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Pierre Martinez
Project Manager
Systems Assessment & Facility Siting Division
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814

Subject: Applicant's Submittal of the Final Geoarchaeology Research Design (Data Request Set 1B [No.97])
Rio Mesa Solar Electric Generating Facility (11-AFC-04)

Dear Mr. Martinez:

On behalf of Rio Mesa Solar I, LLC and Rio Mesa Solar II, LLC, collectively the "Applicant" for the Rio Mesa Solar Electric Generating Facility project ("Rio Mesa SEGF"), we submit the Applicant's Final Geoarchaeology Research Design (Data Request Set 1B [No. 97]).

Sincerely,

Angela Leiba, Vice President
Senior Project Manager/ Environmental Department Manager

Enclosure

cc: POS List
Project File

FINAL

GEOARCHAEOLOGICAL RESEARCH DESIGN BRIGHTSOURCE ENERGY, INC: RIO MESA SOLAR PROJECT RIVERSIDE COUNTY, CALIFORNIA

Prepared for

Bright Source Energy, Inc.

URS Project No. 27652105.00505

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October 2012

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SECTION 1 INTRODUCTION

A Geoarchaeological research design has been prepared to guide fieldwork and the documentation of potential impacts upon cultural resources within the BrightSource Energy, Inc. Rio Mesa Project (RM; also referred to as Project) Area of Potential Effect (APE). Information presented in this research design will govern the geoarchaeological study related to the Project APE. The primary purpose of this research design is to disclose the overall approach the Project will take to comply with state and federal regulations regarding the protection of cultural resources, specifically potential buried cultural resources. In addition, the research design provides the overarching guidance for identification efforts of extant landforms and their potential for subsurface cultural resources.

The content of this research design will include the project description, the definition of the Geoarchaeological Study APE, the fieldwork methods, and the research design, which is intended to guide the identification of potentially archaeologically sensitive landforms and, ultimately, the preliminary evaluation of associated potentially significant cultural resources. The research design is intended to address a range of geomorphic features that occur within the Project APE and provide a preliminary basis for determining the possible presence of subsurface cultural resources.

Upon the completion of the field work, a Geoarchaeological Technical Report (Technical Report) will be prepared and submitted to the CEC and BLM for review and approval. The primary purpose of the Technical Report will be to provide the CEC and the BLM the results of the study and the initial conclusions regarding the potential for the Project to affect buried cultural resources. The Technical Report will serve as the data response to the CEC's Data Request No. 98. The CEC will transmit the Technical Report to the BLM if the agency deems it appropriate.

Lastly, buried archaeological deposits found during the trenching activities will be recorded on DPR 523 forms by the Cultural Monitor. Formal evaluation of site eligibility and/or data recovery is beyond the current scope. The geoarchaeological study is not designed to assess the eligibility of buried archaeological sites identified during trenching. Additional scoping and consultation with the CEC and BLM will be necessary to complete a Phase II analysis of any identified archaeological deposits.

1.1 PROJECT DESCRIPTION

The project site is located in Riverside County approximately 13 miles southwest of Blythe, California (Figure 1). The Project will consist of two solar plants: the southernmost plant will be known as Rio Mesa I and the northernmost plant will be known as Rio Mesa II. The plants will be constructed in separate phases. Rio Mesa Solar I, LLC and Rio Mesa Solar II, LLC, the owners of the two separate solar plants, are jointly known as the "Applicant."

Each plant will include a power block area surrounded by an array of approximately 85,000 heliostats, and will require approximately 1,850 acres (or 2.9 square miles) of land to operate. The nominal capacity of each solar plant will be 250 megawatts (MW), for a total Project nominal output of 500 MW. Certain facilities for the Project will be shared by the two plants and located in a common area. These facilities will include a combined administration, control, maintenance, and warehouse building, and mobile equipment maintenance facilities for the maintenance crew and operators. The total area required for both plants, including the common area, is approximately 3,805 acres.

The Project will deliver power at 220 kilovolts (kV) to Southern California Edison's (SCE's) Colorado River Substation (CRS), located approximately 9.7 miles to the northwest. From the plant switchyards, power will be transmitted underground, at 220 kV, to the Project switchyard (located in the common area).

1.2 FEDERAL AND STATE AGENCIES

BLM will be the lead agency under the National Environmental Policy Act (NEPA), since the road access and transmission line are proposed on federal lands managed by BLM. The California Energy Commission (CEC) is the lead agency under California Environmental Quality Act (CEQA) and has a certified regulatory program under CEQA. This work plan has been designed to accommodate both the CEC/BLM Memorandum of Understanding (MOU) and the separate permitting requirements of CEC and BLM, should the processes be separated.

1.3 AREA OF POTENTIAL EFFECT (APE)

The geoarchaeological study APE is currently assumed to be equivalent to the Archaeological APE or direct effects APE. The delineation of cultural resources survey areas was determined based on the CEC Rules of Practice and Procedure and Power Plant Site Regulations and Designation of Transmission Corridor Zones, Appendix B (g)(2)(C) (CEC 2008). For the purpose of this Project, the geoarchaeological survey areas also are equivalent to the Archaeological APE found in the BLM 8100 Manual, and are in compliance with the Section 106 process [36 CFR §800.16 (d)].

SECTION 2 ENVIRONMENTAL SETTING

2.1 PHYSIOGRAPHY AND GEOLOGY

The project area is bounded to the south and west by the volcanic and plutonic rocks that form the Mule Mountains, to the north by an extension of the Chuckwalla Valley that separates the Mule and McCoy Mountains, and to the east by the broad floodplain of the Colorado River. The immediate project area is characterized by gently sloping alluvial fans that emanate from these mountains. Gullies and washes, running approximately west to east, dissect the site, primarily on the north and south sides. The rock outcrops of the Mule Mountains are heavily eroded and mantled by a Quaternary fan piedmont. Alternatively, the Colorado River floodplain is composed of more recent alluvial material deposited by the river. Between these two areas lies the Palo Verde Mesa, which is primarily composed of inset Pleistocene terraces of the Colorado River. All of these Quaternary landforms are comprised of numerous older remnants and more recent deposits of varying ages. Additional information regarding the geomorphological setting and conditions of the Project area can be found in the initial Geoarchaeological Assessment (URS 2011), as well as in subsection 3.1, *Background* below.

2.2 CURRENT PHYSICAL SETTING

The project area is predominately in a rural setting with land uses that include agriculture (e.g., grains/ hay); historic period military training (e.g., 1942-1944 Desert Training Center or DTC, tank tracks, trenches, and graded areas); dirt roads (e.g., Bradshaw trail, Opal Mine Road, Hodge Mine Road, transmission line road/corridor, and other unnamed unpaved roads); approximately 40 previous ground water test wells and numerous dry well casings; utilities (e.g., four transmission towers and one underground pipeline); and recreational use (e.g., off-highway vehicles [OHVs] and camping). Despite these surficial disturbances, the landscape and topography generally resemble the natural environment.

The following activities are primarily responsible for the previous surface and subsurface disturbance in and adjacent to the project area:

- agriculture,
- historic-period military training (DTC),
- transmission lines and underground gas lines,
- ground water testing,
- recreation use (OHV tracks and camping), and
- road construction, use, and maintenance (e.g., Bradshaw Trail, Opal and Hodge Mine Roads).

SECTION 3 PROJECT LANDFORMS

The following discussion is largely focused on identifying those portions of the project area that have the potential for harboring archaeological deposits that do not exhibit surface manifestation. Through the completion of a geoarchaeological assessment a background model of landscape development can be formulated, as can major landforms be identified and mapped. Through this assessment, geological deposits can be dated and conclusions ascertained regarding areas with an increased likelihood of subsurface archaeological deposits. The following sections summarize the project landscape development based on the findings associated with the geoarchaeological assessment conducted for the Project AFC, Cultural Resources Technical Report (Nixon et al. 2011) and Geoarchaeological Sensitivity Assessment (Rehor 2011).

Per Staff request, the characteristics used to classify landforms and geologic units in the RMS project area—including descriptions by Stone (2006) and more detailed metrics outlined in Bull (1991)—is provided in Section 3.2 and summarized in Table 3.1-3. A complete version of Stone's (2006) geologic study just north of the project area is available online (http://pubs.usgs.gov/sim/2006/2922/SIM2922_pamphlet.pdf).

3.1.1 Models of Landscape Development

It has been shown that some alluvial landforms (e.g., desert pavements that have evolved through accretion of eolian silts and sands, and the gradual bearing of larger clasts to the surface) have the potential for containing buried archaeology (Ahlstrom and Roberts 2001). However, a representative portion (if not the vast majority) of these archaeological deposits will be incorporated into the surface pavement through the same accretionary process. Thus, these older surfaces are not likely to contain archaeology that is not at least partially evident on the surface (Ahlstrom and Roberts 2001; URS 2010).

Geomorphic processes have played a major role in the differential preservation of archaeological sites in the Colorado and Mojave deserts. For example, early cultural sites related to the San Dieguito and Lake Mojave cultural complexes are almost exclusively known from surface contexts on terminal Pleistocene and Early Holocene geomorphic surfaces (Sutton 1996:229). These early sites are typified by sparse remains on desert pavements, often on mesas and terraces overlooking larger washes or paleo-lake shorelines. Schaefer (1994:64) suggests that "these are zones where a variety of plant and animal resources could be located and where water would at least be seasonally available." However, it is much more likely that this is simply a matter of landscape development since the Late Pleistocene; these mesas and terraces, with well-developed desert pavements, represent the differential preservation of older land surfaces at higher elevations. Older sites are preserved on these relict landforms, with other sites of similar age likely buried by subsequent depositional processes, or destroyed by erosional processes. These same processes have also affected the distribution of resources (i.e., lithic raw material, water, biotic communities, etc.) across the landscape and, thus, the placement of archaeological sites in relationship to those resources. The primary factors effecting geomorphic processes in the region are the underlying structural geology and climate change. In addition to these local factors, the Colorado River—affected by extra-regional factors upstream— has had a major impact on landscape evolution within the project area.

Regional climatic trends through the Late Pleistocene and Holocene are important to this current study because of effects on the production of material for alluvial deposition and the concomitant susceptibility of the landscape to erosion. Regional correlations between periods of alluvial fan deposition during the Latest Pleistocene and Holocene indicate that climatic changes superseded other factors as the primary force driving alluvial deposition (McDonald, McFadden, and Wells 2003:203). Within the Mojave Desert, several major intervals of alluvial deposition have been identified and appear roughly correlative across the region, largely transcending geomorphic variation (Anderson and Wells 2003; Harvey and Wells 2003; McDonald, McFadden and Wells 2003). Figure 3.1-1 shows a summary of the timing of these major depositional events across numerous mountain fronts in the Mojave.

