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Sacramento, CA 95814-5512

Subject: **GEOARCHAEOLOGICAL ASSESSMENT AND SUBSURFACE INVESTIGATIONS TECHNICAL REPORT FOR THE CANYON POWER PLANT PROJECT DOCKET NO. (07-AFC-9)**

Enclosed for filing with the California Energy Commission is the original **GEOARCHAEOLOGICAL ASSESSMENT AND SUBSURFACE INVESTIGATIONS TECHNICAL REPORT**, for the Canyon Power Plant Docket No. (07-AFC-9).

Sincerely,

Marie Mills

**TECHNICAL REPORT**

# GEOARCHAEOLOGICAL ASSESSMENT AND SUBSURFACE INVESTIGATIONS

## FOR THE CANYON POWER PLANT PROJECT, ANAHEIM

*Prepared for*

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Public Utilities Department
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July 2009

URS

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# Executive Summary

This report presents the results of a geoarchaeological investigation of the proposed Canyon Power Plant project (CPP; Project) located in Anaheim, California. The purposes of the investigation were (1) to identify paleosols (buried soils) and assess the potential for buried prehistoric archaeological components within the Project area, and (2) to identify and characterize any subsurface archaeological deposits encountered as a result of the investigation. This report is intended to provide adequate background data and testing results to allow California Energy Commission (CEC) Staff to make an assessment of the potential for adverse impacts to buried archaeological resources.

No archaeological materials were identified as a result of the geoarchaeological investigations. In general, the Project area is considered to have a very low potential for buried prehistoric resources. No paleosols (other than the uppermost pedogenic unit, directly underlying the surface concrete) were identified within the project area. All buried contacts were depositional (lithostratigraphic) in nature, with no evidence of pedogenesis at or across these contacts. Identified depositional features are typical of a braided river system, dominated by sand and gravel active channel cross beds, interspersed with limited finer grain horizontally bedded and laminated overbank deposits. Dated depositional units ranged from 2150 Cal BP to 7690 Cal BP, suggesting that the project area was part of a highly dynamic active river system for much of the Holocene. Any prehistoric archaeological materials that might have originally been associated with a near-channel context would likely have been heavily disturbed or completely removed by subsequent channel braids, and are more likely to be preserved on or near the stable Pleistocene fans located north of the project area.

Based on background research and field investigations, it is considered very unlikely that archaeological resources will be encountered during construction activities for the CPP Project. Because of the close spacing of the geoarchaeological trenches across the Power Block area (less than 30 meters between most trenches) and the lack of archaeological deposits, it is unlikely that a large substantial site is buried within this area. Additionally, the lack of paleosols or laterally extensive surfaces, and the presence of largely erosional river-channel contacts, suggests that buried archaeological resources are unlikely throughout the project area. In the unlikely event that buried archaeological resources are present, they will most likely be isolated materials, transported, redeposited, and/or otherwise disturbed by the prehistoric Santa Ana River that once flowed through the Project area.

Given these considerations, archaeological monitoring is not recommended during the majority of construction activities for the CPP Project. To mitigate the limited potential for redeposited isolated archaeological finds, it is recommended that all construction personnel receive archaeological awareness training, including protocol in the event of an unanticipated discovery. An archaeological monitor may be advisable during any limited construction activities extending beyond 3.8 meters (12.5 feet) below surface (i.e., the

oil/water separator sump, jack and bore pit) as subsurface conditions below this depth are unknown, though most likely they are reflective of the same braided river belt conditions observed at shallower depths and have little archaeological potential.

# Table of Contents


**1 Introduction ..... 1-1**

1.1 Project Description and Area of Potential Effects ..... 1-3

1.2 Regulatory Context ..... 1-6

1.2.1 Significance Criteria ..... 1-7

1.3 Personnel ..... 1-8

**2 Geoarchaeological Context ..... 2-1**

2.1 Background ..... 2-1

2.2 Santa Ana River Basin Landscape Evolution ..... 2-1

2.3 Project Area Geomorphology ..... 2-5

2.4 Geoarchaeological Context ..... 2-9

**3 Geoarchaeological Investigations ..... 3-1**

3.1 Methods ..... 3-1

3.2 Results and Discussion ..... 3-4

3.2.1 Trench 3 Summary ..... 3-7

3.2.2 Discussion ..... 3-12

**4 Conclusions and Recommendations ..... 4-1**

4.1 Conclusion ..... 4-1

4.2 Recommendations ..... 4-2

**5 References ..... 5-1**

## List of Tables

Table 1 Depth of Impact for Project Components

Table 2 Subordinate Distinctions within Master Soil Horizons

Table 3 Sedimentary Features of Braided River Systems

## List of Figures

Figure 1 Geoarchaeological Trench Locations and Selected Project Elements

Figure 2 Mapped Quaternary Deposits within the Project Vicinity

Figure 3 Bathymetry of the San Pedro Littoral Cell and Paleo-Channels of the Santa Ana River

Figure 4 1901 Anaheim 1:62,500 USGS Map with Project Components and Previously Identified Cultural Resources

Figure 5 1919 Anaheim Soil Survey with Project Components and Previously Identified Cultural Resources

Figure 6 Braided Channel Depositional Bedforms

Figure 7 Trench 3 South Wall Profile, Canyon Power Plant, Anaheim

Figure 8 Trench 3 South Wall Photo, Canyon Power Plant, Anaheim

## Appendix

A Radiocarbon Results

B Summary Trench Logs

C Example Archaeological Awareness Hand-Out

# List of Acronyms

| | |
|---|---|
| AFC | Application for Certification |
| AMS | Accelerated Mass Spectrometer |
| AMSL | above mean sea level |
| APE | area of potential effects |
| Cal B.P. | calibrated years Before Present |
| CEC | California Energy Commission |
| CEQA | California Environmental Quality Act |
| CFR | Code of Federal Regulations |
| COA | City of Anaheim |
| CPP | Canyon Power Plant |
| CRHR | California Register of Historical Resources |
| CTG | combustion turbine generator |
| GSU | generator step-up transformer |
| GWRS | Orange County groundwater replenishment system |
| OWS | oil/water separator |
| Project | Canyon Power Plant Project |
| PSA | Preliminary Staff Assessment |
| SAR | Santa Ana River |
| RPA | Registered Professional Archaeologist |
| SCR | selective catalytic reducer |
| URS | URS Corporation |
| WQ | water quality |

# 1 Introduction

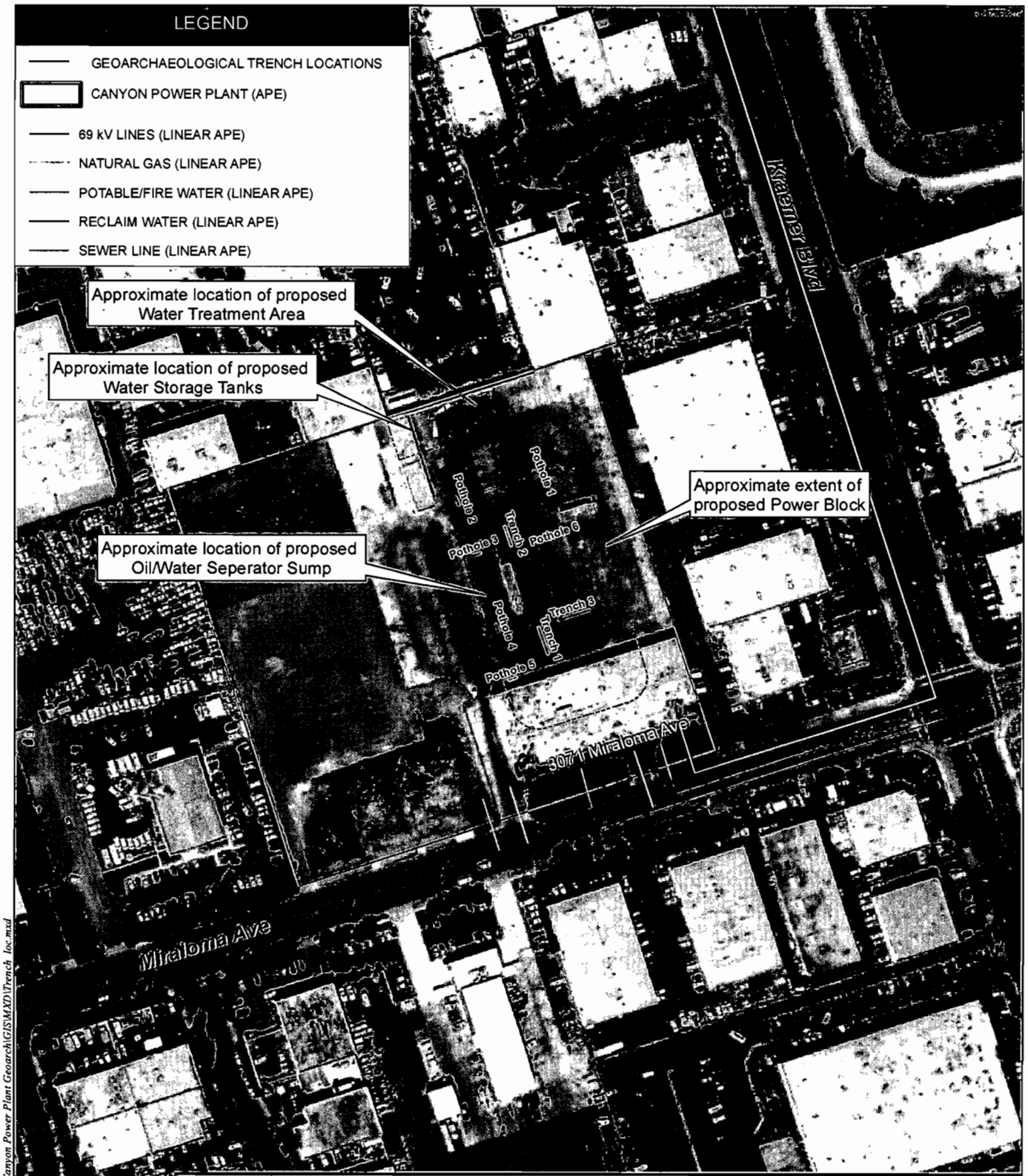
The Southern California Public Power Authority proposes to construct a natural gas power plant (the "Canyon Power Plant"; CPP) on a ten acre parcel located in the City of Anaheim. The subject parcel is located at 3071 Miraloma Avenue, near the intersection with Kraemer Avenue (Figure 1).

The CPP Project area was the subject of a previous cultural resource study (URS 2007), that was used as the basis for developing preliminary recommendations for archaeological mitigation protocol described in the Preliminary Staff Assessment (PSA) for the Canyon Power Plant, Application for Certification 07-AFC-09, Orange County (CEC 2009). The initial cultural resources study failed to identify any significant prehistoric, historic-era, or built environment resources within the horizontal Area of Potential Effects (APE). However, at the time, only cursory consideration was given to the potential for buried archaeological resources that may be disturbed by the projects vertical component.

In the PSA dated May, 2009, it was determined that "only the project's potential to adversely impact at-this-time-unidentified buried archaeological resources requires provision of contingency mitigation measures" (Bastian and McGuirt 2009:4.3-31). In the absence of any viable subsurface data or in-depth geomorphic analysis for the CPP Project area, CEC staff had to rely on limited historical evidence to make a determination of the potential for burial of archaeological resources. Staff concluded that "the historical record of frequent flooding and voluminous sediment deposition is indicative of the Santa Ana River's ability to bury prehistoric archaeological sites in its basin over the past 14,000 years" (Bastian and McGuirt 2009:4.3-34). However, this assumption was not predicated on any field evidence for the presence of significant historical resources, or buried surfaces that may be conducive to the preservation of such archaeological resources, but simply the limited documentary record and environmental setting of the Project area.

Through consultation with the CEC staff, it was determined that acquisition of additional data on subsurface conditions would be a more effective approach to identify and define the actual presence or potential of buried archaeological resources within the Project area through directed research on landscape evolution and subsurface field investigations. This information can then be used to make more informed decisions regarding mitigation measures, such as construction monitoring.

This report presents the results of the subsurface geoarchaeological investigation of the proposed Project area, as well as extended documentary research through historical maps, soils reports, geomorphological, and geological studies. The purposes of these investigations were (1) to identify paleosols and assess the potential for buried archaeological components within the project area, and (2) to identify and characterize any archaeological deposits encountered as a result of the investigation.

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**GEOARCHAEOLOGICAL TRENCH LOCATIONS AND SELECTED PROJECT COMPONENTS**

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SOURCES: CEC Preliminary Staff Assessment (05/07/09) Figure 2; Digital Globe (2008)

## 1.1 Project Description and Area of Potential Effects[1]

The proposed Project is a nominal 200-MW, simple-cycle, peaker power plant, which would take up the eastern half of the proposed project site, and which would consist of four natural gas-fired GE LM 6000PC Sprint gas turbines (the "Power Block") and their auxiliary equipment. A laydown area would occupy approximately the western half of the proposed project site. The footprint of the combined on-site Canyon Power Plant APE is shown in Figure 1.

Additionally the project includes off-site linear facilities (Figure 1 and 2) consisting of :

• a new, 3,240-foot-long, 12-inch, natural gas underground pipeline running east on East Miraloma Avenue to Kraemer Boulevard, then north on Kraemer Boulevard to East Orangethorpe Avenue to connect into SoCal Gas Company's (SCGC) natural gas transmission pipeline L-1218;

• a new, 2,185-foot-long, 14-inch recycled water pipeline, running from the proposed project site to the Orange County groundwater replenishment system (GWRS) on the southeastern side of Kraemer Basin, near the Carbon Canyon Diversion Channel, where a new off-site recycled water booster pump station would also be installed;

• four new underground 69-kV transmission lines running from the on-site switchyard under nearby streets to connect with two existing 69-kV overhead transmission lines, with two new lines running 100 feet to connect to the Vermont-Yorba line and the other two new lines running a total of 7,000 feet to connect to the Dowling-Yorba line;

• fiber optic cable for the supervisory control and data acquisition system running in a common trench with the two 7,000-foot, 69-kV underground transmission lines, to tie into existing underground fiber optic cable; and

• two 10-inch pipelines, each 75 feet long, running from the proposed project site to a COA-owned 14-inch pipeline running along East Miraloma Avenue, would provide potable water, fire water, and a back-up process water supply; and

• a 6-in sewer pipeline, 40 feet long, running from the proposed project site to the Orange County Sanitation District wastewater pipeline running along East Miraloma Avenue, would dispose of both sanitary and process wastewater.

The depth of disturbance, also referred to as the vertical APE, for the CPP Project is variable by project component. The largest and deepest area of disturbance will be the main Power Block area, which consists of the four combustion turbine generators (CTG), associated generator step-up (GSU) transformers, and selective catalytic reducers (SCR), as well as other minor elements. Also within the Power Block area is the relatively small, but deep excavation for the process drain sump. As such, the Power Block area was selected as the

[1] Project description adapted from Preliminary Staff Assessment (CEC 2009:4.3-4 and 5).

target area for subsurface investigations. These selected project components are shown on Figure 1, along with excavated geoarchaeological trench locations. Through consultation with CEC staff, it was determined that excavation to the full extent of the small process drain sump was cost prohibitive and not warranted by the limited excavation necessary for the sump. As such, geoarchaeological excavations were limited to approximately 3.8 meters (12.5 feet) below surface.

As described above, off-site project components are largely related to the emplacement of utility lines, including gas, water, power, and sewer lines that will serve the CPP. The majority of these linear excavations are at typical depths for utilities (less than 6 feet below surface) and will occur along existing street and utility corridors, with significant prior ground disturbance. A deep jack and bore pit is proposed under carbon creek channel. A summary of project impact depths is provided in Table 1.

## Table 1. Depth of Impact for Project Components

| Project Component | Disturbance Depth (In Feet) | Approximate Depth to Undisturbed | Depth Into Undisturbed Alluvium |
|---|---|---|---|
| CTG (Power Block) | 10 | 1 | 9 |
| SCR (Power Block) | 10 | 1 | 9 |
| GSUs (Power Block) | 11 | 1 | 10 |
| OWS process drains sump (Power Block) | 25 | 1 | 24 |
| Raw water storage tank | 9 | 1 | 8 |
| DI water storage tank | 9 | 1 | 8 |
| WQ treatment chamber (Water Treatment) | 12 | 1 | 11 |
| Stormwater Infiltration chamber (Water Treatment) | 12 | 1 | 11 |
| Fuel gas compressor skid area | 3 | 1 | 2 |
| Chiller unit | 7 | 1 | 6 |
| Main electrical bldg. | 2 | 1 | 1 |
| Air compressor | 2 | 1 | 1 |
| POB/maintenance bldg. | 2 | 1 | 1 |
| Ammonia tank | 3 | 1 | 2 |
| Water treatment area | 3 | 1 | 2 |
| GIS switchyard | 4 | 1 | 3 |
| GIS switchyard meter enclosure | 2 | 1 | 1 |
| Perimeter sound wall | 5 | 1 | 4 |
| Black start diesel generator | 6 | 1 | 5 |
| Auxiliary & station transformers | 4 | 1 | 3 |
| Natural gas metering station | 3 | 1 | 2 |
| Construction laydown area | 0.5 | 2 | 0 |
| | | | |
| **On-site trenching:** | | | |
| GWRS Water Line | 5 | 1Unknown | 45 |
| Sanitary Sewer | 5 | 1Unknown | 45 |
| HV Duct Banks | 6 | 1Unknown | 46 |
| LV Duct Banks | 5 | 1Unknown | 45 |
| Natural Gas Line | 5 | 1Unknown | 45 |
| Potable & Fire Water Lines | 5 | 1Unknown | 45 |
| | | | |
| **Off-site trenching:1** | | | |
| GWRS Water Line | 5 | Unknown | 5 |
| GWRS Pump Station | 11 | Unknown | 11 |
| Sanitary Sewer | 5 | Unknown | 5 |
| HV Duct banks (normal depth) | 6 | Unknown | 6 |
| HV transmission vault | 13 | Unknown | 13 |
| HV jack & bore pit (under Carbon Creek Channel) | 26 | Unknown | 26 |
| Natural Gas Line | 5 | Unknown | 5 |
| Potable & Fire Water Lines | 5 | Unknown | 5 |

## 1.2 Regulatory Context

The California Environmental Quality Act (CEQA) requires that public or private projects financed or approved by public agencies assess the effects of the project on historical resources. CEQA also applies to effects on archaeological sites, which may be included among "historical resources" as defined by CEQA Guidelines Section 15064.5, subdivision (a), or may be subject to the provisions of Public Resources Code Section 21083.2, which governs review of "unique archaeological resources." Historical resources generally include buildings, sites, structures, objects, or districts, each of which may have historical, architectural, archaeological, cultural, or scientific significance.

