENTS PROJECT CONSTRUCTION SCHEDULE

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FIGURE 2-8