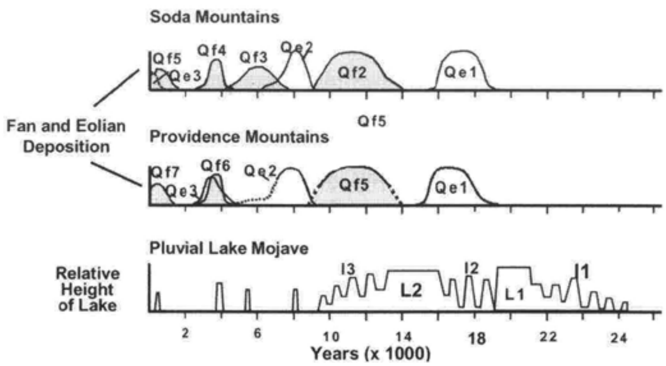

Figure 3.1-1. Correlation of Mojave Desert Geomorphic Events
(Qf designates period of alluvial fan deposition, Qe eolian dune formation, and L pluvial lake highstands; from McDonald, McFadden and Wells 2003:198)

In general, the Pleistocene-Holocene transition, ca. 13,000 to 9,000 years before present (B.P.), represents a major period of fan deposition, followed by subsequent periods during the Holocene at approximately 8,000 to 5,000 B.P., 4,000 to 3,000 B.P., and after approximately 1,500 B.P.. It was initially conjectured that these periods, especially around the Pleistocene-Holocene transition, correlated with general environmental desiccation, a decrease in soil moisture and vegetation, and an increase in sediment supply and erosion (e.g., Bull 1991; Wells et al. 1987). However, recent field studies have demonstrated that changes in vegetation cover alone do not explain increased sediment mobility. Instead, the most plausible hypothesis points towards a northward shift in the dominant late summer/early fall jet stream, allowing tropical Pacific cyclones from southern Mexico into the region and causing unusually large amounts of precipitation over short periods (McDonald, McFadden and Wells 2003:202). A biannual monsoonal weather pattern is still present in the lower elevations of the Colorado Desert, including Palo Verde, where February and August are the two wettest months (Western Regional Climate Center 2011). It is likely that the summer rainy season was more intense during these periods, but precipitation during the remainder of the year would have been similar to the very low levels present today (approximately 2 inches during non-summer months).

Pollen and lake-level records suggest general trends in Late Pleistocene and Holocene climate change, but these records do not make clear what meteorological changes are responsible for the trends. Pleistocene climate was wetter and cooler than today, with extensive lakes (including Ford and Palen lakes northwest of the project area), and pinyon-juniper woodlands extending into much lower elevations (Spaulding

1990). The vegetation transition from the Pleistocene through Early Holocene appears to have been relatively gradual, with woodlands retreating and giving way to desert scrub. During the middle Holocene (ca. 8,000 to 4,000 B.P.) climate appears to have been generally warmer and drier than today, though there are some indications of significant oscillations in climatic patterns (Spaulding 1990), possibly akin to those suggested by McDonald, McFadden, and Wells (2003), that were responsible for the middle Holocene Qf3 fan deposition in the Soda Mountains (see Figure 3.1-1, above). The Late Holocene climate was generally similar to modern conditions. However, given the higher resolution record for this more recent period, it appears that several periods of extended drought (including the Medieval Climatic Anomaly, ca. 1150 to 600 B.P.) as well as at least one cooler wetter period (the Little Ice Age, ca. 600 to 150 B.P.; Grove 1988) marked the Late Holocene.

The project area and lower elevations within the Colorado Desert in general, appear to have experienced vegetation regimes similar to today for most of the Holocene (ca. 11,000 years; Schaefer 1994:60-63). The creosote-scrub habitat that typifies the project area would have been established at lower elevations by the Late Pleistocene, providing prehistoric inhabitants with access to similar natural resources throughout much of prehistory. As discussed above, numerous studies, particularly in higher elevation portions of the Colorado and Mojave deserts, have demonstrated relatively significant climatic, precipitation, and vegetation fluctuations throughout the Holocene (Kaijnkoski 2008). Nonetheless, regional climatic trends through the Late Pleistocene and Holocene are important to the current study because of effects at higher elevations and the production of material for alluvial fan deposition.

Periodic increases in effective moisture likely resulted in higher seasonal wash flow, improving the exploitable habitat for human residents, but also accelerating the geomorphic processes that led to the burial or erosion of archaeological sites. These climatic changes also increased the sediment supply available for wind-blown (eolian) transport on dry lake beds and former stream channels during intervals of decreased effective moisture. Eolian processes deflated sediment source areas and deposited that material elsewhere. Taken together, these processes created, destroyed, and buried landforms that humans may have occupied across the Colorado and Mojave Deserts.

3.1.1.1 Geologic Mapping and Identification of Major Landforms

An in-depth geologic study of the northern portion of the project area was conducted by the United States Geological Survey (USGS). This study included a synthesis and description of geologic units and mapping at a 1:24,000 scale (Stone 2006). This information was incorporated into an online GIS database which was used as the basis for additional geologic mapping for the southern portions of the project area, as shown in Figure 3.1-1. The additional mapping effort was initially conducted through GIS, using aerial and topographic imagery to correlate with the existing mapped geologic units. This mapping was then field verified during a primary field study conducted by URS geoarchaeologist, Jay Rehor, from March 28 to 31, 2010. The purpose of the field study was to verify and modify the desktop mapping effort, assess the veracity of the units previously mapped by Stone (2006) within the project area, and assess those units for geoarchaeological sensitivity through examination of soil profiles and other indicators of landform age and processual development.

By examining the relationship among the landform components, we can develop relative age estimates, conclusions as to the depositional history of that landform, and the potential of each landform to harbor buried paleosols of appropriate age.

Before beginning such a discussion, however, it is necessary to define a common set of descriptive landscape terms and definitions used in the following paragraphs. Many different terms are used to describe desert geomorphology, with vastly different implications of scale, accuracy, and implied formation processes. “Alluvial fan” and “bajada” are two common terms that are often misleading because they are used to refer to different types of depositional and erosional landscapes, and they subsume numerous smaller landform components. The terminology adopted in this study follows after Peterson (1981) because the classification system emphasizes the temporal and spatial relationship between landform components, and was devised in relation to the study and classification of Basin and Range soils, thus making it highly relevant to the current geoarchaeological study. A discussion of these various landforms is provided in the following sections, with direct reference to the project area and the geologic units classified by Stone (2006).

At the broadest scale, the larger Palo Verde Mesa study area has many features that would classify it as a “semi-bolson” (Confidential Figure 3.1-2). Common in desert regions of the Basin and Range, semi-bolsons differ from true bolsons in that they lack a playa or floodplain, on which alluvial fans normally terminate, and instead are cut through by an axial drainage that marks the termination of the various piedmont landforms. However, the Palo Verde semi-bolson is anything but typical, due to the fact that the axial channel is not an intermittent stream or wash as usually found in Basin and Range semi-bolsons, but rather is the Colorado River, a perennial river that has a drainage basin of approximately 250,000 square miles. The Palo Verde Mesa area represents a mixture of typical semi-bolson desert landforms and features that are more typical of semi-arid and sub-humid river valleys. For the purposes of this discussion, we will employ the terminology used by Peterson (1981:30-34) to describe semi-bolson landforms, with some additional terminology more typical of river valleys (e.g., “inset terrace”).

The project area semi-bolson can be further divided into two dominant structural sections. The western half consists of the Mule Mountains and associated coalescing alluvial fan piedmont gradually sloping down to the east. The second dominant structural section is formed by several inset alluvial terraces which form Palo Verde Mesa, and includes the modern floodplain formed by successive aggradations and degradations of the Colorado River. This fluctuation in the base level of the Palo Verde valley has dramatic implications for the preservation of Quaternary deposits. Gradual base level rise in typical internally drained desert basins has favored the burial of Quaternary piedmont deposits by successively younger alluvium. The Colorado River, on the other hand, has experienced net downcutting of over 100 meters during the Quaternary (Bull 1991:50). This downcutting causes a drop in local base level, incision of tributary streams on the piedmont, and promotes erosion and transport of piedmont alluvium to the floodplain (new base level). Backfilling of the river valley, which has likely occurred through much of the Holocene (Metzger et al 1973:G28), gradually increases the base level, but only encourages aggradation and backfilling of the tributary drainages a short distance upslope from the height of the floodplain. The net result of this base level fluctuation is that erosion has played a greater role across the project area than in typical Basin and Range bolsons.

3.1.1.2 Dating Alluvial Desert Deposits

The ages of the various geomorphic surfaces within the project area are of central concern because age is one of the most important factors in constraining the possibility of buried archaeological deposits. Older land surfaces– those that were deposited prior to human occupation in the Americas (ca. 15,000 years ago) and which are still exposed on the surface– have, by definition, no possibility of containing buried archaeological deposits. On the other hand, younger land surfaces, if deposited in the right location, with low enough energy, may bury and preserve archaeological material previously deposited on an older surface. However, if these younger deposits unconformably overlie heavily eroded older formations, any archaeology that may have originally been deposited on the older surface would be effectively destroyed. Determining the nature of any subsurface contacts is thus integral to understanding the potential for buried archaeology within the younger landforms.

Unfortunately, dating of desert geomorphic surfaces is difficult and there is significant variation in the precision of various methods used in determining relative and numerical ages (McDonald, McFadden, and Wells 2003:190). Two primary, non-chronometric methods (e.g., not carbon-14, thermo-luminescence, etc.) are used for determining the age of desert landforms: soil development and desert pavement development. Confidential Figure 3.1-3 provides a graphic representation of pavement and subsoil horizon development through time in desert environments. Both of these methods are heavily dependent on environmental factors, such as temperature, precipitation, and parent material. As such, they are most effective within a confined homogeneous area.

Early investigations into the development of desert pavements hypothesized that they were formed through fluvial and eolian erosion of fine-grain sediments, leaving a deflated lag deposit of coarser material at the surface (Cooke 1970). More recent work– particularly on volcanic lava surfaces where fine-grain alluvial sediments are largely absent– indicates that desert pavements are instead formed through a process of fine-grain eolian sand and silt accretion (Wells et al. 1995). As dust blows onto a surface, it accumulates between larger surface clasts and, over time, infiltrates below the clasts and causes them to “float” on a fine-grain layer that thickens over time. This process may partially explain the upper vesicular A-horizon (see below) noted in most older desert soils. However, erosion may still play a role in the formation of pavements in some contexts, such as eolian dune complexes (McAuliffe and McDonald 1995:61-62).

While desert pavement formation is dependent on factors of time and climate, parent material also plays a major role. In general, alluvium derived from plutonic (e.g., granitic) sources form much weaker pavement– with fewer interlocking stones and less evident varnish– than volcanic and limestone sources (McDonald, McFadden, and Wells 2003:193). Along a Mojave Desert mountain front, it was determined that “minimal, if any, pavement formation occurs on alluvial fan surfaces in the granite-derived piedmont, regardless of age” (Eppes, McDonald, and McFadden 2003:109).

Given these factors, perhaps a more reliable estimate of landform age within the project area is soil horizon development. Due to the time-transgressive nature of soil development in arid environments, the stage of calcium carbonate (CaCO3 or “k”) illuviation and development, and the degree of B horizon development are identifiable markers of age. In this study of the project area, the degree of desert pavement formation and calcic horizon formation were used together as indicators of landform age during field studies. In addition, more typical soil classifications were made on the limited exposed profiles in order to assess pedogenic processes at play in the project area.

In general, soils on older Pleistocene alluvium are characterized by a strongly cemented (Stage III), well-developed calcium carbonate B or K horizon (Confidential Figure 3.1-4). Conversely, Holocene alluvial fan deposits typically exhibit a bar and swale surface morphology lacking prominent desert pavement development. Early Holocene alluvial fan deposits typically exhibit moderate B-horizon development and Stage II calcium carbonate morphology. Middle to Late Holocene alluvial fan deposits tend to have very weakly developed B horizons and Stage I calcium carbonate morphology. Latest Holocene surfaces, which are generally active washes, exhibit no soil development (Dohrenwend et al. 1991:328; McDonald, McFadden, and Wells 2003:193).