Under CEQA, "historical resources" include the following:

- A resource listed in, or determined to be eligible by the State Historical Resources Commission, for listing in the California Register of Historical Resources (Public Resources Code, Section 5024.1).
- A resource included in a local register of historical resources, as defined in Section 5020.1(k) of the Public Resources Code or identified as significant in a historical resource survey meeting the requirements of Section 5024.1(g) of the Public Resources Code, will be presumed to be historically or culturally significant. Public agencies must treat any such resource as significant unless the preponderance of evidence demonstrates that it is not historically or culturally significant.
- Any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California may be considered to be a historical resource, provided the lead agency's determination is supported by substantial evidence in light of the whole record. Generally, a resource will be considered by the lead agency to be "historically significant" if the resource meets the criteria for listing in the California Register of Historical Resources (Public Resources Code, Section 5024.1), including any of the following:
  - Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage
  - Is associated with the lives of persons important in our past
  - Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values
  - Has yielded, or may be likely to yield, information important in prehistory or history

- The fact that a resource is not listed in or determined to be eligible for listing in the California Register of Historical Resources, not included in a local register of historical resources (pursuant to Section 5020.1[k] of the Public Resources Code), or identified in a historical resources survey (meeting the criteria in Section 5024.1[g] of the Public Resources Code) does not preclude a lead agency from determining that the resource may be a historical resource as defined in Public Resources Code Section 5020.1(j) or 5024.1.

Archaeological resources that are not historical resources according to the above definitions may be "unique archaeological resources" as defined in Public Resources Code Section 21083.2, which also generally provides that "non-unique archaeological resources" do not receive any protection under CEQA. If an archaeological resource is neither a unique archaeological nor a historical resource, the effects of the project on those resources will not be considered a significant effect on the environment. It is sufficient that the resource and the effects on it be noted in the EIR, but the resource need not be considered further in the CEQA process.

CEQA requires that if a project results in an effect that may cause a substantial adverse change in the significance of a historical resource, or would cause significant effects on a unique archaeological resource, then alternative plans or mitigation measures must be considered. Therefore, prior to assessing effects or developing mitigation measures, the significance of cultural resources must first be determined. The steps that are normally taken in a cultural resources investigation for CEQA compliance are as follows:

- Identify potential historical resources
- Evaluate the eligibility of historical resources
- Evaluate the effects of the project on eligible historical resources

### 1.2.1 Significance Criteria

According to Appendix G of the CEQA Guidelines, the proposed project could have a significant impact on cultural resources if it would result in any of the following:

- A substantial adverse change in the significance of a historical resource that is either listed or eligible for listing on the National Register of Historic Places, the California Register of Historical Resources, or a local register of historic resources;
- A substantial adverse change in the significance of a unique archaeological resource;
- Disturbance or destruction of a unique paleontological resource or site or a unique geologic feature; or
- Disturbance of any human remains, including those interred outside of formal cemeteries.

CEQA provides that a project may result in a significant environmental effect if it would cause a substantial adverse change in the significance of a historical resource (Public

Resources Code, Section 21084.1). CEQA Guidelines Section 15064.5, subdivision (b)(1), defines a "substantial adverse change" in the significance of a historical resource to mean "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired."

CEQA Guidelines, Section 15064.5, subdivision (b)(2), defines "materially impaired" for purposes of the definition of "substantial adverse change..." as follows:

The significance of an historical resource is materially impaired when a project:

(A) demolishes or materially alters in an adverse manner those physical characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for, inclusion in the California Register of Historical Resources; or

(B) demolishes or materially alters in an adverse manner those physical characteristics that account for its inclusion in a local register of historical resources pursuant to section 5020.1(k) of the Public Resources Code or its identification in an historical resources survey meeting the requirements of section 5024.1(g) of the Public Resources Code, unless the public agency reviewing the effects of the project establishes by a preponderance of evidence that the resource is not historically or culturally significant; or

(C) demolishes or materially alters in an adverse manner those physical characteristics of a historical resource that convey its historical significance and that justify its eligibility for inclusion in the California Register of Historical Resources as determined by a lead agency for purposes of CEQA.

Historic resources are usually 50 years old or older and must meet at least one of the criteria for listing in the California Register (such as association with historical events, important people, or architectural significance), in addition to maintaining a sufficient level of physical integrity (CEQA Guidelines Section 15064.5[a][3]).

## 1.3 Personnel

The fieldwork, analysis, and reporting for the geoarchaeological investigations were carried out by professionals who meet the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (National Park Service 1983) and was consistent with the procedures for compliance with Section 106 of the National Historic Preservation Act, set forth in Title 36 Code of Federal Regulations (CFR) Part 800 (2008).

Project personnel included:

- Jay Rehor, Registered Professional Archaeologist (RPA), acted as Principal Investigator for all field investigations and authored this report. He has an M.A. in cultural resource management from Sonoma State University (California), with a background in the archaeological applications of geology and geomorphology. He has 10 years of experience conducting archaeological investigations in California.

- Brent Leftwich, M.A., RPA, assisted with the field investigations. He is a current Ph.D. candidate in archaeology at University of California, Santa Barbara. Mr. Leftwich has over 10 years experience in archaeology and has conducted cultural resource management projects in California for more than six years. His research interests include hunter-gatherers, lithic analysis, behavioral ecology, and remote sensing.
- Suzanne Black acted as an archaeological field technician. Ms. Black has a B.A. in Anthropology from University of California, Santa Barbara, with three years of experience in Cultural Resource Management and Academic Archaeology. She specializes in prehistoric coastal adaptation and has technical skills in faunal and lithic analysis, human osteological identification, and artifact curation.

# 2 Geoarchaeological Context

## 2.1 Background[2]

The CPP Project area is located in a heavily developed industrial setting. The Project area is at approximately 220 feet (67 meters) above mean sea level (AMSL), near the northern margin of the Santa Ana River floodplain, where it meets the southern toe of the Puente Hills Plesitocene fan piedmont (Figure 2). Given this setting, on the alluvial floodplain of the Santa Ana River (SAR) with several prehistoric archaeological sites identified within a 1-mile radius, CEC Staff considered the Project area a possible location for buried archaeological resources. As such, a geoarchaeological research design was prepared and implemented to assess the potential for buried sites within the Project area.

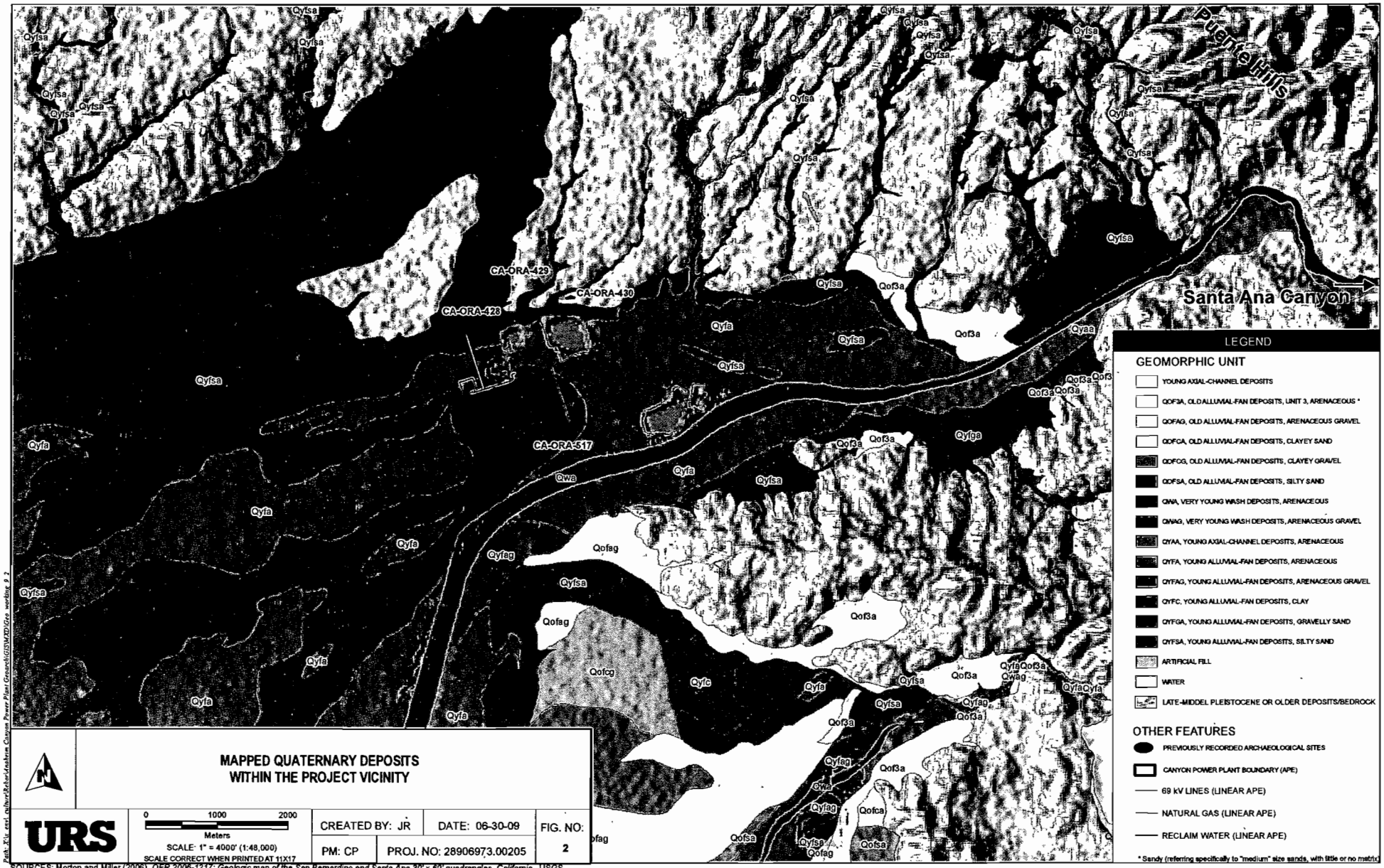
The relationship between archaeological sites and environmental context has long been recognized as important in understanding and interpreting the archaeological record. However, in California, the relationship between landscape evolution over time and the differential exposure and burial of archaeological sites has only begun to emerge as a significant research agenda in its own right, and as a valuable tool in avoiding costly construction delays due to unanticipated discoveries (Meyer 1996). Prior to the last decade, archaeological studies of landscape formation have largely been ad hoc, after the discovery of buried archaeological material.

The SAR is the dominant geomorphic feature within the Project area and, as such, is the focus of much of the background research conducted for this study. For the purposes of this study, the southern portion of the Los Angeles Basin, drained by the Santa Ana River and its tributaries, is referred to as the Santa Ana River Basin. In reality, the Santa Ana River watershed is locally subdivided into two sections: the upper basin, which drains from the San Bernardino Mountains and extends across the Riverside/Chino valley to where the river becomes constricted and flows across the Puente Hills and Santa Ana Mountains through Santa Ana Canyon; and the lower basin, which consists of the broad coastal floodplain downstream from the mouth of Santa Ana Canyon. It is this lower portion within which the Project is located and that is the focus of this study.

## 2.2 Santa Ana River Basin Landscape Evolution

The Late Quaternary history of the Santa Ana River Basin (and the Los Angeles Basin as a whole) is largely one of punctuated base-level rise and fall, related to the interplay of tectonics and eustatic sea level change. Sediment supply for the basin is dictated by the uplift of the various tectonically controlled ranges, including the San Bernardino Mountains, the Santa Ana Mountains, the Chino Hills and the Puente Hills, with drainages

[2] A thorough Archaeological Context for the CPP Project has been provided in the Preliminary Staff Assessment (CEC 2009) as well as other public documents (URS 2007). These documents are part of the public record and, for the sake of brevity, not reproduced herein. Only those aspects relevant to the interpretation of field results are discussed.




SOURCES: Morton and Miller (2006) *OFR 2006-1217: Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California*, USGS.

incising and eroding in reaction to the increase in base-level. Alternatively, deposition of this sediment in the lower coastal portion of the Santa Ana Basin has largely been a reaction to fluctuations in sea level.

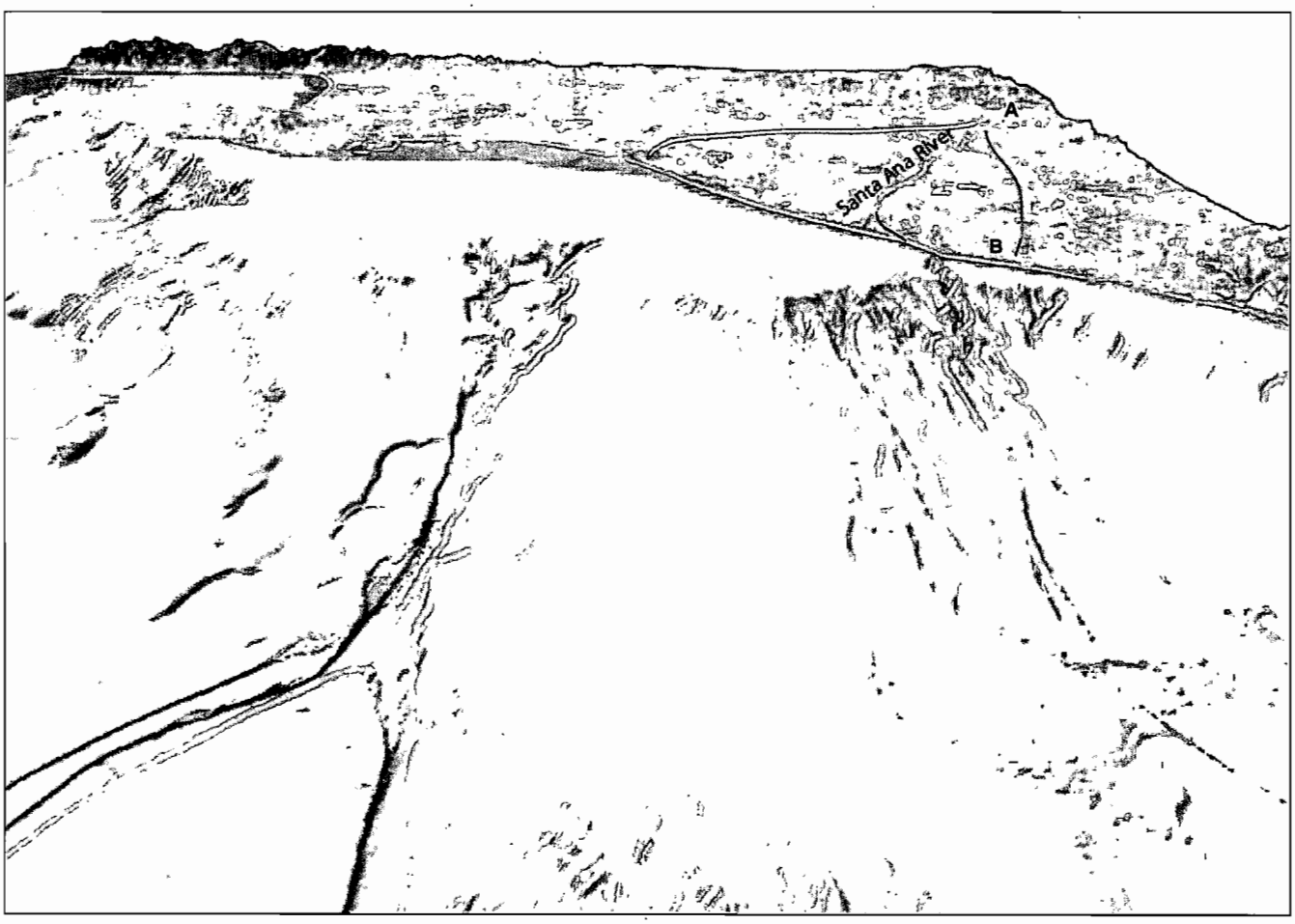
During a sea level lowstand, continental shelves are typically exposed as the shoreline regresses. Erosion is an important process during sea level lowstands, as sediment is transported seaward in fluvial environments towards the receding shoreline. As sediment is transported, new channels are incised into the exposed shelf and preexisting sea cliffs, or shoreline angles. The exposed shelf is incised by fluvial channel networks that transport sediment to the existing shoreline forming fan deltas. The paleo-channels of the braided Santa Ana River delta can be seen in Figure 3, which shows the bathymetry of the continental shelf near Newport, where the SAR drains into the Pacific. Also depicted in Figure 3 are the approximate locations of the SAR for various periods in prehistory. The large variance in channel location is indicative of the mobility of the SAR, and that the coarse of the river is largely controlled by sediment load rather than bedrock or topography (i.e., a broad braided river system rather than a single incised/confined main channel).

When the sedimentation rate exceeds channel capacity or the incision rate, overbank sediments are deposited in interchannel areas. As sea level transgresses, these channels are the first to infill with sediment as a result of the rising base level. During sea level highstands sediment supply slows in relation to creation of new basin accommodation space. The fluvial channels incised during the lowstand will infill first as the base level rises, followed by overbank deposits and fan formation.

California coastal landscapes have undergone dramatic geomorphic change over the past 13,500 years– roughly the period of human occupation. The most dramatic of these changes has been the rise in sea level since the last glacial maximum, around 15,000 B.P. At this time global sea level was more than 300 feet (90 meters) lower than today (Figure 3). As the ice sheets began to melt, sea levels began to rise substantially. Between 15,000 and 11,000 B.P., sea levels rose at a rate of approximately 43 feet (13 meters) every 1,000 years.

The earliest peoples migrating into Southern California at this time would have been confronted with a vastly different landscape than the one seen today. The continental shelf would have been exposed over 10 miles beyond the current coastline north of Newport, while only extending less than 1 mile beyond much of the current shoreline south of Newport, where the continental shelf drops off much more quickly (Figure 3).

Sea-level rise decreased to about 26 feet (8 meters) every 1,000 years between 11,000 and 8,000 B.P. These rising sea levels would have altered the hydrologic and ecological conditions within the Santa Ana River basin. New tidal estuarine environments would have been created as riparian corridors were lost. Sea level rise slowed considerably by approximately 6,000 B.P. Between 6,000 B.P. and the present, sea level has risen at an average rate of about 4 feet (±1 meter) every 1,000 years.




Extent of continental shelf shown in brown, the edge of which is equivalent to the shoreline at approximately 13,500 B.P. (A = approximate location of CPP Project area; B = Newport). Approximate locations of paleo-Santa Ana River channels: Red = >15,000 B.P.; Yellow = ~15,000 B.P. to A.D.1825 (river course likely meandered periodically between this course and current course during this period); Blue = 1825 to 1920 (prior to rivermouth channelization); current course stands out as light line between paleo-courses.

NOT TO SCALE

BATHYMETRY OF THE SAN PEDRO LITTORAL CELL
AND PALEO-COURSES OF THE SANTA ANA RIVER

URS

SOURCES: USGS (2002) *Multibeam Mapping of the Los Angeles, California Margin*, Open File Report 02-162; Perry, B. (2009) *Coastal Systems and Human Impacts.*

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Archaeological sites along the Newport coast provide some insight as to the types of coastal conditions that existed during the Holocene transgression. Between 5,700 and 5,100 years ago, Newport area sites are dominated by faunal species indicative of a rocky coastline. Low sediment supply and strong wave action along the narrow continental shelf, from Newport south, apparently prevented accretion of sand and the formation of dominant beach habitat between 6,000 and 5,000 B.P. (Masters 2007:43). Productivity within this environment appears to have declined during the period between 3,000 and 1,300 B.P., when the Newport coast/bay was largely abandoned. This period has been correlated to a time of strong environmental perturbations, including intensified El Nino activity that would have likely disrupted the exposed coastal environments. Settlements appear to have shifted inland to the San Joaquin Hills at this time, suggesting that terrestrial resources outranked coastal resources during this period (Mason et al 1997). As such, this also may be a period of increased settlement and resource extraction in the CPP project vicinity.

Drainages responded to rising sea levels by retreating upslope and depositing alluvium over previously exposed land surfaces. This effect was heightened as sea level began to stabilize and alluvium accumulated. As a result, formerly stable Pleistocene and early Holocene land surfaces within the Santa Ana River Basin would have been overlain by alluvium largely deposited over the last 6,000 years, as sea levels began to stabilize and approach modern levels. These older buried land surfaces are often marked by well-developed buried soils (paleosols) that have the potential to harbor early prehistoric archaeological sites. In Orange County, the flatlands of the Santa Ana River Basin have thick deposits of Holocene to Late Holocene alluvium that can range from 50 to 300 feet (15 to 90 meters) thick (Herndon 1992:242). These deposits are generally shallower in the eastern margins of the basin and thicken to the west (Herndon 1992:249).

In general, most Pleistocene-age landforms have little potential for harboring *buried* archaeological resources as they developed prior to human migration into North America (ca. 13,500 B.P.). However, Pleistocene surfaces buried below younger Holocene deposits do have a potential for containing archaeological deposits. As suggested above, Holocene alluvial deposits may contain paleosols that represent periods of landform stability prior to renewed deposition. The identification of buried soils within Holocene-age landforms is of particular interest because they represent formerly stable surfaces that have a potential for preserving archaeological deposits.

## 2.3 Project Area Geomorphology

Several data sources are useful in addressing the geoarchaeological potential of the CPP Project area. Existing geologic, soils, and geomorphic maps and related studies within the region provide a context for understanding the geoarchaeology of the Project vicinity. Given the heavy urban development of the Santa Ana River Basin, a focus on historic documents and studies of less developed portions of the SAR give indications as to the natural geomorphology of the Basin prior to significant human modification. Historic maps were

georeferenced in a Geographic Information System (GIS) to allow easy comparison and layering with other Project related data.

Although the modern SAR flows through a single channel, this is not the river's natural morphology. In the lower Santa Ana River Basin, the river has been channelized within constructed concrete and rip-rap levees to mitigate flooding of the river's natural floodplain, which has transitioned from agriculture to highly urbanized development over the past century. The rivers natural tendency is to a braided system, with multiple shifting channels and bars across a wide belt.

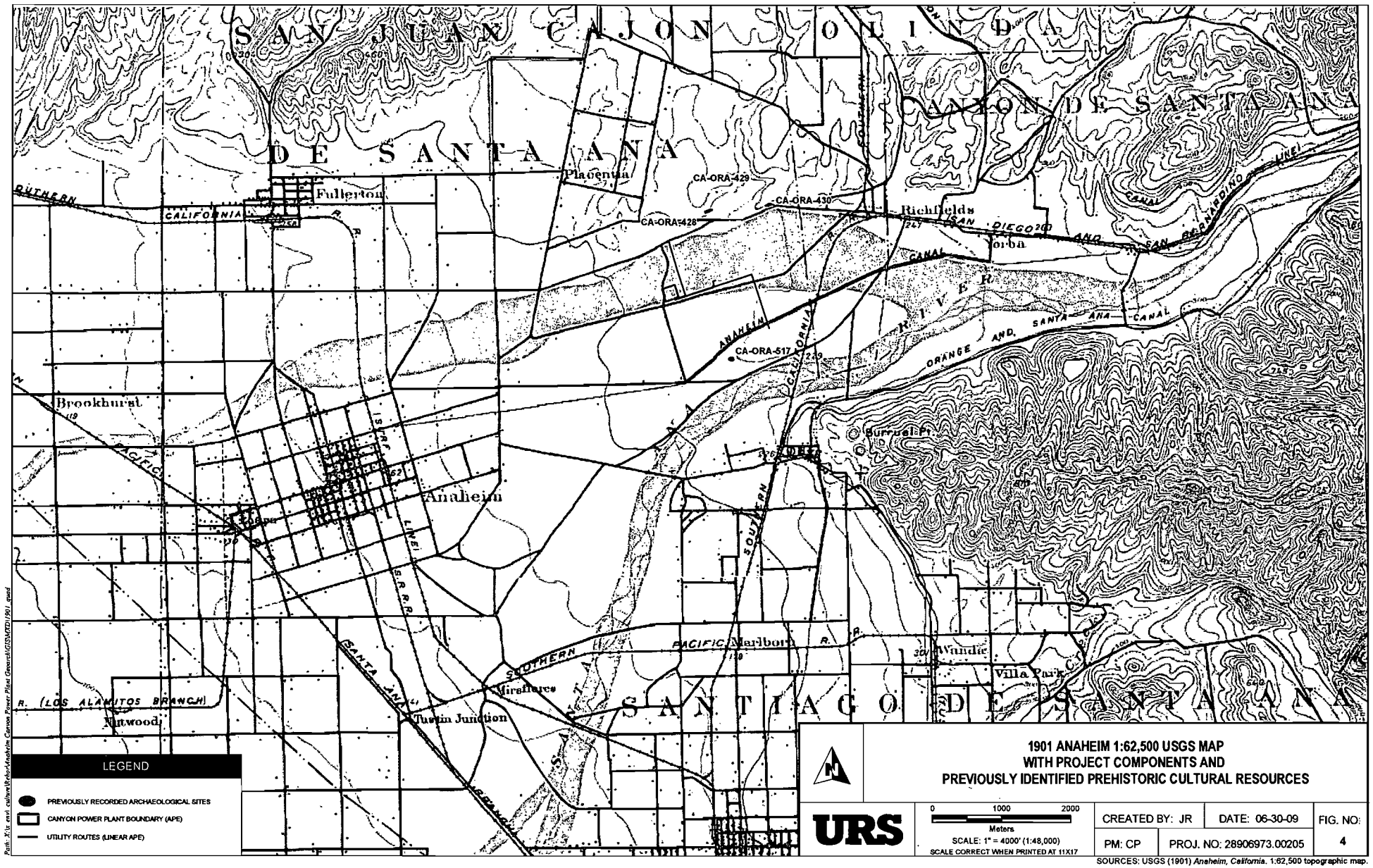
The SAR's natural morphology is evident upstream, in the Riverside region (Haner 1983). Here, in the upper Santa Ana River Basin, some reaches of the braided river belt extend up to 1 km wide. Figure 4 shows the Project vicinity as it was mapped in 1901. As the river exited the mouth of the Santa Ana Canyon, and entered the shallow sandy gradient of the Basin, it transitioned from a single large channel to a braided channel network consisting of a wide channel belt with multiple channels and bars. This same morphology can be seen in historic photos of the SAR in the Anaheim region.

Also apparent in the 1901 map (Figure 4) is a much larger abandoned or intermittent belt, north of the active belt. The CPP project area is almost completely within this mapped channel. It is unclear from the map whether this is a paleo-channel that was abandoned by 1901, or whether it is a channel that is only activated during higher flow periods. Regardless, the figure suggests that the Project area is within a dynamic high-energy braided channel reach of the Santa Ana River. Accordingly, there may be a reduced preservation potential of archaeological sites, at least near-surface, within this abandoned/intermittent channel belt.

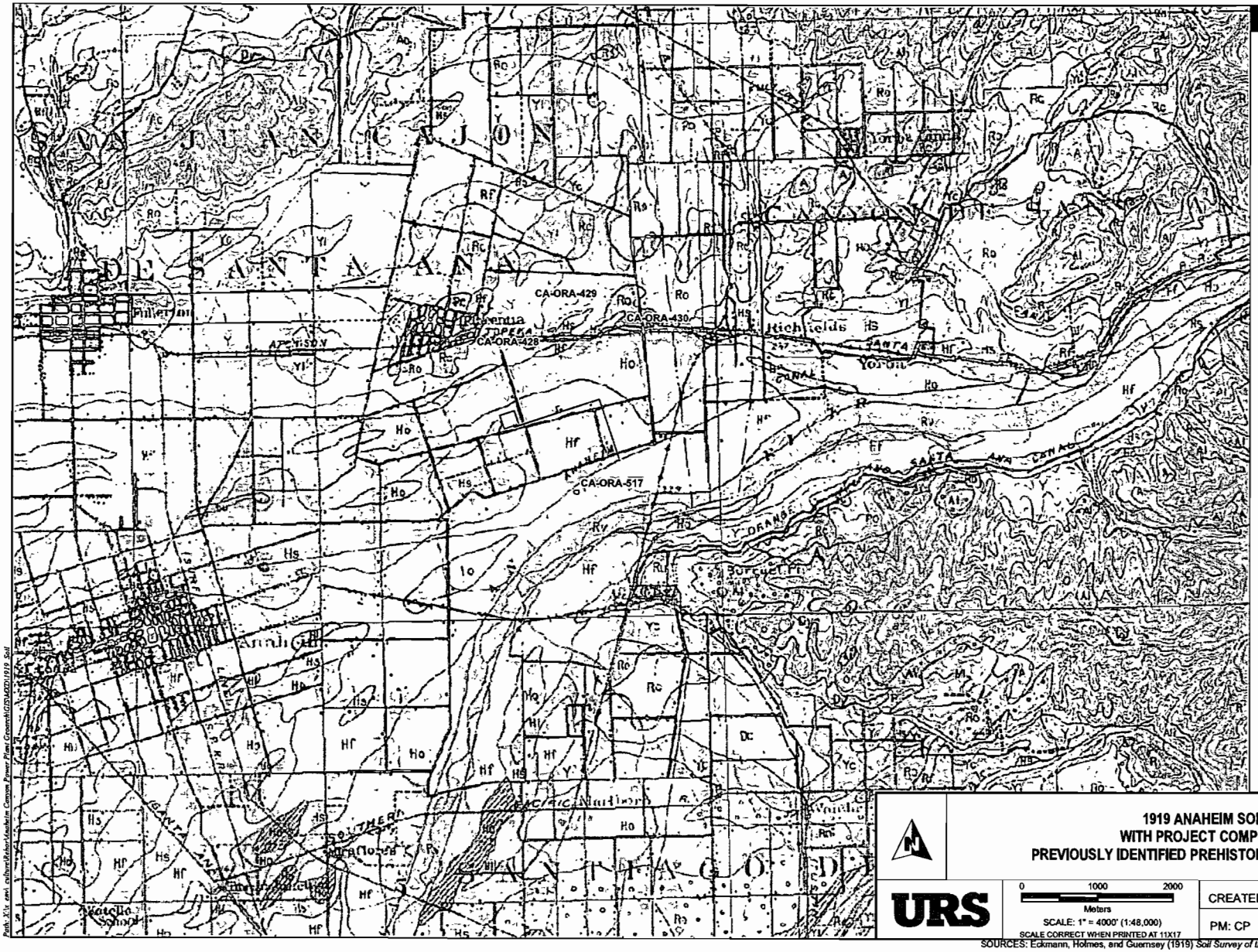
Existing soil mapping is also useful in differentiating geomorphic features within a project vicinity, classifying soil characteristics and age, and beginning to address the potential for archaeological site burial. Often, older soil studies are more instructive because the researchers tended to focus on larger landscape processes and geomorphic features, rather than minute differentiation in soil characteristics, and did so prior to large-scale modern human landscape modifications.

Figure 5 depicts the soils of the Project vicinity as mapped in 1919. The Project APE is mapped as Hanford series soils, ranging from sand to fine sandy loam (Eckmann *et al.* 1919). Hanford series soils are very young, consisting of a single A horizon with weak granular structure and root pores, gradual transitioning to multiple friable unconsolidated C horizons:

> Organic matter is less than 1 percent and decreases regularly with increasing depth. Below a depth of 40 inches some pedons have marked stratification... The Hanford soils are on stream bottoms, floodplains, and alluvial fans... in deep, moderately coarse textured alluvium dominantly from granite and other quartz bearing rocks of similar texture. (Soil Survey Staff 2009a).




SOURCES: USGS (1901) *Anaheim, California.* 1:62,500 topographic map.




LEGEND

SOIL SERIES

- AO, ALTAMONT CLAY ADOBE
- A, ALTAMONT CLAY LOAM
- AL, ALTAMONT LOAM
- AL, ALTAMONT LOAM GRAVELLY PHASE
- DY, DIABLO CLAY ADOBE
- DC, DUBLIN CLAY ADOBE
- HL, HANFORD LOAM
- HF, HANFORD FINE SANDY LOAM
- HO, HANFORD SAND
- HS, HANFORD SANDY LOAM
- M, MONTEZUMA CLAY ABODE
- MC, MONTEZUMA CLAY LOAM ABODE
- RC, RAMONA CLAY LOAM
- RF, RAMONA FINE SANDY LOAM
- RO, RAMONA LOAM
- RO, RAMONA LOAM, REDDISH-BROWN PHASE
- RS, RAMONA SANDY LOAM
- RV, RIVERWASH
- R, ROUGH BROKEN AND STONY LAND
- YC, YOLO CLAY LOAM
- YL, YOLO FINE SANDY LOAM
- Y, YOLO LOAM

OTHER FEATURES

- PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES
- CANYON POWER PLANT BOUNDARY (APE)
- 69 kV LINES (LINEAR APE)
- NATURAL GAS (LINEAR APE)
- RECLAIM WATER (LINEAR APE)

**1919 ANAHEIM SOIL SURVEY**
**WITH PROJECT COMPONENTS AND**
**PREVIOUSLY IDENTIFIED PREHISTORIC CULTURAL RESOURCES**

URS

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Meters
SCALE: 1" = 4000' (1:48,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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SOURCES: Eckmann, Holmes, and Guernsey (1919) *Soil Survey of the Anaheim Area, California*. U.S. Department of Agriculture.