Very few natural subsurface exposures were observed during the field reconnaissance. As such, few soil profiles were recorded and described, and are not discussed extensively in the following analysis. However, a brief review of soil terminology is necessary to allow better understanding of the few figures that contain soil profiles. For this study, master soil horizons were defined using standard United States Department of Agriculture (USDA) soil taxonomy (Soil Survey Staff 2006) and techniques specific to desert soils (Birkeland, Machette, and Haller 1991). This organizational system uses upper-case letters (A, B, C) to describe in-place weathering characteristics. 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 upon which the other soil horizons formed. These master horizons are preceded by Arabic numerals (2, 3, etc.) when the horizon is associated with a different stratum, where number 1 is understood but not shown, and lower numbers indicate superposition over larger numbers. Lower-case letters are used to designate subordinate soil horizons (Table 3.1-1). Combinations of these numbers and letters indicate the important characteristics of each major stratum and soil horizon from which inferences can be drawn.

Table 3.1-1
Subordinate Distinctions within Master Soil Horizons

Subordinate Horizon	Description
c	Cementation or induration of the soil matrix
k	Accumulation of pedogenic carbonates, commonly calcium carbonate
m	Strong cementation
Ox	Oxidized iron and other minerals in parent material (C-horizon)
t	Accumulation of subsurface silicate clay (illuviation)
v	Vesicular soil development

3.1.1.3 Geoarchaeological Assessment Methods

Major landforms within the project area were initially identified using both color and black-and-white aerial photography (Microsoft 2010, Digital Globe 2009), in combination with existing geologic maps of the area (Hamilton 1984; Jennings 1967; Metzger, Loeltz, and Irelna 1973; Stone 1990, 2006). Given these designations, certain broad assumptions could be made about the age and depositional history of each portion of the project area. The mapping and assumptions were verified and modified during an initial field reconnaissance through on-the-ground examination of the landscape and key indicators, such as superposition, relative slope, desert pavement development, and subsoil formation. Subsurface examination within the project area was limited to natural exposures within existing washes and drainages. Due to the gradient of these drainages, the majority of exposures were present in the eastern portions of the project area and diminished to the west. The majority of the drainages in the western portions of the project area are relatively small with only minor incision. No archaeological material was observed in any of the few subsurface exposures.

The combined results of this study are shown in Confidential Figure 3.1-5 and summarized in Table 3.1-2. The following paragraphs provide a discussion of these results.

Table 3.1-2
Summary of Geoarchaeological Sensitivity of Landforms within the Project Area

Geologic Map Unit	Landform	Age Estimate*	Present Depositional Regime*	Sensitivity
TRqm, TRd, Tv, Pgn, Jp, Jv	Rock Outcrops	Tertiary or older	Erosional	None
QTmm and QTa2	Upper Alluvial Fan Piedmont	Early Pleistocene or older	Erosional	None
QTmw	Relict Colorado River Gravel Terrace	Pliocene to Pleistocene	Erosional	None
Qa3, Qa5	Alluvial Fan Piedmont	Pleistocene to Late Holocene	Variable	Very Low to Moderate
Qa6	Lower Alluvial Fan Piedmont	Middle to Late Holocene	Depositional	Moderate to High
Qpv	Colorado River Terrace	Pleistocene	Erosional	Very Low
Qs, Qa6	Alluvial Flat	Late Holocene	Depositional	Moderate to High
Qw	Active Washes (and associated minor landforms)	Pleistocene to Holocene	Erosional	Low
Qm	Modern Alluvial Fan	Recent	Depositional	Moderate to High
Qr	Floodplain	Holocene	Depositional	Moderate to High

* From Metzger, Loeltz, and Irelna 1973; Stone 2006; and Malmon et al. 2011.

3.2 PROJECT LANDSCAPE RECONSTRUCTION

Assignment of landform types and ages within the RMS Project area are based primarily on distinct surface morphological traits, which are easily observable and have similarities with geomorphic units classified locally (Stone 2006) and more generally throughout the Mojave and southern Great Basin (e.g., Bull 1991; Enzel, Wells, and Lancaster 2003). Of particular utility in these assignments is Bull's (1991) seminal study of desert landforms. As discussed above, it has been well documented that landforms across the region, particularly alluvial fan units, were the result of relatively discreet climatic oscillations, and that surface morphologies (as well as subsurface profiles) exhibit some very similar characteristics.

Assignment of landform type (and associated age) was initially made using aerial photographs, and then field checked. Assignments were made based on distinct morphological traits which have been shown to correlate between alluvial landforms of similar age and depositional history. As Bull (1991:51-52) notes, “each age of alluvial geomorphic surface in the valleys tributary to the Colorado River has a distinctly different topography, soil profile, and sedimentology… part of the evidence that the six main geomorphic surfaces are the result of climatic change consists of their regional extent.” Bull provides very in-depth metrics for differentiating between the various regionally synchronous alluvial surfaces. These range from surface morphologies such as degree of pavement formation, degree and color of varnish on surface clasts, surface roughness (e.g., bar-and-channel, bar-and-swale, planar/flat, etc.), degree of dissection/erosion by dendritic drainage channels, and height above active channels; to subsurface pedogenic indicators such as depth and degree of carbonate and argillic clay accumulation. On aerial photos, these characteristics lead to a distinct overall expression of the alluvial fan landform, which can help differentiate between the four broad periods of deposition typically seen in the region (i.e., modern/late Holocene; latest Pleistocene-middle Holocene; late Pleistocene; and Plio-Pleistocene). These metrics, which were used to differentiate between alluvial landforms within the Project area, are reproduced in **Table 3.1-3** for ease of reference, discussed below for each of the landforms, and highlighted in representative photographs of the project area.

Most of the locally derived alluvial-fan deposits in the map area are divided into five units (QTa2, Qa3, Qa4,Qa5, Qa6) based primarily on their surface morphology and their appearance on aerial photographs. Each of these units corresponds to one or more of nine regionally widespread alluvial geomorphic surfaces distinguished by Bull (1991). The oldest and thickest unit (QTa2, equivalent to Q1 of Bull) forms deeply dissected hills and ridges adjacent to the range fronts. Parts of this unit could be as old as late Miocene. Alluvium of Pleistocene age (Qa3 and Qa4, mostly equivalent to the Q2 surfaces of Bull) forms smooth, varnished pavements, whereas Holocene alluvium (Qa5 and Qa6, mostly equivalent to the Q3 and Q4a surfaces of Bull) forms rough surfaces that preserve relict depositional bars and channels. Most of the middle Pleistocene to Holocene alluvial units are interpreted as the products of aggradation events that took place during interglacial climatic environments (Bull, 1991). The youngest locally derived alluvium is that of modern washes (Qw, equivalent to Q4b of Bull), which commonly are incised many meters into the older alluvial-fan deposits.

For landforms other than alluvial fans—those having been deposited directly by the Colorado River—other indicators were used, such as the presence of exotic rounded cobbles and gravels, which could not have come from the Mule Mountains. These fluvial landforms have been well documented (Metzger et al. 1973; Stone 2006; Malmon et al. 2011) and their differentiation from the local alluvial fan landforms, and correlation with established aggradation/degradation cycles of the Colorado River is relatively straightforward. Following the description of each landform, a narrative geomorphic history is presented which attempts to make clear the temporal and depositional relationships between the various landforms.

Table 3.1-3
Characteristics of Quaternary alluvial geomorphic surfaces within RMS Project Area.

Geomorphic Surface	Equivalent of Bull (1991)	Approximate Age* (from Bull 1991 and McDonald et al. 2003)	Characteristic Morphology	Aerial Photo Characteristics	Soil-Profile Horizons (from Bull 1991 and confirmed in limited natural exposures)			Geoarchaeological Sensitivity
					A	Bw, Bt	Bk, K	
Qw	Q4b	active channel (modern)	Unconsolidated, angular to subangular gravel and sand derived from local mountain ranges. Mapped areas include both large individual washes and closely spaced smaller washes. Active washes, with distinct bar and channel morphology, clearly incised into other landforms, except for higher on piedmont, where they made grade laterally into young alluvial sand and gravel of Qa6.	Unvarnished, light hues, with obvious vegetation	None	None	Unweathered sandy gravel	Low
Qa6	Q4a	0-2,000 BP	Surface morphology of abandoned bouldery bars and channels. Young alluvial-fan and alluvial-valley deposits characterized by a lack of desert varnish, generally fine grain size, and evidence of recent sediment transport. Consists mostly of sand, pebbly sand, and sandy pebble-gravel; forms very gently sloping to nearly flat valley floors marginal to older, varnished alluvial-fan deposits. Surfaces are covered by sparse to moderately dense vegetation and commonly are transected by shallow channels of active sediment transport. Thin accumulations of eolian sand, not mapped separately, are present locally. Near mountains, unit includes relatively coarse, youthful, unvarnished gravel deposits of alluvial fans that grade downslope into the fine-grained deposits. Unit also includes deposits of many minor washes and channels (equivalent to Qw) too small to be mapped separately.	Unvarnished, light hues, with obvious vegetation	None	None	Unweathered sandy gravel	Moderate to High
Qa6	Q3c	2-4,000 BP	Similar to above, but preliminary bar and swale surface morphology (i.e., enough time for bars to begin to smooth into channels and form swales); landform is generally 0-2 m above active stream channels. Minor rock vanish on some gravels/cobbles and incipient formation of desert pavement.	Gradational between above and below	10YR 7/4 silt, vesicular, 0.5-2 cm thick	None	Bk at 1-15 cm, I coatings <0.1 mm	Moderate to High
Qa5 (possibly including portions of Qa6, closer to mountain front).	Q3b	4-8,000 BP	Gravel and sand that form relatively young, undissected to little-dissected, bar-and-swale surface morphology with moderate pavements; landform is generally 0-4 m above stream channels. Unvarnished to lightly varnished (color of 7.5YR 3/4 to 3/3). Bars are composed of poorly sorted gravel; swales are composed of sand and fine gravel typically 2 cm in diameter or smaller. Vegetation can be light to moderately dense in swales but is sparse on bars.	Gray tones and "plumose" texture caused by bar and swale topography; minimal vegetation except in drainages	10YR 7/3 silt, vesicular, 5-12 cm thick	None	Bk at 5-20 cm I, coatings 0.1-05 mm	Moderate
Qa5 (and Qa4, not mapped in RMS project area).	Q3a	8-12,000 BP	Similar to above, but partially dissected, bar-and-swale morphology, with distinct pavements 1->10 m above channels. Rock varnish 7.5YR 3/3 to 3/3.	Gray tones and "plumose" texture caused by bar and swale topography; minimal vegetation except in drainages	10YR 7/5 silt, vesicular, 8-16 cm thick	Bw or none	Bk at 8-30 cm I-II, coatings 0.5-1.0 mm	Moderate to Low

Table 3.1-3
Characteristics of Quaternary alluvial geomorphic surfaces within RMS Project Area.

Geomorphic Surface	Equivalent of Bull (1991)	Approximate Age* (from Bull 1991 and McDonald et al. 2003)	Characteristic Morphology	Aerial Photo Characteristics	Soil-Profile Horizons (from Bull 1991 and confirmed in limited natural exposures)			Geoarchaeological Sensitivity
					A	Bw, Bt	Bk, K	
Qa3	Q2c	55-75,000 BP	Slightly dissected, planar pavements 1-6 m above channels. Alluvial-fan deposits of gravel and sand that form relatively old, dissected surfaces mostly characterized by smooth, varnished desert pavement. Typical pavements have little or no surface relief and are composed of tightly to moderately packed, angular to subangular rock fragments and generally less than 30 percent interstitial sand. Most surfaces have a dark brown to nearly black desert varnish (7.5YR 3/2 to 2/3), but some surfaces are lighter in color owing either to a relative abundance of unvarnished or lightly varnished granitic gravel or to vehicular or other human disturbances that have disrupted and crushed the original pavement. Pavement surfaces are dissected and drained by dendritic networks of sandy channels that vary in depth from less than 1 m to several meters; vegetation is moderate in these channels but is sparse to absent on the pavement surfaces. Unit includes surfaces that range from only slightly dissected to deeply dissected, and that may represent a wide range in age (i.e., more highly dissected = older).	Dissected but smooth black desert pavement on undissected areas; barren of vegetation	7.5YR 7/5 silt, vesicular, 8-18 cm thick	5YR 5/6 to 5/8 clayey gravel, Bt 8-30 cm thick	Bk at 20-55 cm, III, coatings 1-6 mm	Very Low
Qa3	Q2b, Q2a	>75,000 BP	Similar to above but with increasing dissection and continued erosion of pavements and distance between pavement areas. Smooth pavements 2-10 m above channels. Rock varnish 7.5YR 2/3 to 2/2. Little to no vegetation. May be represented in Mule Mountains, outside of the RMS project area.	Dissected but smooth black desert pavement on undissected areas; barren of vegetation	7.5YR 7/4 silt, vesicular, 8-20 cm thick	5YR 5/6 to 5/7 mottles, Bt 20-100 cm thick	Bk or K at 40-200 cm, III or IV, coatings >5 mm	None
QTa2	Q1	>1.2 Ma	Alluvial-fan deposits of fine to coarse, poorly sorted gravel and sand that typically form high, deeply dissected, narrow ridges extending away from mountain fronts, and deep ravines. Ridge and ravine or "ballena" landform. Some ridge crests are relatively flat, narrow plateaus that preserve small tracts of smooth desert pavement like that of Qa3, but most ridge crests are sharp to rounded and have been eroded to a level below that of any preexisting alluvial surface. Ridges 3-40 m above channel. Rock varnish 7.5YR 3/2 to 2/2.	Distinctive ridge and ravine ("ballena") appearance, with areas of dark remnant pavement limited to thin lines along the very peak of the ridges	7/5YR 8/3 silt, vesicular, 4-12 cm thick	Removed by erosion	Largely removed by erosion; K locally V and >2 m thick, coatings 20-50 cm	None
QTmw	N/A	>1.8 Ma	Not part of typical Mojave/Colorado River region alluvial fan sequence. Very old high inset terrace of Colorado River. Surface appears similar to very old alluvial fan, with very tightly packed, smooth pavement and very dark/distinct varnish, heavily dissected; indicative of very long period of stability. However, surface composed primarily of non-local rounded cobbles and gravels. Based on apparent age and position on landscape, most likely correlative with "Unit B" of Metzger et al. 1973. Oldest Qa3 fan units cover and are formed from eroded portions of the QTmw deposits.	Heavily dissected with distinct very dark brown hue pavement and lighter brown sideslopes of dissected ridges				None

* BP = years before present; Ma = million years before present

3.2.1 Rock Outcrops (Sensitivity: None)

Rock outcrops are present at the higher reaches of the piedmont, along the western side of the project area (Confidential Figure 3.1-5 and Confidential Figure 3.1-6). These rock outcrops form the Mule and Palo Verde Mountains and are composed of highly dissected bedrock that form steep, highly-eroded hills (inselbergs) sticking up out of the alluvial fans. Within the project area, rock outcrops are limited to the northwestern portions of the project site (Section 16) and are comprised of Triassic quartz monzonite and monzodiorite, designated by map unit TRqm (Stone 2006). While other types of bedrock that form the Mule Mountains are not present within the boundaries of the project area, they are worth noting because they provide portions of the parent material that forms the fans of the alluvial fan piedmont. These other local rock types include gneiss and amphibolite (Pgn), diorite and gabbro (TRd), porphyritic granitics (granodiorite and quartz monzonite; Jp), and volcanics (including rhyolite, dacite, and amphibole; Jv). Rock outcrops have no potential for harboring buried archaeological deposits.

3.2.2 Upper Alluvial Fan Piedmont (Sensitivity: None)

The fan piedmont, which makes up the majority of the western half of the project area and the slopes west of the project area (Confidential Figure 3.1-5), is actually a complex of component landforms composed of stable fans, erosional fan remnants, erosional sideslopes, gullies, and inset fans, which themselves have been further eroded and redeposited downslope. The fan piedmont can be subdivided into two broad categories, which are roughly correlative with relative age: the older upper alluvial fan piedmont and the younger lower alluvial fan piedmont.

The oldest major alluvial fan structure on the piedmont is also associated with the highest elevations of the fan piedmont. Map units QTa2 and QTmm (only a very small portion of which enters the ROW corridor in the northern portion of the project area) are very old remnant alluvial fan deposits. These units have steep gradients adjacent to the mountain fronts and form heavily eroded ballenas, fan remnants having a distinctively-rounded surface of fan alluvium, as they move away from the mountains. Although some very well-developed desert pavements may be preserved at the crest of the ballenas, the majority of the shoulder, sideslope, and footslopes have been heavily eroded and no longer preserve the original pavement surface. Profiles observed on the sideslopes of these units in the western portion of the project area, during geoarchaeological reconnaissance surveys for this project, showed significant over-thickened carbonate development (Stage III+), though the amount of carbonate accumulation may be less than the equivalent age of the landform due to ongoing erosion. Stone (2006:11) concludes that the units are probably equivalent to the geomorphic surface Q1 of Bull (1991), which are presumed to have been deposited over 1.2 million years ago (Ma). As such, the QTa2 and QTmm units of the upper alluvial fan piedmont are assumed to have no potential for buried archaeological resources.

3.2.3 Relict Colorado River Gravel Terrace (Sensitivity: None)

Located within the fan piedmont, this landform in many ways resembles a remnant alluvial fan deposit, with very well formed desert pavement at the surface, and rounded erosional sideslopes similar to the older fan units. However, this landform, designated by map unit QTmw, is composed of large, well rounded gravels and cobbles. The clasts are almost exclusively non-local rock types, with a wide variability including cherts and other silicious rocks, cryptocrystalline quartzites and mudstones, and only minor amounts of gravels derived from the Mule Mountains. This rounded cobble and gravel deposit is identical to the one identified by Stone (2006) in the McCoy Wash area approximately 12 miles (approximately 19.3 kilometers) north, and at almost the exact same elevation approximately(443 to 476 feet (135 to 145 meters) above mean sea level [AMSL]). The well rounded cobbles and their exotic origin clearly demonstrate that they were deposited by the paleo-Colorado River during an aggradational event when the river flowed at much higher elevations than today. Superposition above Palo Verde Mesa indicates that the formation predates the incision and subsequent emplacement of the Qpv river terrace (see Confidential Figure 3.1-5). This relict Colorado River gravel terrace may represent the upper portion of Metzger et al's Unit B; if so, the landform likely dates to the Pliocene or early Pleistocene (Metzger et al. 1973:G22; Stone 2006:12).

As noted above, the surface characteristics of this landform appear similar to an older Pleistocene fan, suggesting that the original Colorado River gravel deposit was likely subjected to post-depositional erosion followed by stabilization sometime during the Pleistocene—perhaps correlative with the deposition of the Palo Verde Mesa (Qpv) alluvium. The rounded gravels and cobbles of the relict Colorado River terrace have been reworked and redeposited, to varying degrees, in the younger alluvial fan units of the lower fan piedmont. Some higher elevation portions of the Qa3 fans have mantled on top of the QTmw terrace (Confidential Figure 3.1-6), while other portions have eroded through and bisected the terrace, thus transporting the rounded cobble material further downslope. Based on limited field observations, these redeposited cobbles appear to have been the primary source for lithic artifacts identified on the Qa6 (and to a lesser degree Qa3) fans. Due to the age of the landform, the relict Colorado River gravel terraces are presumed to have no sensitivity for buried archaeological resources, although some artifacts have been incorporated into the desert pavement surface of the landform and are likely of considerable antiquity.

3.2.4 Lower Alluvial Fan Piedmont (Sensitivity: None to High)

The lower portions of the alluvial fan piedmont within the project area are composed of geologic units Qa3, Qa5, and Qa6. Each of these units represents a period of fan building. These periods have coalesced to form the fan piedmont. Compared to the older upper portions of the piedmont, these fans form a more gradual slope. These Late Pleistocene to Late Holocene alluvial fans are equivalent to Q2, Q3, and Q4a units of Bull (1991).

Qa3 is the oldest of the lower piedmont fan units. These fans are typically covered with a smooth, well varnished desert pavement composed primarily of angular to subangular locally derived gravels and cobbles. The landform generally lacks evidence of bar and swale topography, but is heavily dissected in places by erosional gullies and channels. Confidential Figure 3.1-7 shows a typical surface pavement for the Qa3 fans, though the degree of desert varnish is inconsistent due to variability in parent material across the Mule Mountains and variability in timing of deposition (i.e., Late Pleistocene to earliest Holocene). Vegetation is largely absent except in the erosional gullies. Stage II to III carbonate development is evident in the limited subsurface profiles observed on the Qa3 fans within the project area.

The Qa3 fans likely formed roughly coincident to the emplacement of the Palo Verde mesa alluvium (Qpv; see below) and prior to subsequent incision by the Colorado River. The Qpv alluvium was deposited as the floodplain of the river, and, as such, acted as the local base level at the time the Qa3 fans were deposited. This is demonstrated by the interfingering of Qa3 and Qpv sediments (Stone 2006:11). As such, the Qa3 fans were primarily deposited during the Pleistocene, prior to the incision of the Colorado River below the Qpv terrace deposits (see below). This correlates with Bull's (1991) Q2 fan units which date from 12 to 730 thousand years ago (ka). The fans are primarily as old as, or older than, the first documented evidence for humans in the New World, and, as a result, have a very low potential for buried archaeological deposits.

Qa5 is the next youngest fan unit present on the alluvial fan piedmont within the project area. The unit is not well represented within the project area, but is gradational to the older portions of the Qa6 fan unit (i.e., some minor areas mapped as Qa6 may be closer to Qa5 in both morphology and age). These fans are typified by bar and swale morphology that decreases in intensity further from the apex of the fan. The fans are only partially dissected by erosional gullies and have a weak to moderately packed surface pavement with light varnish. The bars are dominated by gravels while the intervening swales are dominated by smaller pebbles and sands that have infilled the original channels. Vegetation is larger within the swales, but also present on some bars. Subsurface profiles observed within the project area have Stage I to weak Stage II carbonate development. This morphology and subsurface carbonate accumulation is equivalent to Bull's (1991:86) Q3c and Q3b fan units which date from 2 to 8 ka.

It is difficult to assess the sensitivity for paleosols and associated buried archaeological deposits without knowing the nature of the stratigraphic contacts between the Qa5 alluvial fans and any underlying older geomorphic units. No paleosols were noted in any of the natural exposures observed in the project area. Based on previous studies in the Basin and Range, alluvial fans are often underlain by an erosional unconformity that precedes deposition of the fan (URS 2010; Bull 1991:68, 73). This effect is less pronounced at the foot of the fans, where sediments are usually more fine-grained and erosional/depositional energy is lower. As such, the Qa5 portions of the fan piedmont are presumed to have a generally low sensitivity for buried archaeological resources, with slightly increased (moderate) sensitivity at the distal margins of the fans, where they mantle older deposits of the Palo Verde Mesa (Qpv; see below).