Path: X:\v_env_culture\Rehor\Anaheim Canyon Power Plant Groarch\GIS\MXD\1919_Soil

As discussed in *Section 3* of this report, the typical Hanford series soil profile is consistent with the weak surface profile observed during the geoarchaeological field investigations. More recent soil surveys of the region have reclassified the project area as Metz series soils, which have a similar profile of a very weak A horizon overlying multiple non-pedogenic sandy C horizons to at least 118 inches (approximately 3 meters) below surface.

The 1919 soil survey also indicates that there is a coarsening of sediments, from fine sandy loam to sand, to the north of the Project area. Interpolated with the 1901 topographic map, which shows a possible channel belt in the Project area, this suggests that the more active portion of the braided channel system was along the northern portion of the belt (Figures 4 and 5). As we will see, this is also consistent with findings during the subsurface geoarchaeological investigations.

## 2.4 Geoarchaeological Context

Like much of California, early and early-midleHolocene archaeological sites are not well represented in the Los Angeles Basin. This is likely more a reflection of the landscape evolutionary processes described above– having buried and obscured sites from traditional archaeological studies that tend to focus on sites with surface components– rather than an accurate reflection of prehistoric human occupation (Rosenthal et al. 2003). When present, these older sites tend to be located on preserved older Pleistocene landforms. Several buried prehistoric sites have been documented in the southern Los Angeles Basin and Newport vicinity. However, the majority of these sites are located on older (late Pleistocene or older) stable landforms and consist of basal components of stratified archaeological sites (i.e., buried beneath other culturally accumulated deposits, rather than alluvial sediments).

Padon's (1998) review of archaeological sites along the Santa Ana River identified six important prehistoric habitation sites near the southern terminus of the river in the Huntington Beach area. Padon's report incorrectly reported these sites as on the east and west "bluff[s] of the Santa Ana River" (Padon 1998:13-14). While the sites are located on high ground adjacent to the floodplain of the Santa Ana River, it is incorrect to correlate the geomorphic formations with the Santa Ana River. The geomorphic formations that these prehistoric habitation sites are situated on are not alluvial terraces related to the Santa Ana River. Instead, these sites are deposited on very old (Middle Pleistocene or later) paralic beach, estuarine and colluvial deposits resting on uplifted wave-cut terraces, functionally unrelated to the Santa Ana River (Morton and Miller 2006). Padon's review identified one additional archaeological resource, an isolated burial, nearby the six habitation sites but within the actual floodplain/braided channel belt of the Santa Ana River. This isolated burial was discovered during excavations for a swimming pool, and was recorded as a female in a flexed position with no associated artifacts or cultural materials. Given proximity to the six large habitation sites (many of which are known to contain burials) and the presumed population density within the Newport Bay/Pacific Ocean interface during multiple periods of prehistory, such a burial is not surprising.

Padon also reported three prehistoric food processing sites (ORA-428, -429, and -430) less than 1 km (0.6 mile) northwest of the Project area. As shown on Figure 2, all three of these sites are situated off of the recent Holocene floodplain/fan deposits, on remnant Pleistocene landforms unaffected by recent alluvial activity. Consistent with the quaternary mapping of the area, the three prehistoric food processing sites are on much older stable soils (Figure 5). Ramona series soils consist of a well-developed A horizon overlying a very thick and over-developed series of multiple argillic B horizons to over 5.5 feet below surface (Soil Survey Staff 2009b). These soils are formed on old Pleistocene terraces and fans, and suggest a very old and stable landsurface compared to the adjacent recent Holocene alluvial deposits.

The only previously recorded archaeological site near the CPP Project vicinity and within the Holocene floodplain is CA-ORA-517. The archaeological deposit consisted of a single human burial unearthed in 1976 during backhoe trenching operations, several hundred meters north of the current Santa Ana River channel. The site was recorded as the remains of "one completely disturbed individual... [with] no artifactual material found in any of the back dirt or within the trench walls... [and] no evidence of cultural burial" (Tadlock 1976). Unfortunately, little other evidence is recorded on the brief site record, other than that the discovery was made at 5 to 6 feet below surface in "washed river-bed sand." It is not clear whether a complete skeleton or only portions were recovered, or whether the bones were articulated or disassociated. Given that there was no evidence of a pit feature, the association with river-bed sand (implying a higher energy environment than finer silty overbank deposits), and proximity to the modern SAR channel, it is very likely that the individual was only a disarticulated collection of bones, perhaps from a previous cultural burial that was disturbed and/or redeposited by the SAR or, more likely, that the individual "burial" was the result of accidental death (e.g., drowning during a flood stage of the SAR).

No archaeological resources were reported during the extensive excavations for the numerous groundwater recharge basins adjacent to the Project area (shown in pink on Figure 2). These basins were excavated in sediments equivalent to the Project area, to depths of between 50 and 160 feet. The closest excavation, the Kraemer Basin, was excavated during the early 1980's, by which time cultural resources regulations and standards for reporting archaeological discoveries had already been implemented.

Whether the predominance of archaeological deposits on Pleistocene landforms is the result of conscious cultural decisions (i.e., placement of sites on higher, more stable ground with a better viewshed and less prone to flooding or inundation) or differential preservation (i.e., removal of cultural deposits during successive channel meanders) it is clear that, within the Santa Ana River Basin, previously recorded prehistoric archaeological sites tend to be concentrated outside of the active floodplain.

Post-depositional processes within the SAR floodplain are variable and "because of the meandering nature of the historic Santa Ana River... the subsurface structure of deposited material can vary substantially within relatively short distances" (City of Placentia

2008:3.11-4). Preservation potential for any locale is dependent on the landscape history within that specific locale. Within the floodplain, preservation is largely dependent on proximity to paleo-river channels and the relative energy associated with erosional and depositional events.

# 3 Geoarchaeological Investigations

Given the possibility for buried archaeological resources within the CPP Project area, a geoarchaeological sensitivity study was developed. Previous geotechnical borings within the Project area identified a surface fill material underlain by deep, mostly unconsolidated, sands, gravels, and silts, to a depth of 50 feet (MACTEC 2007). The foci of geotechnical investigations are typically very broad, classifying deposits in very general terms, with little concern for identifying soil development, horizons, or interpretation of the geomorphic evolution of a site. The results of such investigations are usually of limited use in assessing a sites geoarchaeological potential. As such, a geoarchaeological trenching study was designed to assess the potential for archaeological deposits within the Project area and, more generally, identify paleosols, and assess the landscape evolution of the area.

The characteristics of a trench profile can indicate the age of the land surface if certain conditions are met. A soil profile may be moderately developed or well developed, as indicated by the presence of a clay-enriched zone (B horizon) in which clay, iron oxides, and other products of weathering have been concentrated over a long period of time. Or, the profile may be poorly developed, as is the case chiefly on the surface of flood plains, natural levees, and channels of modern rivers and on young alluvial fans. Jenny (1941, 1961) has shown that, as a profile develops, the profile's characteristics are functions of the type of parent material, the climate, the vegetation, the topographic position in the landscape, and the age.

Generally, the more well developed the weathering (soil) profile is, the longer that sediments were exposed on the surface and the more time there was for human activity to occur on that surface and accumulate an archaeological deposit. The nature of subsequent deposition and/or erosion dictates the preservation potential of that surface. A well developed surface that is then covered by low-energy fine grain deposition is more likely to preserve an archaeological deposit than one that is subject to erosion and high-energy coarse-grain deposition.

Well developed surface profiles within the Los Angeles Basin generally occur on alluvial fans or river flood plains or on shallow marine sedimentary deposits that have been tectonically uplifted or folded and no longer receive sediment from the present drainage network. Poorly developed profiles generally occur along the channels, levees, and flood basins of current streams graded to modern sea level.

## 3.1 Methods

Between June 8 and June 10, 2009, a subsurface geoarchaeological trenching program was conducted at the proposed CPP Project site. As specified in the work plan, dated June 4, 2009, the program was designed to assess the potential for buried archaeological resources within the Project's APE. The investigation was focused on the main "Power Block" area of the proposed Project, as this is where the most extensive ground disturbance will occur and,

thus, where there is the most potential for disturbing buried archaeological resources. In combination with background research and existing data, the results from this area can be extrapolated to assess the geoarchaeological potential of the entire Project area.

The work plan specified that a maximum of 50 linear meters (165 feet) of trench would be excavated across the proposed Power Block area, to a maximum depth of 3.8 meters (12.5 feet) below surface. At least 33.3% of the linear total was to be "formal" trenches, with the remaining length to be divided among numerous small "pot-holes" (smaller trenches not intended for human entry, approximately 10 feet long), in order to gain the maximum coverage and subsurface exposure across the Power Block area. The intention was to shore the formal trenches, using aluminum hydraulic speed shoring, to allow the geoarchaeologist and archaeologists to enter the trenches, clean profiles, and accurately document the subsurface stratigraphy. A John Deere 410G backhoe, fitted with a 36 inch bucket, was used for all excavations.

Upon opening the first trench (T1), it quickly became apparent that shoring would not be feasible. The subsurface profile was comprised almost entirely of unconsolidated granitic sands, with little or no fine-grain cohesive matrix. Within the first meter (~3 feet) of excavation, sidewalls began sloughing into the trench and continued doing so to depth. One option, initially considered, was to slope the trench (benching would have been ineffective given the unconsolidated nature of the sediments). However, the process of adequately sloping the sands would have obscured any stratigraphy and, even still, the slopes would have been unstable. The only safe way to enter such a trench, comprised entirely of sediments weaker even than Type C "soils" (used here as a determination of cohesive strength, following OSHA guidelines, but not implying pedogenic development), would have been to emplace a trench box within the excavation. Of course, this would have obscured the sidewalls and defeated the purpose of the geoarchaeological study. It was determined that the best method for evaluation of the CPP's subsurface stratigraphy was to continue excavation, allowing the sidewalls to slough and find a natural angle of repose, and to conduct all observations from stable ground surface (concrete). A large garden hoe, fitted with a handle extension, was used to clean portions of the profiles and collect samples for classification and analysis.

A total of three trenches and six potholes were excavated in this manner across the proposed Power Block area. Each trench was approximately 10 meters (33 feet) in length, while each pot-hole was approximately 3 meters (10 feet) in length. In reality, all excavations expanded greatly in width due to sloughing (i.e., pot-holes tended to be more round than rectangular). In total, it is estimated that more than 300 $m^3$ (10,000 $ft^3$) of material was excavated.

During excavation, the trench and spoils were monitored for archaeological materials by the Project Geoarchaeologist and two additional archaeologists. All spoils were actively sorted through as they were excavated, using shovels and rakes. As new material was excavated from the base of the trench (after removal of any sloughed material) a portion

was set to the side by the operator, separate from the larger spoils pile, and screened through ¼-inch hardware mesh. No archaeological, paleobotanical, or other cultural materials were encountered during the CPP geoarchaeological investigations.

A total of six bulk sediment samples were sent to Beta Analytic, Inc., for radiocarbon dating. A priority was set on four of these samples for complete AMS analysis, with two alternates pre-processed in case any of the samples failed to produce adequate amounts of organic material (given the low expectation for organic humic accumulation within the unconsolidated channel sands). All four of the primary samples produced viable results, and are discussed below.

Stratigraphic units were identified based on physical characteristics such as composition, color, superposition, textural transitions, and pedogenic properties (i.e., relative soil development).

Typically, master soil horizons are defined using standard United States Department of Agriculture soil taxonomy (Soil Survey Staff 2006). This organizational system uses upper-case letters (A, E, B, C) to describe in-place weathering horizons. Most horizons and layers are given a single capital letter symbol where:

"A" is the organic-rich upper horizon developed at or near the original ground surface;

"B" is the horizon formed in the middle of a profile, with concentrations of illuviated clays, iron, etc., and general changes in soil structure;

and "C" is the relatively unweathered parent material which the other soil horizons formed upon.

Lower-case letters are used to designate subordinate soil horizons (Table 2). Combinations of these numbers and letters indicate the important characteristics of each major stratum and soil horizon, from which inferences can be drawn.

**Table 2. Subordinate Distinctions within Master Soil Horizons**

| Subordinate Horizon | Description |
|---|---|
| b | Buried genetic horizon (i.e., buried in-place; not used with C-horizon) |
| p | Disturbed or artificial fill (including plow-zone) |
| t | Accumulation of subsurface silicate clay (illuviation) |
| ox | Oxidized iron and other minerals in parent material (C-horizon) |
| u | Unweathered parent material. |

However, given that only a weak surface profile was observed, with no buried pedogenic horizons, typical master horizon conventions were abandoned for the majority of subsurface deposits. Lithostratigraphic units, described below, are assumed to be Cu horizons (unweathered parent material) unless otherwise noted.

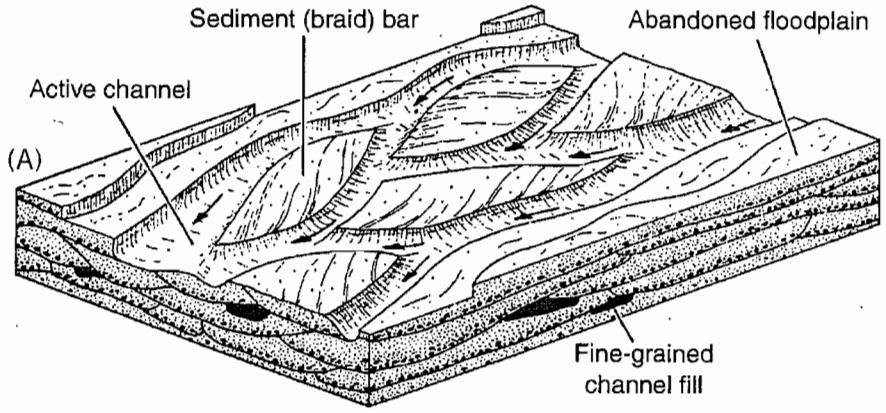
## 3.2 Results and Discussion

This section presents the results of geoarchaeological trenching within the Project area, including the age, nature, and extent of the subsurface strata identified, as well as the archaeological potential of each unit.

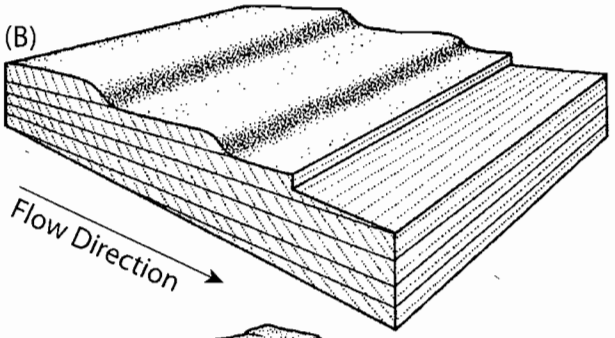
Some general trends in depositional environment and landfrom development were consistent across the entire study area. Below the upper disturbed weathering profile– directly overlain by the surface concrete and subject to historic grading and disturbance– no significant subsurface pedogenic development was identified. The upper pedogenic unit consisted of a single simple weak ABp-horizon and C-horizon profile, to approximately 1 meter below surface. Numerous lithostratigraphic units were identified below this upper weathering profile, all consisting of various forms of river channel and levee deposits, with no pedogenic development within or across the depositional units. These unconsolidated sandy alluvial sediments suggest a very low geoarchaeological potential for the proposed Project area. None of the identified lithostratigraphic units was continuous between trenches, which would be expected of an active dynamic braided channel belt. The absence of subsurface pedogenic development also indicates a dynamic environment, with no surfaces exposed for an appreciable amount of time and/or exposed surfaces eroded during subsequent channel meander events.

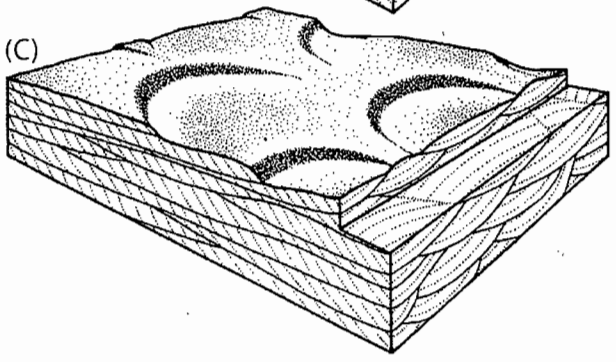
Figure 6 provides a graphical summary of the landforms and associated bedforms, typical of the deposits observed during the geoarchaeological field investigations. Table 3 provides descriptive correlates of these landforms, and typical associated deposit morphology (i.e., grain size, sorting, etc.).