Qa6 is the youngest fan unit represented on the alluvial fan piedmont. As discussed above, this unit is gradational to the Qa5 unit, but generally exhibits a morphology that is indicative of a younger geomorphic surface. This includes a surface that exhibits bar and swale morphology grading to recently abandoned bar and channels in some locations. Surfaces closer to the Mule Mountains and older fan units are characterized by loosely packed cobbles, coarse gravels, and sands, while the distal portions of the fans are dominated by finer grained sediments (pebbles and sands; Confidential Figure 3.1-8). Little or no varnish is present. Vegetation is present across the fan surface, but varies from sparse to moderately dense. Subsurface profiles exhibit Stage I carbonate development or none at all. This morphology and subsurface carbonate accumulation is consistent with Bull's (1991:86) Q4a fan unit which dates to 0.1 to 2 ka, but may be more similar to Q3c (2-4 ka) in places. Sensitivity for buried archaeological resources is presumed to be similar to that of the Qa5 map unit.

Within the majority of the project area—except for the northwestern extent of the transmission line and substation alternatives where the fan piedmont grades out to a broad alluvial flat (see below)- the Qa6 fans terminate at a topographical barrier created by the Palo Verde Mesa. In profile, the western extent of the mesa crests and then forms an almost imperceptible backslope (dipping to the west; Confidential Figure 3.1-9). This backslope was likely created through erosion rather than tectonic tilting, as tectonic activity is thought to have been dormant in the area prior to emplacement of the Colorado River sediments (Metzger et al. 1973:G36). In many locations, a very small erosional gully has formed at the contact between the toe of the Qa6 fan and the backslope of the Palo Verde Mesa, draining north or south to the nearest active wash (Qw; see below). This distal margin contact of the Qa6 fan represents the most likely location for preservation of paleosols, due to it being the lowest energy depositional setting of the Qa6 fan unit, and the potential for burial and preservation of the underlying Qpv surface.

3.2.5 Colorado River Terrace (Sensitivity: Very Low)

Palo Verde Mesa, which forms the 70-foot-high cliff along the edge of the modern Colorado River floodplain (Palo Verde Valley), is the result of a series of aggradation and progradation events by the paleo-Colorado River. A diagram of the series of events that led to the multiple terraces and floodplain landforms observed today in the Palo Verde region was developed by Metzger et al. (1973:Plate 4) and is reproduced here in Confidential Figure 3.1-5. The landform mapped here as a Colorado River terrace and designated by map unit Qpv (Confidential Figure 3.1-2) is equivalent to Units D and E of Metzger et al. (1973:G24). The break in slope in the middle of the Palo Verde Mesa, evident in cross section (Confidential Figure 3.1-5), is designated by the dotted line on Confidential Figure 3.1-5.

The Colorado River terrace deposits are characterized by a very thick deposit of stratified clays, silts, and sands, with minor gravels. The surface of the landform is characterized by tan to light-gray, sandy and pebbly alluvium. This overlies the cliff-forming unit of light-reddish-brown bedded fine-grained material. There is considerable variability in the surface expression of the terrace deposits, with some areas containing sand and pebbly sand with a mixture of local and river gravels (equivalent to Unit E of Metzger et al. 1973), and other areas largely lacking larger clasts (equivalent to Unit D; Confidential Figure 3.1-10). The terrace deposits are mostly devoid of the bar and swale morphology of the younger fan units, but are minimally dissected by erosional gullies. An extensive marker bed, consisting of well-developed, blocky red clay, was observed in several of the larger wash profiles near the top of the Qpv strata (Confidential Figure 3.1-11). This bed is consistent with other locations along Palo Verde Mesa where vertebrate Pleistocene fossils have been found and that are interpreted as having been deposited in small, shallow floodplain lakes (Metzger et al. 1973:G25).

Due to the unconsolidated, fine-grain nature of the surface of this landform, it is often very difficult to distinguish Qpv in the field from the distal margins of the Qa6 alluvial fans. The surface of the Qpv terrace deposits have begun to erode down into underlying pedogenic carbonate soil horizons in some locales. As a result, small carbonate pebbles have eroded out and been incorporated into the surface of the landform. These carbonate pebbles, or peds, are absent on the Qa6 fans. The change in slope between the backslope of the terrace deposits and the distal edge of the Qa6 fans, described above (and shown in Confidential Figure 3.1-9), is readily identifiable in the project's GIS and is, perhaps, the best means of identifying the contact.

The Colorado River terrace deposits have been assigned a date of middle to Late Pleistocene based on the presence of fossils (Metzger et al. 1973:G25). As such, they are considered too old to contain buried archaeological deposits. The only caveat to this assessment lies in the unconsolidated nature of much of the Qpv surficial deposits. While these unconsolidated fine-grain deposits are conducive to erosion and transport into the larger washes and off of the Palo Verde Mesa, it is also possible that some of this transported material has been redeposited on the mesa surface as thin eolian and/or alluvial deposits. Such deposits observed within the project area are limited (1 to 2 meters across) and are generally very thin (a few centimeters). While there is potential that these areas of redeposited fine-grain sediment could obscure archaeological deposits, it is unlikely that they would completely obscure an archaeological site. Furthermore, buried artifacts and/or features are likely to be similar to those found across the rest of the site. As such, the Colorado River terrace landform of Palo Verde Mesa has a very low sensitivity for buried archaeological resources.

3.2.6 Alluvial Flat (Sensitivity: Moderate to High)

The alluvial flat, located in the northwestern portion of the project area near the transmission line and substation alternatives, represents the eastern extent of the Chuckwalla Valley. The majority of the alluvial flat is composed of the distal portions of the Qa6 fans. As such, this area could also be considered an apron of the lower fan piedmont. However, alluvial flat is preferred here because it describes the properties of the geomorphic surface– a nearly level alluvial surface at the base of the piedmont– without assuming genesis from a single parent landform, and without inherent morphological assumptions. Within this area, the Qa6 fan surface is composed of primarily fine-grain material with limited gravels and little or no relief. Also present on the alluvial flat are areas that have been mapped as eolian sands (Qs). These are unconsolidated sand dunes and sheets that have blown east from the Chuckwalla Valley and Ford Dry Lake, and mantle the Qa6 alluvial deposits. Smaller areas of eolian sand occur locally in other portions of the alluvial flat but have not been mapped due to their limited areal extent.

As with other portions of the distal Qa6 fans and Palo Verde Mesa river terrace deposits, differentiation between the two units can be difficult in the northwest portion of the project area. This is further complicated by the presence of eolian sands that, when deposited as a small, thin sheet, are similar to the unconsolidated, fine grain portions of the river terrace landform. The alluvial flat generally is a very young landform at the surface. The flat, distal portions of the lower alluvial fan piedmont are presumed to be dominated by the latest Holocene alluvium, while the eolian sand that mantles it is even younger. No subsurface exposures were observed within the alluvial flat, thus, the presence and condition of any paleosols is unknown. However, the geoarchaeological sensitivity is considered to be similar to those portions of the Qa6 fans that mantle the Palo Verde Mesa terrace deposits (i.e., moderate). A higher sensitivity can be assumed for those areas mapped as Qs, as these are very recent deposits that can easily obscure surface artifacts. Small unmapped areas of eolian sand, while potentially obscuring isolated artifacts or features, are small and thin enough that they are unlikely to obscure complete sites. Any sites obscured by Qs deposits are likely to be relatively young (less than ca. 1 ka) due to the age of the underlying Qa6 deposits.

3.2.7 Active Wash (Sensitivity: Low)

This landform, mapped as unit Qw, is comprised of unconsolidated sand, gravel, and boulder deposits of the larger active channels, as well as component landforms related to the active channel. While the active wash is primarily an erosional structure, small depositional features, such as inset fans and terraces and fine overbank deposits, are the result of deposition by the channel and are subsumed in this map unit. The active washes are dominated by gravel bar and sandy channel surface morphology (Confidential Figure 3.1-8). Mapped areas include both large individual washes and closely spaced smaller washes. Vegetation within the washes is greater than anywhere else in the project area due to the greater availability of water. The active washes are modern in age, equivalent to the Q4b geomorphic surface of Bull (1991), but, for the most part, have no sensitivity for buried archaeological resources as the result of ongoing active erosion.

Certain minor component landforms of the active washes are depositional. The largest of these component landforms are the inset fans or stream terraces. These landforms are created through deposition along the margins of the active channel, and are confined by the channel and adjacent older higher elevation landforms (e.g., the erosional sideslope of Qpv or Qa3). Although these component landforms are young and depositional in nature, they are generally considered to have a low potential for paleosols and associated buried archaeological resources due to their deposition on an erosional unconformity. As demonstrated on Confidential Figure 3.1-9, the inset fans and terraces of the active washes are laid down in areas that were previously scoured by the active channel—thus creating an unconformity and significantly reducing the likelihood of preservation of archaeological resources. In general, the active washes and component landforms are considered to have a low sensitivity for paleosols and associated buried archaeological deposits.

3.2.8 Modern Alluvial Fan and Floodplain (Sensitivity: Moderate to High)

These distinct landforms are discussed together here because of their close functional relationship and because they both have very limited presence within the project area. Modern alluvial fan deposits are mapped as Qm and represent the depositional equivalent of the active washes, where the washes débouché from the Palo Verde Mesa onto the modern alluvial floodplain of the Colorado River. The modern floodplain deposits are mapped as Qr. Both units are composed of unconsolidated clay, silt, and sand, and are largely undifferentiable in the field due to the interfingering of the deposits and the degree of agricultural disturbance across the Palo Verde Valley up to the base of the mesa. For the purposes of this study, the modern alluvial fan landform was mapped from the edge of Palo Verde Mesa to the beginning of agricultural fields. Due to the young age of both of these landforms (latest Holocene to modern), and their depositional nature, they are considered to have a high potential for containing paleosols and associated buried archaeological resources.

The modern floodplain deposits (Qr) represent the most recent aggradational cycle of the Colorado River, and are equivalent to “younger alluvium” defined by Metzger et al. (1973) (Confidential Figure 3.1-5). The scale of the river’s degradation and aggradation is demonstrated by the presence of charcoal from 57 feet (± 17.4 meters) below the floodplain sediments near Blythe that was dated to 5,400 before present (BP), and to 8,600 BP from 110 feet (± 33.5 meters) below surface (Metzger et al. 1973:G28). If the surface of the Palo Verde Mesa terrace deposits (Qpv) represent the Late Pleistocene floodplain surface, this means that well over 200 vertical feet (± 61 meters) of sediment was eroded out of the Palo Verde Valley during the Late Pleistocene, and over 100 feet (± 30.5 meters) of sediment has filled the entire Blythe-Palo Verde Valley since the river began to aggrade again at the onset of the Holocene. In many ways, the scale and rapidity of this deposition precludes the accumulation of large stratified archaeological sites, and suggests that buried archaeological sites are more likely to be smaller, temporally discreet deposits. Nonetheless, the potential for paleosols and buried archaeological deposits is considered to be high.

Buried sites within the modern floodplain are likely to be located within close proximity to paleo-channels of the Colorado River. It has been well documented throughout California that sites tend to cluster near important resources, such as rivers and lakes, and the effect is only heightened in arid environments where water is a highly valuable resource. The same is true in buried contexts (Meyer et al. 2009). Therefore, the identification of archaeological deposits within the modern fan and floodplain landforms will be facilitated by the identification of paleochannel deposits. These deposits will be characterized by coarser grain channel bed forms that are distinct from the surrounding fine-grain alluvium. These paleochannels are more likely to be located within the body of the floodplain than on the margins. Therefore, the geoarchaeological potential of the Qr and Qm deposits within the project area (i.e., directly adjacent to Palo Verde Mesa) may be diminished compared to other locations further afield in the floodplain.