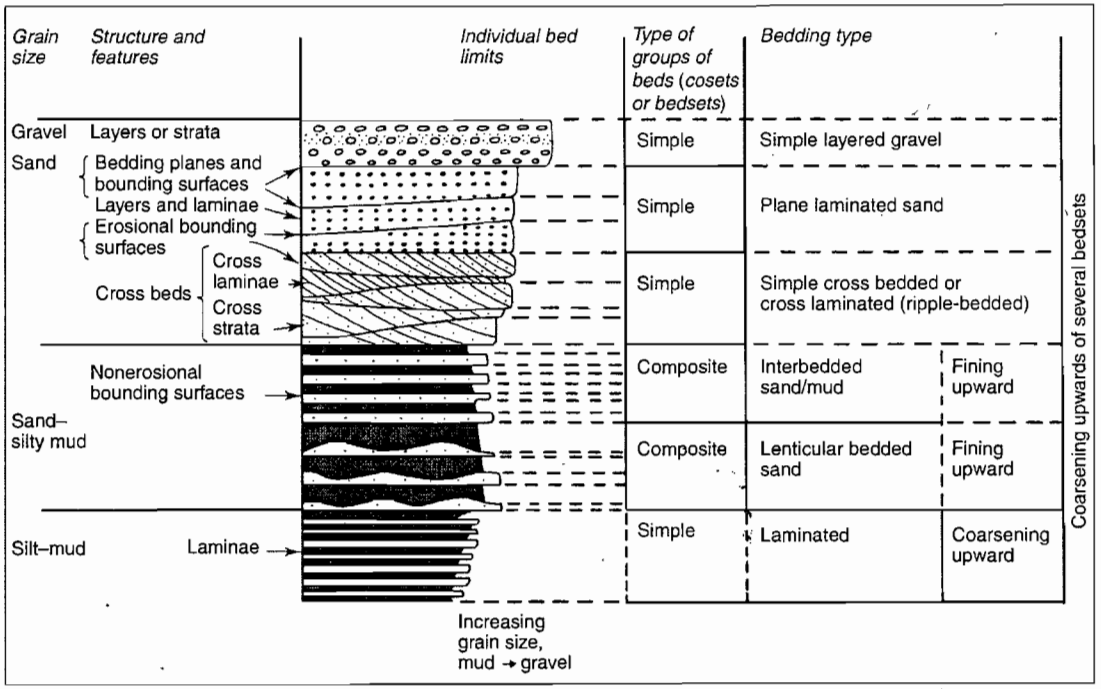
Trench 3 was selected as the type profile to be discussed in-depth because it provided the largest intact exposure and easily identifiable cross-cutting relationships between lithostratigraphic units. The absence of buried pedogenic units or stable, laterally continuous, low-energy depositional units with non-erosional contacts– conducive to human occupation and preservation of archaeological material– makes in-depth discussion of each trench/pothole both repetitive and fruitless in terms of the archaeological potential of the Project area. Summary field logs for each trench/pot-hole are provided in Appendix B.




Block diagrams showing: (A) general surface morphology of a braided stream with active channels and bars, as well as deposition of lenticular sediment bedforms at depth; the preservation potential of intact sites within such deposits is low; (B) close-up of tabular cross-bedding produced by the migration of ripples with straight crests; (C) close-up of troughs or lenticulr cross-bedding produced by the migration of sinuous ripples. The table below illustrates the conditions and grain sizes that create the various sedimentary structures.




NOT TO SCALE

## BRAIDED CHANNEL DEPOSITIONAL BEDFORMS

URS

SOURCES: Goldberg and Mcphail (2006) *Practical and Theoretical Geoarchaeology*, Figures 1.8 and 5.5; Collinson and Thompson(1989) *Sedimentary Structures*, Figure 2.2.

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| Facies type | Sedimentary structure/Texture | Depositional process/Interpretation of surface morphology | Two-dimensional shape (perpendicular to palaeoflow) | Comparison with architectural elements of Miall (1985) |
|---|---|---|---|---|
| Coarse-grained primary channel fills | Broad erosive bases with internally massive to weakly defined high/low-angle cross-bedding | Medium to coarse-grained, broad based, first-order channels that are filled by the deposits of bar forms and sediment lobe migration | Tabular | Gravel bars and bedforms, GB and lateral accretion, LA |
| Coarse-grained secondary channel fills | Arcuate convex, lower surface forming a ribbon-shaped deposit with fills containing massive or high/low angle cross-bedding. These fills may have a very coarse basal lag deposit | Result from the infilling of secondary channels, often as sheet splays flow into the channels from adjacent major channels. Plugging can also occur as lobes stall, causing a choking avulsion (Leddy *et al.*, 1993). Convex-up ribbon-form channel fill deposits of coarse sand have a limited matrix. Channels may be filled by massive sediments or lateral accretion deposits | Arcuate | Channels, CH or scour hollows, HO |
| Medium-grained splay deposits | Medium-grained overbank splay deposits. Low-angle or horizontal parallel bedding often showing small, stacked, fining-up sequences | Result from overbank splays from the channel margin or chute lobes that form on bar margins. Medium-grained, thin, laterally extensive splays often stacked to form a tabular unit | Tabular-rhomboidal | Laminated sands, LS and parallel bedded gravels of GB |
| Fine-grained channel fills | Arcuate channel form. In the field, channel fills contain horizontal laminae or cross-bedding; pebbles may be aligned along cross-bedding | Formed in slackwater environments where minor channels are plugged at the upstream end and suspension fallout passively infills the channel form. Fine-grained deposits often only form in the initial stages of abandonment | Arcuate | Channels, CH |
| Erosional remnants | Irregular-shaped fine-grained deposits. Field deposits are horizontally laminated or cross-bedded | Result from the erosion of fine-grained channel fills and floodplain fine facies | Random – irregular | Not represented in classification scheme |
| Floodplain fines | Thin, fine-grained laminated deposits | Deposition is the result of suspension fallout of fines in slackwater overbank environments, where deposits fill the existing floodplain topography | Tabular | Laminated sand sheet, LS or overbank fines, FF |

**Table 3. Sedimentary Features of Braided River Systems**

(from Morton, Ashworth, and Best 2002, Table 3)

### 3.2.1 Trench 3 Summary

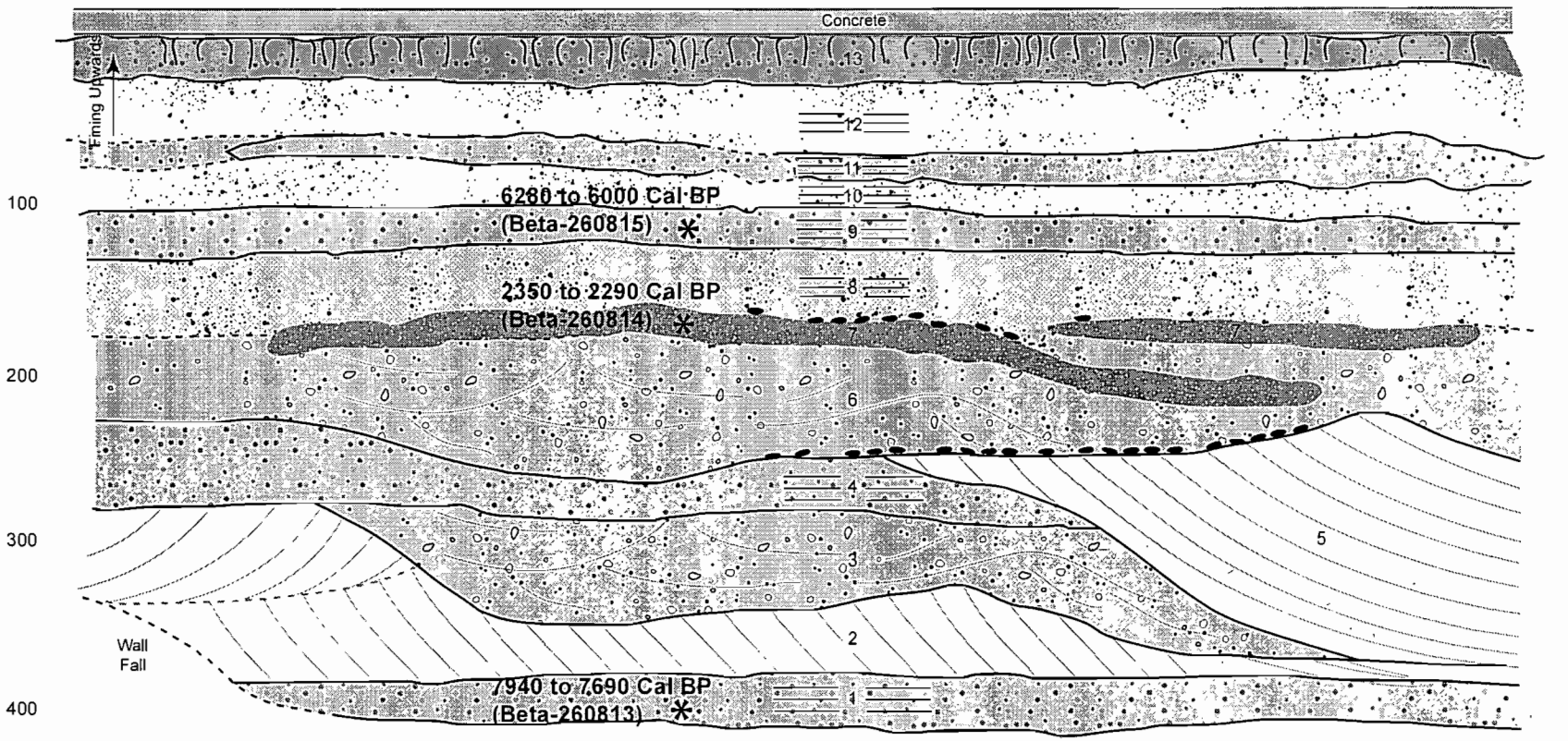
Trench 3 (T3) was oriented approximately east-west within the Power Block area (Figure 1) and was the last excavation of the CPP geoarchaeological field study[3]. Based on experience with the preceding trenches, a larger area was opened up in the surface concrete to allow sloughing of the unconsolidated sands without undercutting the surface concrete. This resulted in a larger exposure and more stable ground from which to examine lateral variance in the subsurface stratigraphy. Given this, some deposits that may have been grouped as a single unit in other trenches were expanded into multiple units with depositional/erosional and temporal relationships. While these relationships do not have functional implications for the archaeological sensitivity of the Project area, the additional subdivision of units does further highlight the very dynamic nature of the subsurface deposits. A graphical summary of the lithostratigraphic units described below is provided in Figures 7 and 8. Depth measurements are from the actual ground surface, below the overlying concrete.

*Unit 1* (440 to 400 cm) consists of horizontally bedded, weakly consolidated, clean fine sand with some medium and very fine sands. Grains are largely subangular to subrounded. The unit is slightly moist, due to the finer grain size, with a single grain structure and no pedogenic indicators (i.e., no clay films, no structure, nonreactive with HCl, no rubification or apparent organic accumulation, etc.). Color is mottled based on individual grain variability but is generally a light brownish gray (10YR 6/2). The unit is the deepest encountered and was not observed at the base of any of the other excavations. The unit is interpreted as a near-channel levee, splay, or overbank deposit. A bulk sample from this unit returned a calibrated date of 7940 to 7690 cal B.P. (Beta-260813).

*Unit 2* (365–400 cm) consists of poorly sorted very fine to coarse clean sands, unconsolidated, with thin cross-bedding dipping at a 40° angle to the west in the lower portion of the unit and 35° to the east in the upper portion of the unit. Grains are largely subangular to subrounded. A few gravel laminae are present at the contact between cross-beds (foresets). The unit is dry, with a single grain structure, no pedogenic indicators, and a mottled color based on individual grain variability but with a generally light grey color (10 YR 7/2). The unit is interpreted as active channel fluvial dune/bar deposits, with the abrupt change in foreset dip representing a shift in the direction of flow of the braided channel (and/or intrusion by another channel). Unit 2 has a distinct erosional contact with the underlying unit (1).

*Unit 3* (305–365 cm) consists of unsorted, uncosolidated gravels and clean sands, with few very coarse gravels (>4 cm diameter). Bedding within the unit is indistinct, but appears to consist of numerous lenticular cross-beds formed by sinuous ripples within the channel (Figure 6c). Grains are largely subangular to subrounded. The unit is dry, with a single grain structure, no pedogenic indicators, and a mottled color based on individual grain

[3] As shown in Figure 1, the proposed CPP Project area is oriented approximately 18° west of true north. For the sake of brevity and ease this "project specific north" is referred to as north during the course of this discussion, with other cardinal directions accordingly adjusted (i.e., minus 18°).




INTERPRETATIONS

1 = Horizontal overbank deposits
2 = Fluvial dune
3 = Active channel/side channel filled w/poorly sorted flood (?) deposits
4 = Overbank deposits
5 = Dune emplaced is scoured channel
6 = Active channel
7 = Silt w/some organics (organic mat infilling local low?)
8 = Near channel bar
9 = Overbank
10 = Near channel bar
11 = Overbank

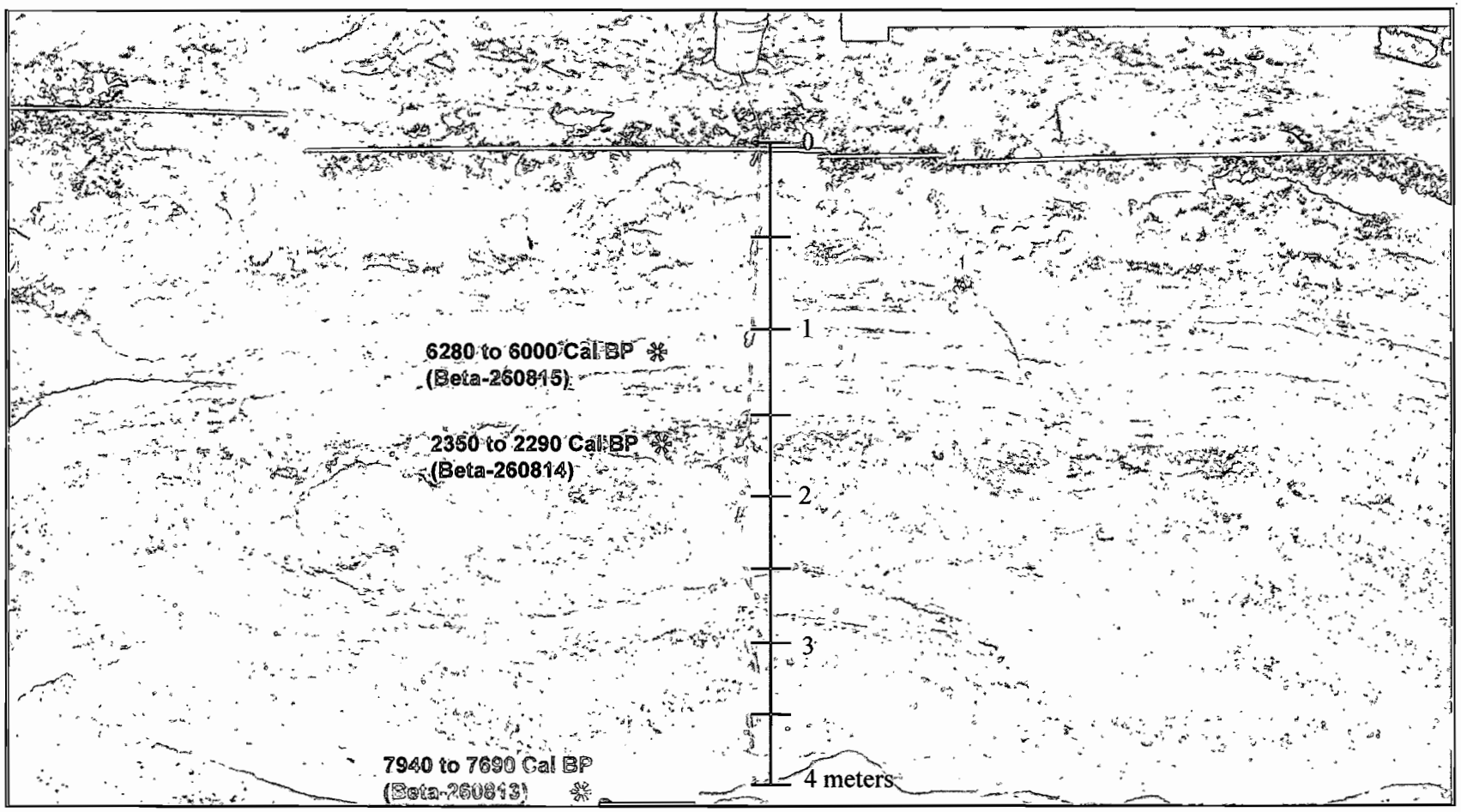
* ═══#═══ indicates horizontal bedding/laminae

# TRENCH 3 SOUTH WALL PROFILE
# CANYON POWER PLANT, ANAHEIM

URS

50 0 50 100 cm
SCALE: 1" = 100 cm
SCALE CORRECT WHEN PRINTED AT 8.5X11

| CREATED BY: JR | DATE: 00-00-09 | FIG. NO: 7 |
|---|---|---|
| PM: CP | PROJ. NO: 28906973.02005 | |




TRENCH 3 SOUTH WALL PHOTO
CANYON POWER PLANT, ANAHEIM

URS

| CREATED BY: JR | DATE: 06-22-09 | FIG. NO: 8 |
|---|---|---|
| PM: CP | PROJ. NO: 28906973.002005 | |

variability but with a generally light grey color (10 YR 7/2). Unit 3 is incised (i.e., erosional contact) into the underlying bar/fluvial dune unit (2) and is representative of an infilled high-energy active channel. Flow direction of the this portion of the channel was likely oriented generally north-south.

*Unit 4* (280–305 cm) consists of horizontally bedded, weakly consolidated, moderately sorted clean fine sand with some medium and very fine sands. The unit is almost identical to Unit 1, but with slightly coarser grain size (larger medium sands and more coarse sands). Functional interpretation is similar to Unit 1 but indicates a higher energy environment–i.e., near channel levee deposits or possibly tabular beds with indistinct cross-bedding, formed by a lower energy channel with straight ripples (Figure 6b). The unit has a distinct erosional contact with both Unit 3 and 2.

*Unit 5* (225–375 cm) is a large cross-bedded unit deposited in an erosional unconformity incised into Units 2, 3, and 4. The unit is dominant within the western portion of T3 and pinches out to the east. Unit 5 consists of moderately well-sorted medium and fine sands with a single grain structure, no pedogenic indicators, and a mottled color based on individual grain variability but with a generally light grey color (10 YR 7/2). The unit is structurally similar to Unit 2, but with coarser grain size, indicating a higher energy environment, and more shallowly dipping bedding (20° to the west). The unit likely represents a large fluvial dune/mid-channel bar, infilling an incised channel.

*Unit 6* (195–280 cm) consists of poorly sorted, uncosolidated coarse and medium sands, with few gravels. Bedding within the unit is indistinct, but appears to consist of numerous lenticular cross-beds, similar to Unit 3. Other characteristics are similar to Unit 3, but with a smaller overall grain size, indicating a lower energy depositional environment. A discontinuous gravel lag deposit is present at the base of the unit, consistent with an erosional contact with underlying Units 4 and 5. Functional interpretation of Unit 6 is indeterminate, but may represent an active channel deposit similar to Unit 3, perhaps interspersed or interbedded with small discontinuous mid-channel bars.

*Unit 7* (180–195 cm) is an unusual deposit within the stratigraphic column. It consists of a slightly plastic silty clay loam with few gravels, and a massive structure, which form discontinuous beds across and interfingered with the underlying Unit 6 sediments. Clays do not appear to be pedogenic (i.e., no films, etc.) and are well incorporated into the silty matrix. The darker color of the deposit (dark grayish brown; 10YR 4/2) indicates that the unit may have a higher organic content than other sediments within the column. Other pedogenic indicators are lacking. This unit is interpreted as the infilling of small depressions between near/mid-channel bars and dunes during receding water flows, creating moist protected pockets conducive to algal mat growth and perhaps other limited vegetation (see *Discussion* below). Similar discontinuous structures were observed in other excavations throughout the Project area. A bulk sample from Unit 7 returned a calibrated date between 2350 and 2150 cal B.P. (Beta-260814). Another bulk sample, from an equivalent unit at 190 cm in Trench 2, returned a calibrated date between 2920 and 2760

cal B.P. (Beta-260812); suggesting that conditions conducive to the development of these more clay and organic rich lenses may have persisted in the Power Block area for several hundred years.

Above Unit 7 a marked change in sedimentation is observed, with all overlying units being deposited more or less horizontally and an absence of distinct cross-bedded fluvial bedforms. The structural homogeneity of the upper units indicates a change in depositional regime within the CPP Project area some time after approximately 2000 B.P. These changes are discussed further below.

*Unit 8* (125–180 cm) consists of horizontally bedded, unconsolidated, fine to coarse sand with few gravels. Grains are subangular to subrounded. The unit is dry, with a single grain structure, no pedogenic indicators, and a mottled color based on individual grain variability but with a generally light grey color (10 YR 7/2). Internally, the unit consists of thin (1 to 5 cm thick) alternating beds of fine and coarse sands. Unit 8 likely represents the periodic accretion of a coarse-grained near-channel levee deposit and/or low flow channel deposits during a period of fluctuating water volume within the Santa Ana River. The lower contact with Units 7 and 6 consists of a discontinuous gravel lag deposit, indicating an erosional surface.

*Unit 9* (105–125 cm) consists of horizontally bedded, weakly consolidated, very well sorted clean fine sand. The unit is slightly moist, due to the finer grain size, with a single grain structure and no pedogenic indicators. Color is mottled based on individual grain variability but is generally a light brownish gray (10YR 6/2). The unit is very similar to the basal unit (1), and likely was formed by near-channel overbank, splay, or axial channel in-fill deposits (Table 3). A stratigraphically unconformable calibrated date of 6280 to 6000 cal B.P. was returned from a bulk sample of this unit. The apparent antiquity of the Unit 9 sediments is likely the result of reworking and redeposition of older organics within the fluvial sediments. Given the very low organic content of the CPP Project area sediments, even a small amount of redeposited material can greatly influence the overall bulk result.

*Unit 10* (90–105 cm) consists of unconsolidated, poorly sorted, fine to coarse clean sands with few gravels. The unit is very similar to Unit 8, with slightly coarser overall grain size. Although bedding is horizontal, this unit was likely formed in a smaller low-flow auxiliary channel during a period of fluctuating water volume.

*Unit 11* (70–90 cm) consists of unconsolidated, moderately sorted fine and medium clean sands. The unit is similar to Unit 9 with very thin horizontal bedding. The unit was likely formed as a near-channel levee deposit.

*Unit 12* (40–70 cm) is a medium to coarse sand deposit that is the basal portion of a fining upwards sequence which ends at the surface, and within which the only pedogenic sequence is formed. This portion of the sequence (Cu) is representative of the basal higher-energy levee or splay deposit, fining upwards to the fine sands at the surface, indicative of reduced flow capacity during a single flood event.

*Unit 13* actually consists of two pedogenic horizons: a C $_{(ox?)}$ horizon (15–40 cm) of fine sand that may be slightly oxidized (has a one value color change from underlying unweathered sands) and has only trace amounts of illuviated fines (due to the large pore spaces between the clean sand clasts of the parent material); and an ABp horizon (0–15 cm). The geotechnical study for the AFC classified this upper deposit as imported fill material. However, the sediments appear nearly identical to the underlying parent material, but with additional pedogenic alteration, suggesting that the unit is actually a soil developed in-situ but graded and redeposited during construction of the existing food service facilities. This upper soil consists of a fine sandy loam with very weak blocky structure and numerous fine root holes. It has a wet consistence that is slightly sticky and slightly plastic, and is slightly hard when dry, suggesting some clay accumulation. Under a 10x hand lens, very few faint clay films are observable on ped faces and root holes. Contact with the underlying C horizon is distinct, due to mechanical excavation/grading and redeposition. An upper organic-rich A horizon may have been removed during construction or was never fully formed. The structure and pedogenic alteration of this unit, while admittedly weak, is much greater than any other unit observed within the trench profile, suggesting that it was exposed at or near the surface for much longer than any of the other units. Indeed, this upper unit is the only evidence of an even slightly stable land surface within the study area.

### 3.2.2 Discussion

Although the modern Santa Ana River flows through a single channel, this is not the river's natural morphology. Within the Santa Ana River Basin, the river has been channelized between constructed concrete and rip-rap levees to mitigate channel belt meander and flooding of the river's natural floodplain, which has transitioned from agriculture to highly urbanized development over the past century. The rivers natural tendency is to a braided system, with multiple shifting channels and bars across a wide belt. The ability of the active channel belt to migrate across large distances is evidenced along the coast (Figure 3) where the mouth of the SAR, entering the Pacific Ocean, has varied as much as 29 km (18 miles) over the last 15,000 years.

The subsurface depositional forms observed within the geoarchaeological trenches are consistent with a braided river system, dominated by sand and gravel active channel cross-beds, interspersed with limited finer grain horizontally bedded and laminated overbank, levee, and splay deposits. As concluded by Goldberg and Mcphail, "the preservation potential of intact sites within such [braided river system] deposits is low" (2006:93). Based on the dates obtained for sediments from Trenches 3 and 2, it appears that the CPP Project area was part of an active braided channel river system for the majority of the middle to late Holocene, if not longer. However, given the nature of the clean sandy sediments, with large interstitial pores and low overall organic content, the accuracy of the bulk AMS dates must be questioned. There is a distinct possibility that organics have either

been transported through the stratigraphic column, or eroded from older landsurfaces and redeposited by the river. This latter source of contamination is discussed more below.

Profiles observed and recorded within the other trenches and potholes were functionally similar to that described above for T3, with no distinct marker beds observable between multiple excavations. There is no evidence of buried organic or pedogenic horizons, which would indicate a stable landsurface with natural resources that would attract human activity. While it is possible (though not likely) that such stable surfaces may have existed in the project area during prehistory, subsequent active high-energy braided river processes have removed any trace of these.

During initial analysis of the first profile section of Trench 1, two buried deposits with apparent evidence of pedogenic development were identified at 200 and 280 cm below surface. At first these were interpreted as being buried AB and Bt horizons (respectively) separated by a loose sandy C horizon. However, upon further examination of the trench, it was clear that these were not laterally continuous units but small isolated pockets 10 to 40 cm long and less than 10 cm thick.

At least two geomorphic processes can explain these isolated pockets of pedogenically altered sediments. The first is a function of the morphology of evolving braided channel systems. During high water flows, fluvial dunes are formed within the numerous river channels and coalesce to form sand bars. As the water recedes, the low spots between the dunes provide wet areas for algal mat development (Haner 1983:253). These low spots become discontinuous areas of organic accumulation which either completely dry out as water levels continue to recede, or are infilled and covered over with additional fine sediment once water levels begin to increase again (essentially acting as small-scale floodplains surrounded by levees formed by the dunes). This process likely explains the buried AB-type soil identified in Trench 1, as well as other isolated areas of more organic-rich fine sediments, such as Unit 7 in Trench 3.

The second geomorphic process to explain the isolated accumulations of pedogenic soils is through the erosion and redeposition of formerly stable land surfaces by the river. This process has been recognized in river valley systems (e.g., Faust, Olmo, and Escudero 2000; Ritchie *et al* 2006) throughout the world. The majority of eroded soils will be broken down and mixed with the other sediment load of the river. However, portions of very well-developed, highly cohesive soils– such as the Ramona soil series developed on old Pleistocene fans just north of the project area (Figure 5)– may retain their original structure and be quickly redeposited. Given the proximity of well-developed soils just north of the project area, this process may explain the type of small pedogenic soil deposit at 280 cm in Trench 1. These small eroded cohesive soil packages essentially act as clasts within the sediment load.

Further evidence of redeposition of eroded surfaces was found during screening of sediments for archaeological materials, when occasional moist concentrations (approximately golf ball size or smaller) of organics and clays would come out in the

screens. A few small localized deposits of humic soils and pedogenic clays, similar to those in Trench 1, were observed in other trenches/potholes, but with no stratigraphic continuity within or between trenches.

Internally horizontally bedded deposits, which dominated the upper 1 to 2 meters of each excavation, are largely the result of levee and overbank deposition. Grain coarseness within these beds is dictated by proximity to the active channel, with coarser grained material representing very near-channel levee deposits and fine grains (silts and clays) being deposited further away with diminishing flow and carrying capacity. A single fining upward sequence may represent a single flood event or seasonal peak and recession in water volume.

Depth to the base of the upper horizontal deposits generally diminished to the north, suggesting that active channels remained to the north for a longer time and/or that erosion of underlying bedforms was greater to the south, allowing for more infilling by overbank deposits. A small infilled channel cutting through the upper horizontal deposits in Pothole 6 favors the former option, and would represent a single small braid channel extending south from a larger active channel system.

The transition to horizontal bedding in the upper ~180 cm of Trench 3, suggests that the Project area was no longer dominated by high-energy active channels after this time (after approximately 2000 years ago). While grain size, sediment sorting, and lack of pedogenic development indicate that the Project area was still part of a braided system that fluctuated between channel and near-channel regimes, the lack of large-scale fluvial bedforms (dunes, foresets, etc.) suggest that the hydraulic capacity of the channels had been greatly reduced.

In general, it appears that the Holocene alluvial deposits within the Project vicinity– related to the prehistoric Santa Ana River and its tributaries– are not conducive to the formation of stable landsurfaces and preservation of buried archaeological sites. As such, the greatest potential for buried archaeology within this portion of the Santa Ana River Basin is in areas where stable Pleistocene landforms are buried under distal, low-energy portions of the floodplain.

Originally, the old Pleistocene fan surface north of the project area– upon which the three prehistoric food processing sites are situated– likely extended further to the south. In a low-energy floodplain environment, this surface may have become buried below the floodplain of the Santa Ana River. However, given the geomorphic position of these older sediments, adjacent to an active braided river channel belt (Figure 4), it is more likely that the older stable landsurface has been eroded rather than buried. As such, it is not anticipated that the natural gas line, running north along Kraemer Avenue (Figure 2), will encounter any paleosols or sedimentary structures different from those observed in the Power Block area. Thus, the geoarchaeological potential of this portion of the linear APE, along with those portions more solidly within the active basin, is considered very low.

# 4 Conclusions and Recommendations

The following sections present the combined results of the geoarchaeological background and field investigations, interpreted within a CEQA regulatory framework and an assessment of the potential for the proposed CPP Project to cause adverse effects to potentially significant unique archaeological resources (or "historical resources"). Recommendations are provided for the implementation of mitigation measures outlined in the PSA.

## 4.1 Conclusion

CEC Staff's initial assessment (CEC 2009) of the project area, as potentially geoarchaeologically sensitive, is understandable and defensible given the small amount of background data that was available for the initial assessment. The project area is located within the floodplain of the Santa Ana River, which is known historically to carry and deposit a very large sediment load during flood events. Given the presence of prehistoric sites within the immediate project vicinity, it was considered plausible that similar sites may be buried under recent alluvium of the Santa Ana River. However, based on data obtained during the CPP geoarchaeological investigations and analysis of additional background literature, this initial assessment no longer seems tenable.

All but one of the previously recorded sites identified within the Project vicinity– as well as those further downstream (Padon 1998)– were located on old Pleistocene landforms not subject to the erosive potential and changing course of the SAR braided river belt. The one archaeological resource identified near the Project vicinity and within the SAR floodplain (CA-ORA-517), is an isolated find with no other cultural associations that may have been redeposited by, or the direct result of, a flood event.

No archaeological materials were identified as a result of the geoarchaeological investigations. No buried landforms, conducive to the deposition and preservation of historical resources, were identified as a result of the geoarchaeological investigations. In general, the Project area is considered to have very low potential for buried unique archaeological resources.

However, without complete exposure of the Project area, the possibility of unidentified archaeological deposits cannot be completely dismissed. In the unlikely event that buried archaeological resources are present, they will most likely be isolated materials, transported, redeposited, and/or otherwise disturbed by the prehistoric Santa Ana River that once flowed through the Project area. Such heavily disturbed archaeological resources are unlikely to be eligible to the California Register of Historical Resources, based on lack of context, association, and integrity. Deeper project impacts, such as the separator sump and jack-and-bore pit, may disturb deposits with a *limited* potential for unique archaeological resources.

## 4.2 Recommendations

Cultural resources mitigation measures proposed in the PSA were predicated on limited data and no knowledge of subsurface conditions within the Project area. The geoarchaeological investigations described in this report were specifically designed to assess the potential for buried cultural resources within the vertical APE of the CCP Project area. Based on the data, there appears to be little potential for significant archaeological resources within the Project area. As such, the mitigation measures specified within the PSA are no longer appropriate or recommended.

Archaeological monitoring is not recommended during the majority of construction activities for the CPP Project. Although there is currently little evidence to suggest the existence of potentially significant historical resources within the Project area, the possibility cannot be completely discounted. To mitigate the very limited potential for redeposited isolated archaeological finds, it is recommended that all construction personnel receive archaeological awareness training, including protocol in the event of an unanticipated discovery. Appendix C provides an example of a quick reference sheet which can be distributed to construction personnel as part of any awareness training, and used in the unlikely event of an unanticipated discovery.

An archaeological monitor may be advisable during the limited construction activities extending beyond 3.8 meters (12.5 feet) below surface (i.e., the oil/water separator sump, jack and bore pit) as subsurface conditions below this depth are unknown; though most likely they are reflective of the same braided river belt conditions observed at shallower depths within the Project area, and have little potential for historical resources.