3.3 PROCESSUAL LANDFORM DEVELOPMENT OF THE PROJECT AREA

Based on the landform descriptions above, study of the Palo Verde Mesa (Metzger et al. 1973), and the broader regional correlations with well-studied and dated landforms (e.g. Bull 1991; Enzel, Wells, and Lancaster 2003; Malmon et al. 2011), the following narrative landscape evolutionary history has been developed for the Project area:

The plutonic and volcanic rock units, which form the Mule Mountains, were emplaced during the Mesozoic Era (ca. 65.5 to 251 Ma) as part of the larger Cordilleran and Andean arc magmatism. These units were subsequently deformed and uplifted during the Late Cretaceous (65.5 to 99.6 Ma) in association with the Mule Mountains thrust fault (Stone 2006:7). Erosion of these uplifted rock units was likely ongoing during this time, though the earliest surficial evidence of any erosion in the vicinity of the Project area is represented by map unit QTa2. The QTa2 is a very old alluvial fan, located at the highest elevation of any fan unit in the Project vicinity, directly fronting the Mule Mountains rock outcrops. The unit has since been heavily eroded, redeposited, and/or buried, leaving relatively small, discontinuous areas of deeply dissected narrow rounded ridges (ballenas) which have been mostly eroded below the level of any original surface pavement. In a few locations, at the peaks of ballenas, a flat lying, heavily varnished and imbricated pavement is still present, overlying a thick caliche horizon. Alluvial fans of this type are extensive throughout the Mojave region and are believed to have been deposited prior to 1.2 Ma (Bull 1991) and may be as old as the Miocene (>5.3 Ma). During that time, the fan unit was probably very extensive, forming large fan skirts (bajadas) along the mountain fronts.

Sometime during or subsequent to the initial formation of the QTa2 fan, the Colorado River flowed through the Project area, at an elevation much greater than today (at least 420 feet AMSL, versus approximately 260 feet AMSL today). Depositional evidence of this is preserved in the QTmw deposits. As discussed above, this is a relatively high-energy fluvial deposit, the surface of which is represented by well-rounded exotic gravels and cobbles transported from far upstream. These paleo Colorado River deposits were first recognized north of the Project area in McCoy Wash, at a similar elevation above Palo Verde Mesa (Stone 2006). The relationship between the QTmw terrace deposits and the QTa2 fan deposits is unclear, as both have been heavily eroded since original deposition and are no longer found in direct association (at least at the surface). The QTmw terrace is likely associated with the upper portion of "Unit B" of Metzger et al. (1973) as shown in **cross-section "A" on Confidential Figure 3.1-4**. Metzger et al. (1973:G22-G23) describe Unit B as sequence of heterogeneous fluvial deposits of the Colorado River, composed of silt, sand, gravel, and a minor amount of clay; "A unique lithology of unit B is the lenses of Colorado River pebble-cobble gravel… The gravel is made up of pebbles and cobbles that came from many miles upstream, and others that came from tributaries. Those from upstream sources are, rounded to well rounded and are composed of dense rocks [including quartzites and cherts]… from 6 to 8 inches in diameter. Initial deposition of Unit B occurred during the Pliocene or early Pleistocene (1.8 to 5.3 Ma).

Following the deposition of Unit B and the presumed associated QTmw terrace deposit, the Colorado River experienced a major degradational period, which eroded large portions of, and deeply into, Unit B, creating a large valley (**Confidential Figure 3.1-4, cross-section "B"**). This erosional period may have occurred as a result of extensive glaciation and lowered sea levels during the Pliocene.

At a certain point, the Colorado River transitioned to a major aggradational regime. Several hundred feet of alluvium, consisting of variable units of sand, mud, and minor gravels were deposited by the river over this period (**Confidential Figure 3.1-4, cross-section "C"**). As described above, these deposits form the Palo Verde Mesa (Qpv) landform, and the "Unit D" of Metzger et al. (1973). Although Metzger et al. (1973:G29) were hesitant to ascribe this depositional event to the Chemahuevi Formation—because of a belief that the Chemahuevi was formed under lacustrine conditions and an impoundment of the river upstream of Blythe—a more recent analysis of formations and dating along the length of the Colorado River, suggest that there is an extensive deposit downstream of the Grand Canyon, that can be functionally correlated, with some local variation (Malmon et al. 2011). Within the Project area, this depositional unit is represented by the Palo Verde Mesa (Qpv) deposits, but can be variably referred to as a local variation of the Chemahuevi Formation.

The gradient of this formation, over the 700km course of the river between the Grand Canyon and the Gulf of California, is almost 50% steeper than the modern floodplain (prior to construction of Hoover Dam) suggesting that this depositional period occurred relatively quickly and as a result of increased sediment supply rather than base-level response (Malmon et. al 2011:66)[1]. Numerous dates have been obtained for the Palo Verde Mesa deposits and the wider Chemehuevi Formation, including relative dates associated with fossil finds, radiocarbon dated wood, luminescence of quartz grains, and Uranium series dates of carbonates (both in soil and from fossils; Malmon et al. 2011:39). For the Palo Verde Mesa locale, numerous fossils have been found within the Colorado River deposits. All of these are Pleistocene taxa that occurred after 1.7 Ma, but few have been directly dated. Of the few radiocarbon dates obtained for the wider Chemahuevi Formation, all returned dates at or above ca. 40,000 BP, near the limit of the radiocarbon method; which raises doubts as to the efficacy of those results. Luminescence dates from numerous locales are nicely bracketed between >40,000 and approximately 70,000 BP. These dates, and chemical correlation between tephra layers in the northern outcrops of the formation, and those documented from Mammoth Lakes, indicates that the Chemhuevi Formation (including the local Palo

[1] Aggradation resulting from an increase in base level typically results in a moderately flat gradient, as sediment is deposited relatively evenly along the length of the watercourse, as a result of rising waters. Conversely, deposition during periods of increased sediment load with a lack of equivalent hydrologic increase, results in more material dropping out of suspension upstream, and decreasing downstream (thus resulting in a steep gradient).

Verde Mesa occurrence) was deposited between approximately 55,000 and 75,000 BP (Malmon et al. 2011:37-47).

Soon after deposition of the bulk of the Palo Verde Mesa deposits, the Colorado River underwent a minor degradation or fluctuation, which resulted in the erosion of a minor terrace in the formation and the widespread deposition of a near-channel sand unit (Unit E in **Confidential Figure 3.1-4, cross-section "D"**). As discussed in the previous section, this upper sand unit contains sands and minor gravels of both local (Mule Mountains) and exotic (upstream) derivation. Both Metzger et al (1973) and Malmon et al. (2011) group this minor sand unit with the larger formation, indicating that it was deposited soon after the cessation of the lower "Unit D" sedimentation (Confidential Figure 3.1-4) and is part of a single aggradation/degradation cycle. As the Colorado River began to degrade further, and stopped exerting influence on the Palo Verde Mesa (Qpv) landform, the landform entered a stabilized regime.

As discussed in the Paleontology section of the AFC for this project (URS 2011) a distinct "paleosol" has been identified at or near the surface of the Palo Verde Mesa (Chemehuevi Formation) deposits. While use of the term paleosol is questionable in this situation, given that it is largely present at the surface and not buried, the degree of soil development is indicative of the fact that the sediments remained relatively stable, at the surface, for the majority of the time since their deposition (i.e., for >40,000 years). Variability in carbonate morphology and other pedogenic indicators seen across the Palo Verde Mesa "paleosol" are indicative of variable erosion of the surface over time and during soil formation. This erosion is also indicated by the presence of distinct carbonate peds incorporated into the surface over a large portion of the landform (i.e., carbonates formed during initial pedogenesis were subsequently eroded out). A radiocarbon date of ca. 13,500 calendar years for a fossil tortoise shell fragment—reported in the Paleontology section of the AFC—does not indicate that the paleosol or the associated Qpv/Chemehuevi Formation was deposited at that time, but simply that the tortoise existed at the surface of the formation and burrowed into it during the terminal Pleistocene. Indeed, the Paleontology report acknowledges that the vast majority of fossils present within the Palo Verde Mesa paleosol are burrowing animals and that larger species are only represented "if rodents or carnivores drag pieces of the skeleton into their burrows" (URS 2011:*5-2*).

During the late Pleistocene, at approximately the same time as the deposition of the Palo Verde Mesa/Chemehuevi Formation, sediment within the Mule Mountains was transported downslope as an extensive alluvial fan unit, mapped here as Qa3 (after Stone 2006). Based on surficial morphology (described in the previous section and summarized in **Table 3.1-3**), the higher elevation portions of this landform, closer to the Mule Mountains rock outcrops, are equivalent to the Q2c alluvial fans described by Bull (1991). These alluvial fan units exhibit a very tightly packed angular to subangular surface pavement, with the darkest color of any of the Colorado River region fan units (Bull 1991:64-65). Pavement surfaces are dissected and drained by dendritic networks of sandy channels that vary in depth from less than 1 m to several meters. Dating of this widespread landform throughout the Mojave region using various dating techniques—from uranium-series dating of pedogenic carbonate to calibrated fault slip rates based on offset within the fan unit—provides a range of ca. 55,000 to 75,000; remarkably similar to the dates obtained for the Chemehuevi Formation. This consistency highlights the conclusion, demonstrated by numerous researchers in the Mojave/Colorado River region, that massive aggradations of valley floors and piedmonts seem to have been relatively rare occurrences which are recorded on a regional scale (Bull 1991:104). The Qa3 alluvial fans sit lower than the older QTa2 fans, and were likely deposited after erosion of, and include reworked sediments from, the QTa2 fans and QTmw terrace deposits.

Given the established timing discussed above for the deposition and stabilization of the Qpv/Chemehuevi Formation, it is probable that the dramatic incision of the Colorado River into the Palo Verde Valley (**Confidential Figure 3.1-4, cross section "E"**) occurred during the last glacial maxima (ca. 21,000 to 18,000 BP) in response to dramatically lowered sea levels. This period of degradation is also reflected in the distal portions of the Qa3 map unit, which is more of an erosional landform and contains much less preserved pavement (and thus a lighter color when viewed on aerial photos).

Beginning at the Pleistocene-Holocene transition, the Colorado River and the surrounding piedmonts began to aggrade once again (**Figure3.1-4, cross section "F"**). As sea levels began to rise and vast amounts of sediment were mobilized, due to a lack of vegetation cover keeping pace with the changes in temperature and precipitation, the Colorado River entered an aggradational period and the Palo Verde Valley began to infill. As discussed above, a radiocarbon date from 110 feet below the modern floodplain surface (map unit Qr) returned a date of approximately 8,600 BP. This date was not from the base of the Holocene floodplain deposits, and it is likely that the deepest portions of the floodplain sediments corresponds to the major environmental perturbations of the terminal Pleistocene, with sedimentation ongoing through much of the Holocene.

Within the Project area, the fan piedmont also entered another major period of aggradation at this time. The Qa5 and Qa6 alluvial fan units discussed above are terminal Pleistocene to Holocene in age. Based on surface morphology, the Qa5 units, and some limited proximal portions of the Qa6 fan units closer to the Mule Mountains, appear to be equivalent to Bull's (1991) Q3a and Q3b fan units. These alluvial fans form relatively young, undissected to little-dissected, unvarnished to lightly varnished surfaces typically displaying bars and swales modified from original depositional bars and channels. Based on radiocarbon and uranium-series dating from other mountain ranges in the Mojave Desert region (Bull 1991), these alluvial fans were deposited between approximately 4,000 and 11,000 BP. The Qa6 fans, on the other hand, represent the most recent episode of alluvial fan deposition. Based on surface morphology—a lack of desert varnish on surface clasts, lack of pavement, and distinct bar and channel morphology—these map units were largely deposited in the last 2,000 years (equivalent to fan episode 4a of Bull 1991). Within the distal reaches of the piedmont, closer to Palo Verde Mesa, the Qa6 fan is composed of finer grain sediments and may mantle older fan units such as the Qa5 and Qa3, as well as intermediate fan episodes (i.e., Qa4 of early Holocene age) not defined on the surface of the proposed project area.