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# Appendix A
# Radiocarbon Results

BETA

*Consistent Accuracy . . .*
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**Beta@radiocarbon.com**
**www.radiocarbon.com**

**Darden Hood**
**President**

**Ronald Hatfield**
**Christopher Patrick**
**Deputy Directors**

June 19, 2009

Mr. Jay Rehor
URS Corporation
1333 Broadway
Suite 800
Oakland, CA 94612
USA

RE: Radiocarbon Dating Results For Samples CPP-T1-190cm, CPP-T3-U1, CPP-T3-U7, CPP-T3-U9

Dear Mr. Rehor:

Enclosed are the radiocarbon dating results for four samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Thank you for prepaying the analyses. A receipt is enclosed. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

Digital signature on file

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**President**

**Ronald Hatfield**
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**Deputy Directors**

June 19, 2009

Mr. Jay Rehor
URS Corporation
1333 Broadway
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Oakland, CA 94612
USA

RE: Radiocarbon Dating Results For Samples CPP-T1-190cm, CPP-T3-U1, CPP-T3-U7, CPP-T3-U9

Dear Mr. Rehor:

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Thank you for prepaying the analyses. A receipt is enclosed. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

Digital signature on file

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

# REPORT OF RADIOCARBON DATING ANALYSES

Mr. Jay Rehor

Report Date: 6/19/2009

URS Corporation

Material Received: 6/12/2009

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---|---|---|
| Beta - 260812 | 2720 +/- 40 BP | -24.2 o/oo | 2730 +/- 40 BP |
| SAMPLE : CPP-T1-190cm | | | |
| ANALYSIS : AMS-PRIORITY delivery | | | |
| MATERIAL/PRETREATMENT : (organic sediment): acid washes | | | |
| 2 SIGMA CALIBRATION : Cal BC 970 to 960 (Cal BP 2920 to 2900) AND Cal BC 940 to 810 (Cal BP 2890 to 2760) | | | |
| Beta - 260813 | 6960 +/- 50 BP | -23.7 o/oo | 6980 +/- 50 BP |
| SAMPLE : CPP-T3-U1 | | | |
| ANALYSIS : AMS-PRIORITY delivery | | | |
| MATERIAL/PRETREATMENT : (organic sediment): acid washes | | | |
| 2 SIGMA CALIBRATION : Cal BC 5990 to 5740 (Cal BP 7940 to 7690) | | | |
| Beta - 260814 | 2240 +/- 40 BP | -23.5 o/oo | 2260 +/- 40 BP |
| SAMPLE : CPP-T3-U7 | | | |
| ANALYSIS : AMS-PRIORITY delivery | | | |
| MATERIAL/PRETREATMENT : (organic sediment): acid washes | | | |
| 2 SIGMA CALIBRATION : Cal BC 400 to 340 (Cal BP 2350 to 2290) AND Cal BC 330 to 200 (Cal BP 2280 to 2150) | | | |
| Beta - 260815 | 5330 +/- 50 BP | -23.3 o/oo | 5360 +/- 50 BP |
| SAMPLE : CPP-T3-U9 | | | |
| ANALYSIS : AMS-PRIORITY delivery | | | |
| MATERIAL/PRETREATMENT : (organic sediment): acid washes | | | |
| 2 SIGMA CALIBRATION : Cal BC 4330 to 4040 (Cal BP 6280 to 6000) | | | |

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

**Laboratory number:** **Beta-260812**

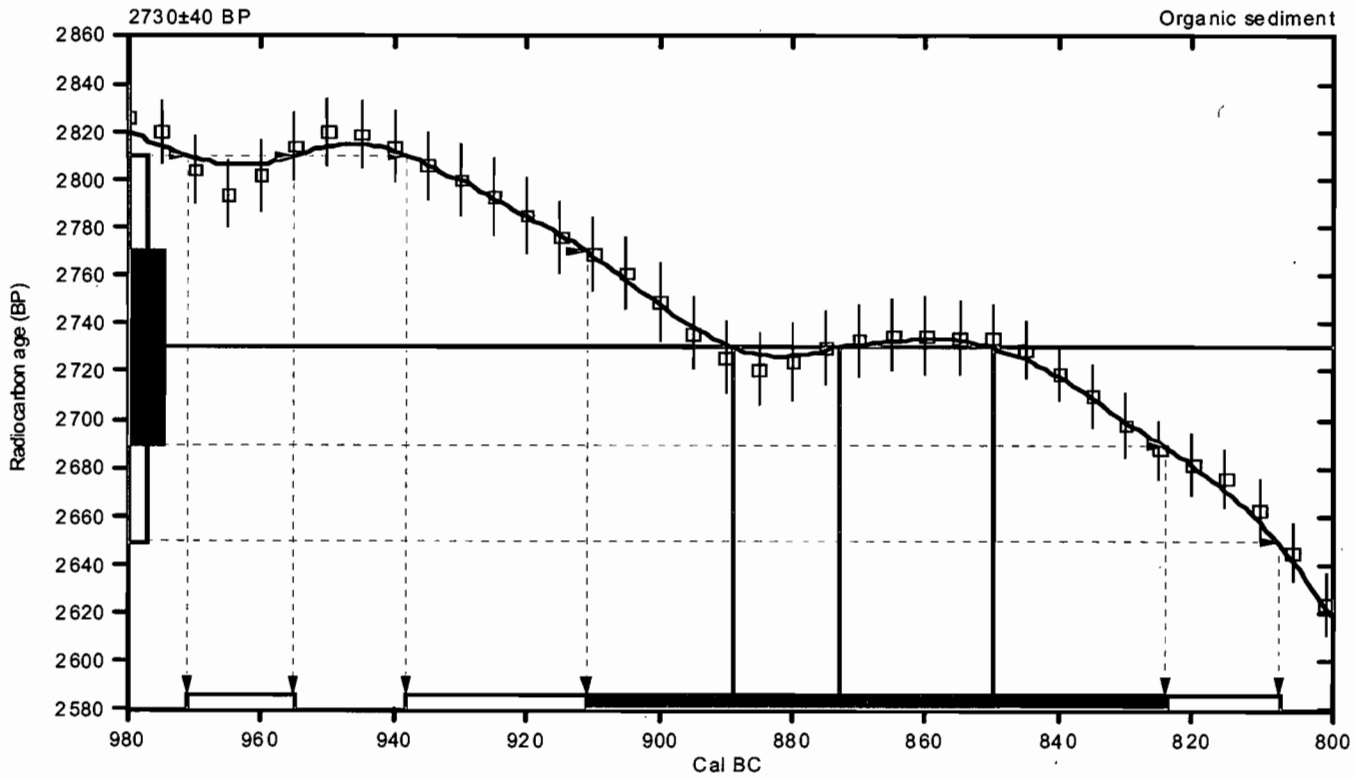
**Conventional radiocarbon age:** **2730±40 BP**

**2 Sigma calibrated results: (95% probability)** **Cal BC 970 to 960 (Cal BP 2920 to 2900) and Cal BC 940 to 810 (Cal BP 2890 to 2760)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal BC 890 (Cal BP 2840) and Cal BC 870 (Cal BP 2820) and Cal BC 850 (Cal BP 2800)

1 Sigma calibrated result: (68% probability) Cal BC 910 to 820 (Cal BP 2860 to 2770)




References:


***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

***A Simplified Approach to Calibrating C14 Dates***

*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*



## Beta Analytic Radiocarbon Dating Laboratory

*4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com*

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

**Laboratory number:** **Beta-260813**

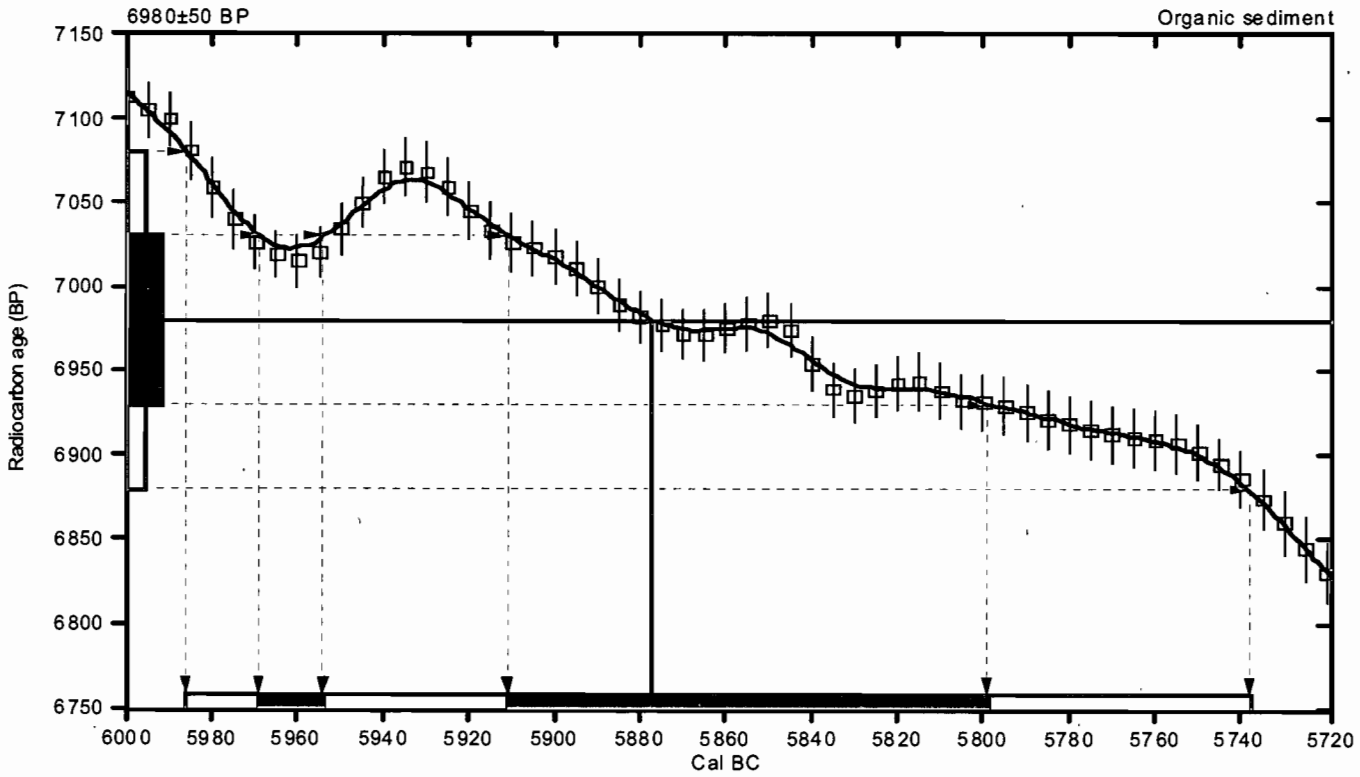
**Conventional radiocarbon age:** **6980±50 BP**

**2 Sigma calibrated result: (95% probability)** **Cal BC 5990 to 5740 (Cal BP 7940 to 7690)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 5880 (Cal BP 7830)

1 Sigma calibrated results: (68% probability) Cal BC 5970 to 5950 (Cal BP 7920 to 7900) and Cal BC 5910 to 5800 (Cal BP 7860 to 7750)




References:

***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

***A Simplified Approach to Calibrating C14 Dates***

*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*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# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.5:lab. mult=1)

**Laboratory number:** **Beta-260814**

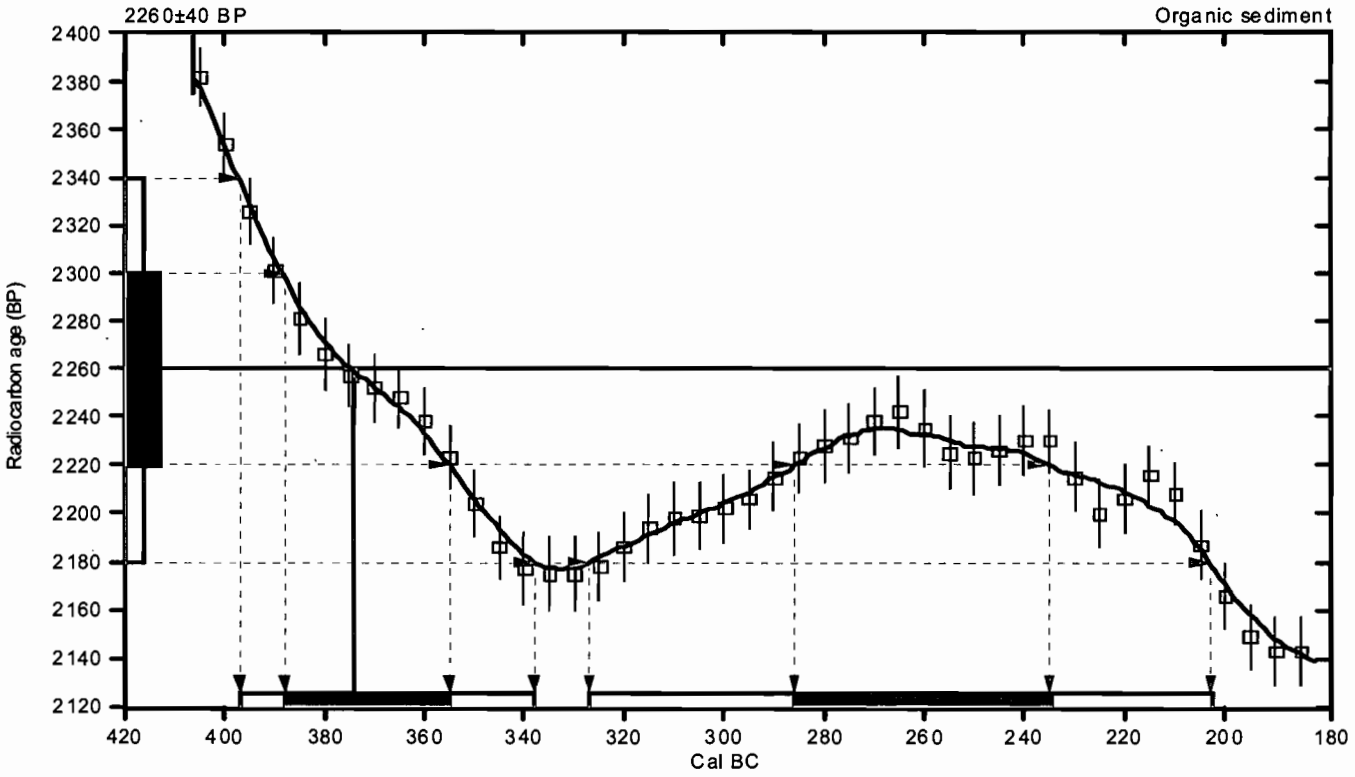
**Conventional radiocarbon age:** **2260±40 BP**

**2 Sigma calibrated results:** **Cal BC 400 to 340 (Cal BP 2350 to 2290) and**
**(95% probability)** **Cal BC 330 to 200 (Cal BP 2280 to 2150)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 370 (Cal BP 2320)

1 Sigma calibrated results: Cal BC 390 to 360 (Cal BP 2340 to 2300) and
(68% probability) Cal BC 290 to 240 (Cal BP 2240 to 2180)




References:

***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

***A Simplified Approach to Calibrating C14 Dates***

*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*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# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.3:lab. mult=1)

**Laboratory number:** **Beta-260815**

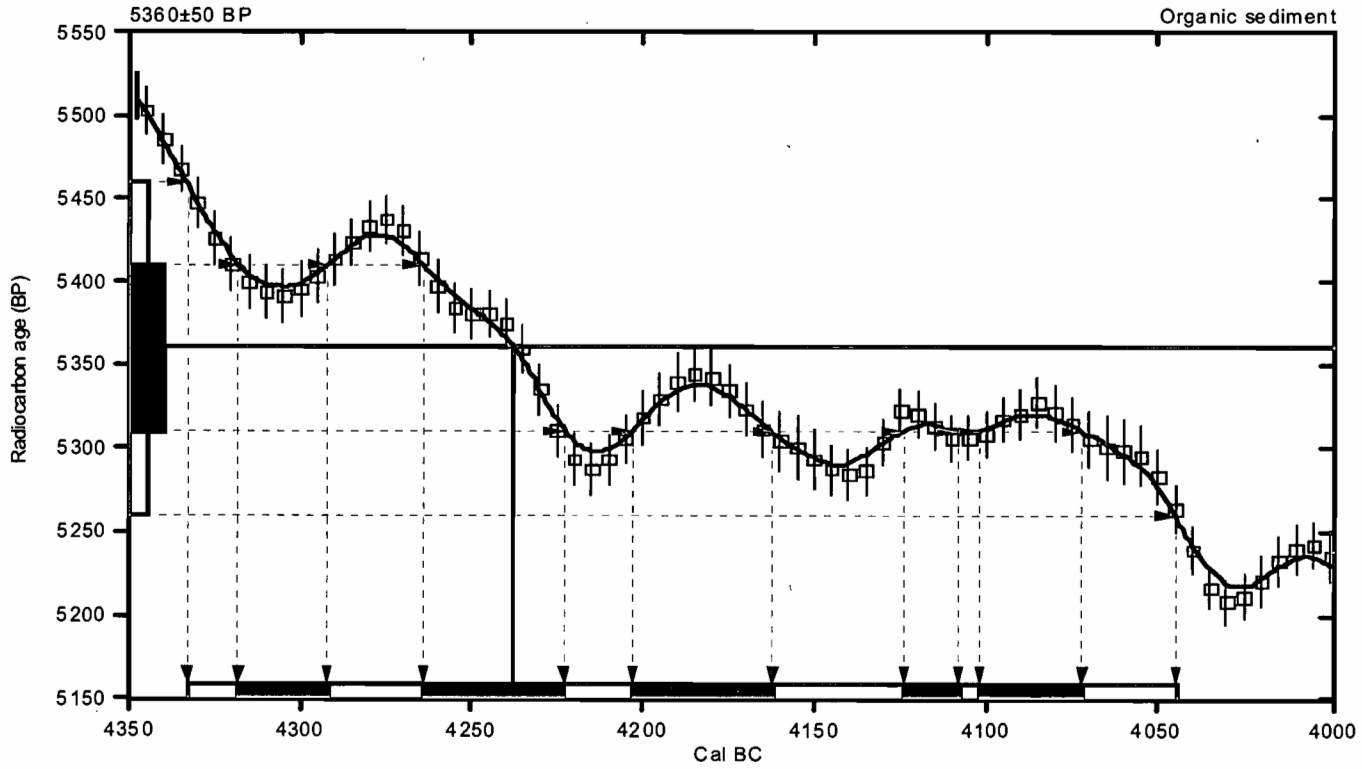
**Conventional radiocarbon age:** **5360±50 BP**

**2 Sigma calibrated result: (95% probability)** **Cal BC 4330 to 4040 (Cal BP 6280 to 6000)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4240 (Cal BP 6190)

1 Sigma calibrated results: (68% probability) Cal BC 4320 to 4290 (Cal BP 6270 to 6240) and Cal BC 4260 to 4220 (Cal BP 6210 to 6170) and Cal BC 4200 to 4160 (Cal BP 6150 to 6110) and Cal BC 4120 to 4110 (Cal BP 6070 to 6060) and Cal BC 4100 to 4070 (Cal BP 6050 to 6020)




References:

***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

***A Simplified Approach to Calibrating C14 Dates***

*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*


## Beta Analytic Radiocarbon Dating Laboratory

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# Appendix B
# Summary Trench Logs

| Trench 1 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0 to +15 | Concrete | ------- |
| 9 | 0-20 | A/Bp | Fine sandy loam with massive to weak blocky structure; very few/weak clay films on root holes; slightly sticky and plastic when wet and slightly hard when dry; wavy distinct contact (graded and redeposited); possibly removed A-horizon. (10YR 4/2). |
| 9 | 20-40 | C | Well sorted, fine to medium sand (very weakly consolidated with minor fines); loose with single grain structure. (10YR 6/2). |
| 8 | 40-75 | Cu | Coarser unconsolidated sand with gravels (near-channel levee?). (10YR 6/2). |
| 7 | 75-120 | | Thinly horizontally bedded silty fine sand and medium sand beds; single grain poorly consolidated (finer grain=better consolidated); similar to Unit 9. |
| 6 | 120-170 | | Same as Unit 8. |
| 5 | 170-180 | | Coarse sand bed (slightly oxidized and moist, perhaps due to retention of water above underlying clay deposits). |
| 4 | 180-200 | | Discontinuous lenses of sandy clay (10YR 5/3) within loose medium cross-bedded sand (10YR 6/2); clay lenses have few distinct clay films on ped faces and pore holes; likely represents near-channel formation of organic-rich depressions. |
| 3 | 200-270 | | Unconsolidated cross-bedded poorly sorted (mostly medium) sands with gravel lenses between some cross-bed contacts (fluvial dune/point bar). |
| 2 | 270-280 | | Medium sand with small pockets of fat clay, likely redeposited pedogenic clays. |
| 1 | 280-400 | | Poorly sorted and unconsolidated, gravels and coarse sand active channel infill (related to Trench 3, Unit 5?). |

| Trench 2 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0 to +15 | Concrete | ------- |
| 6 | 0-20 | A/Bp | Fine sandy loam with massive to weak blocky structure; very few/weak clay films on root holes; slightly sticky and plastic when wet and slightly hard when dry; wavy distinct contact (graded and redeposited); possibly removed A-horizon. (10YR 4/2). |
| 6 | 20-55 | C | Well sorted, fine to medium sand (very weakly consolidated with minor fines); loose with single grain structure. (10YR 6/2). |
| 5 | 55-100 | Cu | Medium and fine unconsolidated sands (near-channel levee/overbank) |

| | | | |
|---|---|---|---|
| **4** | 100-250 | | Inter-fingered poorly sorted coarse sand and channel deposits, incised into at least two distinct episodes of cross-bedded fluvial dune/point bar formation (i.e., entire unit is a sequence of channel and near-channel braided stream bedforms). |
| **3** | 250-280 | | Thin horizontally bedded unconsolidated sands (fine to medium). |
| **2** | 280-315 | | Medium sand with small pockets of fat clay, likely redeposited pedogenic clays. |
| **1** | 315-385 | | Unconsolidated cross-bedded poorly sorted (mostly medium) sands with gravel lenses between some cross-bed contacts (fluvial dune/point bar). |

| Trench 3 | | | |
|---|---|---|---|
| **Unit** | **Depth (cm below surface)** | **Horizon** | **Description** |
| | 0 to +15 | Concrete | ------- |
| **13** | 0-15 | A/Bp | Fine sandy loam with massive to weakly blocky structure; very few/weak clay films on root holes; wavy distinct contact (graded and redeposited). |
| **13** | 15-40 | C | Well sorted, fine to medium sand; weakly consolidated with silt (slight one value color change from underlying horizon; slightly oxidized?) |
| **12** | 40-70 | Cu | Coarser unconsolidated sand and gravels |
| **11** | 70-90 | | Mostly well sorted fine sand, moist and weakly consolidated. Very thin horizontal depositional bedding 10YR 6/2 (light brownish gray) |
| **10** | 90-105 | | Coarse sands and gravels; poorly sorted; 10YR 7/2 (light gray) |
| **9** | 105-125 | | Mostly well sorted fine sand; moist and weakly consolidated; 10YR 6/2 (light brownish gray) |
| **8** | 125-180 | | Alternating beds of coarse sand and fine sand<br>10 YR 7/2 (light gray) |
| **7** | 180-195 | | Sand with clay; discontinuous lenticular deposit Overlying cross-bedded fluvial deposits; 10YR 4/2 (Dark grayish brown) |
| **6** | 195-280 | | Thinly cross-bedded fluvial/channel sands and gravels; poorly sorted and unconsolidated; 10YR 7/2 (light gray) |
| **5** | inset in Units 3 and 4 | | Similar to Unit (2) but with beds at 20° to west. |
| **4** | 280-305 | | Thin horizontally bedded, mostly well sorted fine sand, weakly consolidated (levee/overbank deposits?). 10YR 6/2 (light brown gray) |
| **3** | 305-365 | | Thinly cross-bedded channel sand and gravels. Poorly sorted and unconsolidated; similar but with more gravels than 195-280cm; (10YR 7/2) |
| **2** | 365-400 | | Fine to medium sand with thinly bedded few gravel lenses mostly |

| | | | |
|---|---|---|---|
| | | | well sorted; bedding at 40° angle, dipping towards the west. (First fluvial dune?) Eroded and cut into by overlying layer. |
| 1 | 400-440 | | Mostly well sorted fine sand, weakly consolidated horizontally bedded; 10YR 6/2 (light brownish gray) |

| Pothole 1 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0 to +15 Upper | | Concrete with rebar. Little to no soil development except at surface of profile; all deposits below upper AB are unconsolidated sands and gravels. |
| 1 | 0-25 | A/B | |
| 2 | 25-80 | C | Fining upward sequence from 80cm lithologic contact |
| 3 | 80-185 | | Very thinly bedded sands and gravels, braided stream channel deposits; few minor oxidized beds, coarse granite sand. Contact at 185 cm (Fining upward sequence dipping towards south; i.e., upper horizontal bedding thicker to south). |
| 4 | 185-250 | | Thinly cross-bedded sands and gravels (dipping to west); unconformable contact at 250cm. |
| 5 | 250-270 | | Coarse gravel channel deposits. |
| 6 | 270-380 | | Thinly cross-bedded sands (point bar/fluvial dune foresets) |

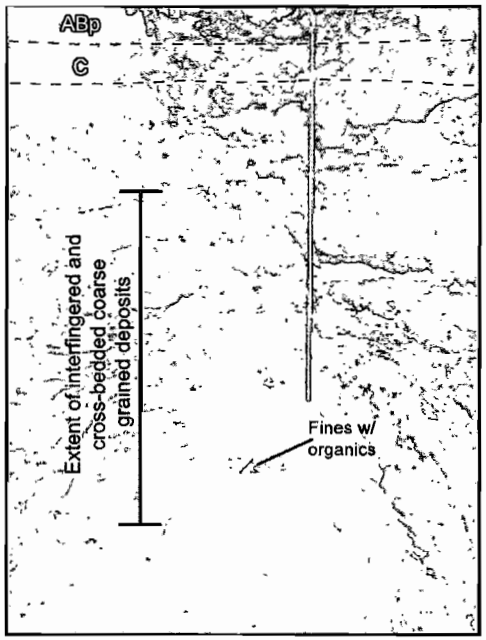
| Pothole 2 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| -Same as P1, but with several small infilled channels (unsorted coarse sand and gravel) cutting through Unit 4 (appear to be too small to be the channels that formed the dunes/point bars of Unit 4). | | | |

| Pothole 3 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| -Generally same as P1 but without oxidized granitic sand contacts.<br>-Dark thinly bedded sands have higher mica content (not from clays or organics).<br>-At approximately 100 cm: Silt and fine sand ponding against a coarser sand bar. See photo #1197-1198 | | | |

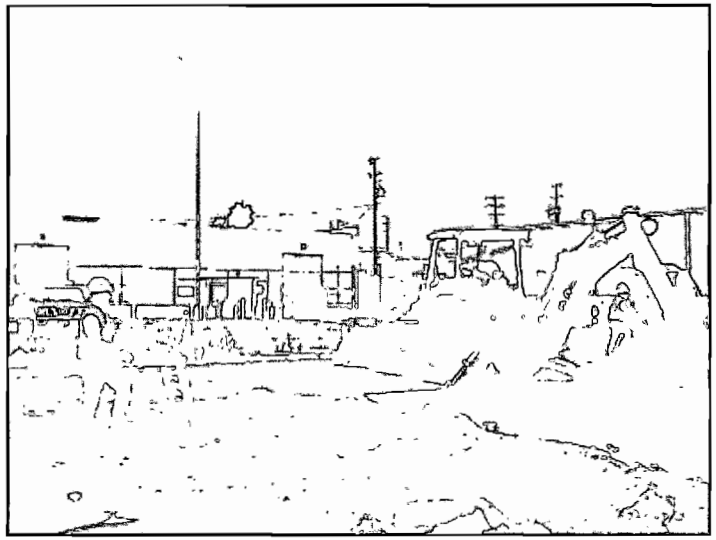
| Pothole 4 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0-25 Upper | A/B | |
| | 25-120 | C | Fining upwards sequence |
| | 120-200 | | Thinly bedded sands and coarse sands |
| | 200-230 | | Coarse sand and gravel channel fill |
| | 230-390 | | Thinly cross-bedded sands with some gravel lenses<br>(Each foreset is approximately 10cm thick with gravel lenses making log deposits between events- thin sand beds between this gravel marker). |

| Pothole 5 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0-25 upper | A/B | |
| | 25-110 | C | Fining upwards sequence |
| | 110- | | Thinly bedded sands and coarse sands |
| **Generally same as P4; more coarse sands, less gravels | | | |

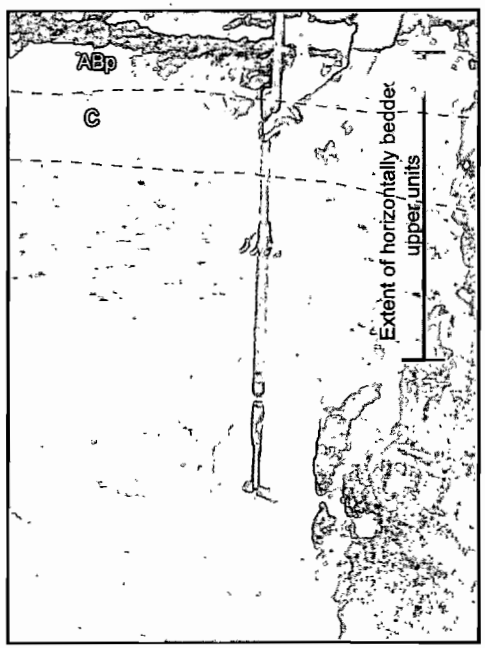
| Pothole 6 | | | |
|---|---|---|---|
| Unit | Depth (cm below surface) | Horizon | Description |
| | 0 to +30 | | Concrete |
| | 0-20 | A/Bp | |
| | 20-100 | C | Fining upwards sequence |
| | 100-220 | | Thinly bedded sands and gravels, braided stream channel |
| | 220-230 | | Coarse sand and gravel bed with large granite cobbles (apprx.30cm diameter). Correlates with strat #5 in P1 |
| | 230-400 | | Thinly cross-bedded sands with some gravel lenses |



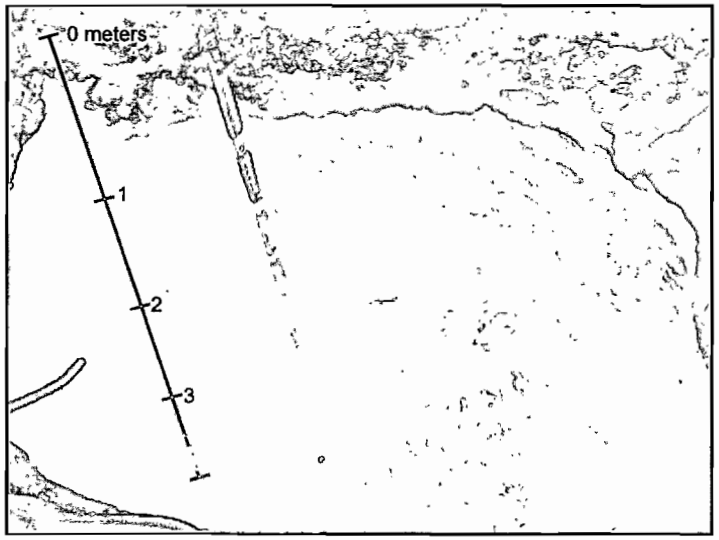

Trench 2, west wall, showing interfingered fluvial bedforms



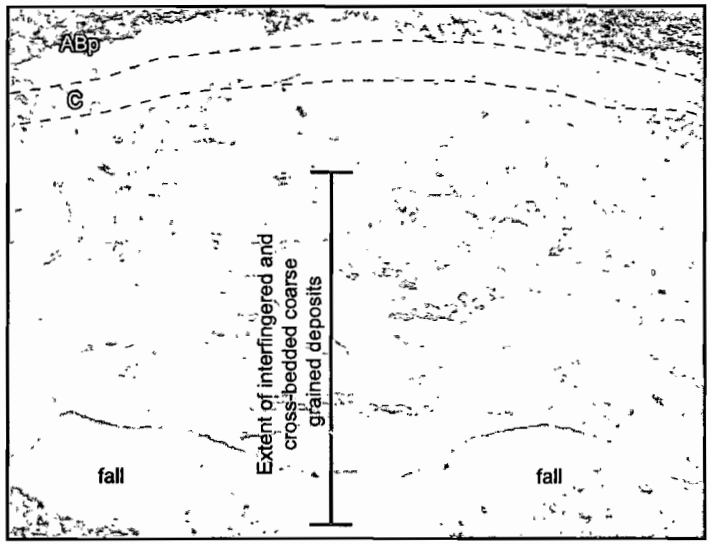
Excavation of Trench 3




Cleaning sidewall of Trench 1,discreet clay with coarse sand lense at bottom of hoe.




Pothole 5 overview




Pothole 1 overview

**Selected Views of Exploratory Trenches and Deposits Exposed in the Canyon Power Plant Project Area**

# Appendix C
# Example Archaeological Awareness Hand-Out

# ALERT !

This is to notify you that this project site may be located in an **archaeologically sensitive area.** If you notice anything that indicates the presence of an archaeological resource within the project site, the designated **Cultural Resources Specialist (CRS)** _____name_____ must be contacted **immediately**. If you see anything that appears like archaeological remains call: ____phone number_____ or ____alternate phone number_____. All work within the vicinity of the discovery must stop until the CRS has evaluated the discovery. You should be on the lookout for both prehistoric and historical archaeological sites. It is not always easy to identify archaeological sites when they are encountered. Below are some things that may indicate the presence of an archaeological site.

PREHISTORIC ARCHAEOLOGICAL SITE

- Concentrations of shellfish remains
- Evidence of fire (ashes, charcoal, burnt earth, fire-cracked rocks)
- Concentrations of bones
- Recognizable Native American artifacts (arrowheads, shell beads, stone mortars (bowls), humanly altered rock, etc.)

HISTORICAL ARCHAEOLOGICAL SITE

- Building foundation remains
- Trash pits
- Privies (outhouse holes)
- Floor remains
- Wells
- Concentration of bottles, broken dishes, shoes, buttons, cut animal bones, hardware, household items, barrels, etc.
- Wood structural remains
- Clay roof/floor tiles
- Stone walls or footings
- Gravestones

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228- WWW.ENERGY.CA.GOV

**APPLICATION FOR CERTIFICATION FOR THE *CANYON POWER PLANT PROJECT***

**Docket No. 07-AFC-9**

**PROOF OF SERVICE**
***(Revised2/25/2009)***

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## DECLARATION OF SERVICE

I, Ashley Y. Garner, declare that on July 22, 2009, I served and filed copies of the attached **GEOARCHAEOLOGICAL ASSESSMENT AND SUBSURFACE INVESTIGATIONS TECHNICAL REPORT** dated **July 22, 2009.** The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at **[www.energy.ca.gov/sitingcases/canyon/index.html]**. The document has been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

**(*Check all that Apply*)**

**For service to all other parties:**

__X__ sent electronically to all email addresses on the Proof of Service list;

__X__ by personal delivery or by depositing in the United States mail at Sacramento, California with first-class postage thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

***AND***

**For filing with the Energy Commission:**

__X__ **sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (*preferred method*);**

***OR***

____ depositing in the mail an original and 12 paper copies, as follows:

**CALIFORNIA ENERGY COMMISSION**
Attn: Docket No. **07-AFC-9**
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
**docket@energy.state.ca.us**

I declare under penalty of perjury that the foregoing is true and correct.

Ashley Y. Garner