Throughout the geomorphic history of the Project area, described above, the Colorado River has acted as the local base level for water coming out of the mountains. Given the elevation of the Palo Verde Mesa and Mule Mountains piedmont above the river, it can be assumed that the larger washes (Qw) which are active today, have been active since the late Pleistocene (**Confidential Figure 3.1-4 cross sections "D" and "E"**), when the Colorado River incised the Palo Verde Valley and water coming off the piedmont was forced to cut through the mesa (Chemehuevi Formation) in order to reach the river.

3.4 PRELIMINARY SUMMARY OF GEOARCHAEOLOGICAL SENSITIVITY

The field-verified findings from this geoarchaeological reconnaissance of the Rio Mesa SEGF project area are consistent with previous findings from the other Basin and Range contexts. In a recent summary of the nearby Mojave Desert region, Sutton (1996) concludes that, contrary to the popular belief that all archaeological sites exist in surface contexts, “there are… many depositional environments [within the Basin and Range], and there is a great potential for buried sites in many areas… e.g., along the Mojave River, along lakeshores, and in cave sites” (1996:225). Given results from other locations (e.g., Roberts, Warren, and Eskenazi 2007), dune complexes, springs, and other areas with widespread episodic and stabilized eolian deposition should also be added to the list. All of these landform types are largely absent from the current study area, which is consistent with an overall low sensitivity for buried archaeological sites within the landforms of the project area.

The fine grain distal margin of the lower alluvial fan piedmont (unit Qa6), which may be mantled on top of Pleistocene Colorado River terrace deposits of Palo Verde Mesa (Qpv) and possibly older alluvial fan units (Qa5, Qa4), may represent the most extensive geomorphic feature in the project area that has the potential for buried archaeological deposits (with no surface manifestation). However, the degree of this potential is largely unknown due to a lack of subsurface exposures at this contact. Based on observation of surface sites on the fan piedmont, one of the primary natural resources attracting prehistoric populations to the project area was the extensive quartzite, chert, and cryptocrystalline river cobbles that have been redeposited across the fans from the relict Colorado River gravel terrace (QTmw). Similar rounded, exotic materials are present in smaller amounts on limited portions of the Qpv surface (in areas equivalent to Unit E of Metzger et al. 1973). These gravels and cobbles tend to be smaller and less frequent than those observed on the fan piedmont, but, nonetheless, may have acted as an attractive toolstone source prior to deposition of the younger portions of the fan piedmont. As such, any sites buried by the Qa6 and Qa5 fans are likely to be similar to those observed on the fan surface (i.e., dominated by lithic assays and associated expedient tools) but of greater antiquity.

Although composing a much smaller portion of the project area, places where unconsolidated and active eolian sands (Qs) have obscured alluvial landforms also have the potential for burying archaeological resources. The most extensive of these sand sheets is present at the very northern extent of the project area on the alluvial flat landform in the Coachella Valley proper [?]. Smaller localized eolian features, found on the Colorado River terrace (Palo Verde Mesa) and the northern alluvial flat, appear to be so limited that they are unlikely to obscure any significant portion of an archaeological site.

Finally, the young actively aggrading alluvial sediments of the modern alluvial fan (Qm) and alluvial floodplain (Qr) generally have a high potential for burial of archaeological sites. These landforms have a very limited presence in the Project area.

A secondary conclusion of this geoarchaeological study is that prehistoric site locations within the Rio Mesa Solar study area seem to largely covary with the availability of raw lithic materials. The series of coalescing fans that make up the alluvial fan piedmont west of Palo Verde Mesa have their source in the Mule Mountains. The dominant parent material present above these fans is quartz monzonite, with more limited outcrops of gneiss, diorite, granodiorite, with limited other volcanics (rhyolite, dacite, and amphibole). Much of this material has little utility for prehistoric tool making. At the same time, the quartzite, cryptocrystalline, and chert cobbles and gravels of the relict Colorado River terrace (QTmw) have been eroded and reworked into the lower fan piedmont and are more conducive to prehistoric tool production. This is demonstrated by the widespread lithic scatters present on these landforms. Areas of similar materials are also present on the Palo Verde Mesa terraces (Qpv).

SECTION 4 RESEARCH DESIGN

The research design provides a framework and theoretical context for project goals, field methods, discussion and interpretations of geomorphic features, and recommendations for future studies (and data needs). The research design provided herein is for a geoarchaeological study conducted through geoarchaeological test excavations and monitoring of geotechnical borings.

4.1 RESEARCH ISSUES

This section explicitly enumerates the research questions, data needs and sampling strategy used to facilitate the development of refinements to the initial geoarchaeological study and reconnaissance, in order to better assess the geoarchaeological sensitivity and developmental history of those documented landforms.

4.1.1 Research Questions

The following research questions will guide the Applicant's implementation of the Research Design to further refine our understanding of the project area landscape's constituent landforms, and to further document and refine the genetic and historical relationships among them. The research questions will also guide the documentation of each pertinent landform's particular stratigraphy; interpretation of the energy regimes that led to the sedimentary deposition of each landform; interpretation of the chronology and duration of pedogenic processes that may have occurred for each landform; and discern whether the deposition of particular landform components was synchronous or may have been time transgressive.

1. Can further refinement of landform designations and tentative chronological associations developed in the initial Geoarchaeological Assessment be achieved? It has been well documented that landforms with similar morphological traits, over a wide geographic area of the Mojave Desert and Colorado River regions, are temporally synchronous due to widespread cyclical environmental perturbations. Landforms within the RMS project area have been ascribed to these broad chronological sequences based on morphology; however, the precise timing of these local depositional events is unknown. For those landforms that fall within or near the latest Pleistocene (e.g., Qa6, Qa5, and possibly distal portions of Qa3) exact timing of deposition, and subsequent stability (pedogenesis) or burial is crucial in determining the potential for buried archaeological deposits associated with the landform.

2. For those landforms determined to have a depositional chronology and energy regime conducive to sensitivity for buried cultural resources (especially the distal lower energy portions of younger alluvial fan units Qa6 and Qa5), can the subsurface conditions of those landforms be identified and documented? Specifically, can the lithostratigraphic and pedostratigraphic units that comprise the landforms, the age, duration and tempo of pedogenic processes, energy regimes and depositional environment, and subsequent preservation of those units be identified and documented?. This will allow for a refined assessment of the potential for buried archaeological deposits, and the likely nature, age, and depth of those deposits.

3. In addition to refining the subsurface conditions of potentially sensitive depositional landforms (Research Issue 2) can the variation across and within those landforms be established and documented, in order to better define spatial variability in the geoarchaeological sensitivity of each landform? Given the understanding of regional landscape formation, there is relatively high confidence that areas with a, for example, Qa6 type morphology (see Section 3), are similar to other such landforms laterally across the project area. However, what is not well documented is the variability in deposition linearly from the proximal (upslope) to distal (downslope) margins of each of those broader landforms; the goal being to define portions of the landforms where sediments are too high-energy or were deposited too rapidly to have been likely to have preserved primary artifact associations within any archaeological deposits, versus those portions that are low-energy and with a slow processual deposition which is conducive to site formation and the preservation of these primary associations.

4. For those landforms that may contain surface archaeological sites, but are too old or high energy to contain buried archaeological deposits, can the subsurface relationship between the old landform and any adjacent younger landforms be defined, as there is the potential for buried archaeological sites at that subsurface contact? Specifically, for landforms that have been determined to be older than the latest Pleistocene (ca. 16,000 BP) (e.g., the Qpv landform) and are buried by younger deposits, the nature of the buried surface (whether stable or erosional) is of particular import to the potential for buried archaeology.

5. Finally, for landforms that contain surface archaeological sites, can the near-surface nature of the landform be characterized to understand the potential, or lack thereof, for subsurface components associated with the sites? For example, if a landform is shown to have very been deposited in a very high energy setting, the potential for significant near-surface archaeological deposits is minimal; alternatively, if the surface of a landform can be shown to have accreted slowly through low-energy alluvial or eolian deposition, the potential is much higher.

4.1.2 Data Needs

1. Representative subsurface profiles of potentially sensitive depositional landforms, with adequate spacing to demonstrate lineal variation within each landform.

2. Sufficient exposure and examination of profiles to delineate major pedostratigraphic units (e.g., paleosols and buried landforms), time-transgressive depositional sequences within units, and relevant unconformities.

3. Representative profiles at or near the intersection of different landforms.

4. Datable material to establish the chronology of Project landform evolution.

4.1.3 Summary

The primary focus of the new phase of geoarchaeological research will be the excavation and exposure of representative landform profiles for those portions of the project area where the sedimentary landforms identified during the initial geoarchaeological reconnaissance assessment are of an age and appropriate depositional nature, where a potential for buried archaeological deposits was identified, and where the construction and operation of the proposed project would disturb native ground to a depth of greater than one meter. These excavations will allow for the collection of data which is useful in:

a. refining the geologic correlations that were field verified during the initial geoarchaeological reconnaissance and resultant Geoarchaeological Sensitivity Analysis and geoarchaeological sensitivity map (described above in Section 3);

b. assess whether the identified landforms were deposited rapidly or gradually over a relatively long period of time (i.e., time transgressive);

c. establish and refine the age of the lithostratigraphic and pedostratigraphic units that compose the landforms; and

d. establish the lineal variation in the depositional energy responsible for the development of each landform.

This refined data set, and the interpretation of it, will allow for a more complete understanding of the geomorphic evolution of the Project area, and the association of surficial archaeological sites to that landform development, as well as the relative potential for the Project to impact buried archaeological resources.

CEC Staff indicated that during the initial geoarchaeological assessment too much emphasis was placed on the identification of paleosols as convenient stratigraphic markers of past land surfaces, where archaeological sites could potentially be subject to erosional processes; and not enough emphasis on the identification of areas of high-rate low-energy deposition, where archaeological sites would potentially be delicately buried and preserved (Rio Mesa Solar Electric Generating Facility Licensing Case Documents, Docket Number: 11-AFC-04, WebEx Recording of the March 1, 2012, Data Request and Issues Resolution Workshop, Posted March 5, 2012.). Grain size, depositional environment and energy regime, and pedogenic indicators of soil/paleosol development will be further refined for each of the subsurface exposures excavated during the geoarchaeological subsurface investigation. While the Applicant agrees that the quality of archaeological preservation is higher in relatively low energy depositional environments that have high depositional rates, it is not the most likely place to encounter buried archaeology. Cumulic soils (landforms where deposition outpaces soil development; i.e., where paleosols are not formed) do not lend themselves to the accumulation of large complex archaeological sites. A constantly acreting landform is not conducive to long-term occupation. At most, one could expect very ephemeral sites, spread-out more or less randomly throughout the vertical and horizontal extent of the cumulic landform. In trying to reduce the "needle in the haystack" problem of identifying buried archaeological sites across a large project area, paleosols are the best option because they would have been exposed at the surface for a sufficient amount of time to increase the chances of site formation (and subsequent burial). On any horizontal slice of a landform, a paleosol is more likely to have an archaeological site on it than an equivalent slice of unweathered alluvium. Necessarily, the geoarchaeological research will focus on areas that may contain paleosols of appropriate age (latest Pleistocene through Holocene) as well as those with fine-grain deposition that is more conducive to preservation.

4.2 FIELD METHODS

The following sampling strategy and fieldwork protocols will guide the Applicant's implementation of the Research Design to further refine the geographic extents of the project area's constituent landforms, and to further document and refine the genetic and historical relationships among them. The strategies and protocols will also guide the documentation of each pertinent landform's particular stratigraphy; interpretation of the energy regimes that led to the sedimentary deposition of each landform; interpretation of the chronology and duration of pedogenic processes that may have occurred for each landform; and discern whether the deposition of particular landform components was synchronous or may have been time transgressive.

4.2.1 Project Effects and Level of Effort

The subsurface geoarchaeological investigation set out here is a critical link in the acquisition of the data necessary to ensure adequate regulatory compliance for the proposed project. The purpose of the investigation is primarily to provide key information necessary to our understanding of two related aspects of the historic character of project area landforms: (1) the potential for each landform to harbor intact buried archaeological deposits, greater than 1 meter in depth (i.e., geoarchaeological sensitivity); and (2) the potential for surface archaeological sites, identified through pedestrian surveys, to have an associated shallowly buried component, based on the near-surface developmental characteristics of the landform upon which each site is situated. In each of these cases, the level of effort and methodology should be commensurate with the degree of potential project-related impacts to archaeological resources.

By far the largest area of potential impact is associated with the heliostat reflector fields, which surround each of the two power block and tower areas (Figure 3.1-12). Each field will consist of approximately 85,000 heliostats, and will require approximately 1,850 acres of land to operate. Each of the total approximately 170,000 heliostat reflectors will need to be supported by a pole or foundation. The current best-practice methodology - which reduces the area of impact for each heliostat, and thus minimizes effects to other resource areas such as soils, biology, archaeology, etc. - is a "vibrate in-place" methodology. The vibrate in-place methodology employs a metal pylon, or pedestal, to support each heliostat, rather than a concrete foundation or footing which requires a much greater footprint and more equipment and ground disturbance. Although final design of the heliostat pedestals is pending results of geotechnical investigations, it is expected that emplacement will likely be as such: (1) a hollow stem auger, between 12 to 18 inches in diameter, would be used to loosen the upper 3 to 4 meters (10 to 13 feet) of soil in each heliostat location; (2) on completion of the pre-drilling, a closed end pylon, approximately 6 to 8 inches in diameter will be driven or vibrated into the loosened soil, no greater than the depth of the pre-drilling.

During both the pre-drilling and pylon insertion, no soils are brought to the surface and, thus, there is no potential for observing subsurface sediments or stratigraphy. However, the overall effect from the installation of the heliostat pedestal on buried archaeological resources is considered to be very minimal. A maximum 12- inch diameter disturbance, in an otherwise undisturbed buried archaeological deposit, would likely have an insignificant impact on the potential information values of that deposit, especially given that no sediments would be removed using the auger and vibrate in-place methodology. Furthermore, given the spacing of the heliostats, the overall impact and potential for actually piercing a buried deposit becomes negligible. Assuming an approximately 12- inch diameter auger and taking into account the approximately 170,000 proposed heliostats, the total, undispersed area of disturbance would be less than three acres. Over a total field size of approximately 3,700 acres, this represents a negligible percentage (0.0008 percent) of the total area of the heliostat fields. The proposed project's potential impact on archaeological deposits buried deeper than one meter below the present ground surface would not appear to be a significant impact given the impact's relative extent. The consideration of the project's potential to impact these deeper deposits in the heliostat fields will, therefore, be left out of the scope of the present subsurface geoarchaeological study. The purpose of subsurface geoarchaeological investigation in the area of the heliostat fields, then, is to adequately demonstrate the broad-stroke character of the near-surface evolution of the landforms in that area with regard to the potential for surface archaeological sites there to have buried components. A total of 21 trench locations have been proposed within the heliostat field area. Of these, 8 are within the Qa6 fan landform, as this represents the dominant landform upon which the heliostat field is situated. Much smaller portions of the field are situated on the Qa3 and Qa5 landforms, and thus fewer proposed investigations there (3 and 2, respectively). In addition, both of these latter landforms are considered to have reduced geoarchaeological sensitivity, as discussed above in Section 3.

The remainder of the heliostat field area is located on landforms determined to be part of the Palo Verde Mesa (Qpv) deposits of the paleo-Colorado River (see discussion in Section 3). Based on previous dating and evolutionary history of the landform, it is thought to be too old and unlikely to contain buried archaeological resources. The purpose of the last 8 geoarchaeological trenches in the heliostat field area, on the Qpv landform, are primarily for paleontological investigation. These trenches will, however, double as geoarchaeological trenches to verify the assumptions made above in Section 3. These eight trenches shall be excavated and documented in a manner entirely consistent with the methodology described below.

Perhaps the most significant impact, with regards to buried archaeological resources, will be the two towers and associated power blocks in the center of each of the heliostat fields. Current conceptual designs for each of the two towers, pending results of geotechnical investigations, consists of an approximately 175 feet wide (across the flats) and 12 feet deep octagonal foundation. In addition, other underground utilities and power block related facilities will be constructed adjacent to the towers, none of which would exceed the lateral or vertical scale of the tower foundations. The two power block and tower areas are located exclusively on the Qa6 alluvial fans. For these proposed tower and power block areas (Figure 3.1-12, Inset Map 2 and 3) six geoarchaeological test pits are proposed in order to better define the subsurface stratigraphy, processual development of the landform in that specific area, and potential for disturbance of more deeply buried archaeological resources.

Certain facilities for the Project will be shared by the two plants and located in a common area. These facilities will include a combined administration, control, maintenance, and warehouse building, and mobile equipment maintenance facilities for the maintenance crew and operators. As shown in Figure

3.1-12, this common area is relatively small (less than 20 acres) and only a small portion of that area will likely receive subsurface impacts. Additionally, part of the common area is located on the Qpv landform, which is considered to have a low sensitivity for buried archaeological resources. Associated subsurface impacts in this area will likely include foundations for buildings and emplacement of subsurface utilities, which may exceed 1 meter in depth. These impacts are expected to be relatively limited and not exceed approximately 2 meters in depth. Two trenches are proposed within this relatively small common area.

In addition to the proposed trenches, six additional discretionary trenches will be held in reserve for the geoarchaeologist's use where ongoing field results reveal the need for further clarificatory data.

The total number and location of trenches is considered sufficient to answer the research questions outlined above. Although subsurface impacts related to the RMS Project are spread over an area of approximately six sections (ca. 3,800 acres), any additional level of effort is not necessary for several reasons: (1) lack of impact to archaeological deposits buried greater than one meter below the present ground surface over the majority of the APE (i.e., the heliostat fields); (2) need for limited investigation of landforms considered too old to contain buried archaeology, based on geologically-established, regionally correlative, surface morphologies; (3) areas of deepest subsurface impact (e.g., tower/power block areas) are relatively small and will be relatively homogeneous within that area; and (4) as discussed in Section 3, previous geologic study of the major alluvial landforms and depositional events in the Mojave/Colorado River region has shown that there is a large degree of internal consistency between major alluvial processual units and, as such, results from one location can be dependably correlated and interpolated laterally across the similar landform types. One result of the present geoarchaeological investigation will be to ascertain the dependability and usefulness of extant regional geologic correlations to research questions that are implicitly bound in an archaeological time scale.

4.2.2 Sampling Strategy

For the majority of the Project area, on Metropolitan Water District (MWD) property, twenty (26) locations have been selected for the placement of exploratory 1-meter-wide by five-meters-long geoarchaeological/paleontological trenches (Figure 3.1-12). These locations were selected based on their applicability to the research questions identified above, association with landforms identified and field verified during the reconnaissance survey as potentially being of appropriate age and depositional nature to harbor buried resources, and the level of project-related impacts anticipated for each given area.

In an effort to help further define the thickness and extent of the paleosol, the Applicant has also agreed to do additional paleontological testing in the project area as part of Data Request 128. In order to minimize additional impacts to the resources mentioned above, all the trenches and borings being excavated by the Applicant's Geotechnical Contractor will be observed, documented, and sampled by the Project Geoarchaeologist, as well as Paleontological and Cultural Monitors. The placement of all of the trenches and most of the borings was determined by the Project Geoarchaeologist and Paleontologist, with the exception of the borings labeled "MWD Exploratory Borings" which were determined by the Project Geotechnical Contractor (Figure 3.1-12).

Trenches are primarily focused on the landforms identified as younger alluvial fans (Qa6 and Qa5) which are considered to have the greatest potential for harboring buried cultural resources. Three series of trenches across Qa6 extend east-west, from the head to the toe of the landform in order to document changes in the depositional energy and internal structure of the landform from proximal (upslope) to distal (downslope) ends, and variability in the potential for preservation of archaeological materials. Lateral consistency across the fan units, between these lineal series of trenches, is expected to be very high, due to the documented consistency of synchronous landforms across the region (e.g., Bull 1991; see discussion in Section 3).

Several of these trenches have been sited near the interface between the younger alluvial fan units and other identified older and/or coarser-grained landforms. These locations are intended to document the subsurface interaction between the adjacent landform types and provide data on the nature of any subsurface contacts between the two units.

Although many of these landforms have sufficient observable surface characteristics (e.g., clast size, degree of desert varnish, degree of pavement formation) or have been geologically dated and documented by other researchers (e.g., the Qpv landform, see discussion above), a small number of trenches have been placed within these landforms to verify assumptions made during the reconnaissance field study. In particular, trenches placed within the Pleistocene Colorado River inset terrace deposits (Qpv) have been placed in locations where project related impacts will exceed 1 meter below surface, and will be used to assess near-surface conditions and the veracity of assumptions regarding the lack of geoarchaeological potential.

4.2.3 Fieldwork Protocols

Each geoarchaeological trench will be excavated using a full-size backhoe fitted with a 3-foot wide bucket. Each trench will be approximately 5 meters long at the surface and excavated to the maximum anticipated depth of the proposed project's construction excavation in a particular area, or to the maximum depth of the backhoe's reach (approximately 4 meters), whichever is shallower, unless the Project Geoarchaeologist determines that the subsurface character of the project area appears to preclude the potential presence of archaeological deposits at greater depth. Examples of such determinations would be in cases where thick deposits of gravels indicate too high-energy of a depositional environment for the preservation of archaeological deposits, or where bedrock is encountered. The Project Geoarchaeologist would need to document and report each instance where the complete depth of a trench was not reached. The backhoe excavation of trenches and excavated spoils will primarily be observed from the surface and then be documented from the surface. If pedogenic or archaeological features are observed from the surface, which require closer inspection and/or sampling, the trench will be shored using hydraulic speed shoring, so that the Project Geoarchaeologist can enter the trench safely, document subsurface stratigraphy and pedogenic indicators, in detail, and collect soil and dating samples. In addition, one trench on a given landform, or new section of a landform, will need to be shored and entered by the Project Geoarchaeologist, in order to more closely examine and better expose, document, and sample stratigraphic and pedogenic units. Once these units are understood and documented, correlation between similar units will most likely be possible from the surface.

In addition to the geoarchaeological trenches, numerous geotechnical and paleontological mechanical excavations (backhoe excavated pot-holes and corkscrew augers) have been planned (Figure 3.1-12). In order to gather the maximum amount of data regarding subsurface conditions, these excavations will also be observed, documented, and sampled by the Project Geoarchaeologist.

For each excavated trench, the Project Geoarchaeologist will produce a measured representative profile drawing, using a metric scale. Observed stratigraphic units will be described based on physical characteristics such as composition (grain size, parent material), color, superposition, textural transitions, and pedogenic properties (i.e., relative soil development). Each profile, including all observable textural and soil transitions, will be logged on standard soil recordation forms and photographed. These will include a detailed description of each lithostratigraphic and pedostratigraphic unit and be used to correlate units identified in other trenches. In trenches where archaeological features are observed in profile, or where cross-cutting or interfingered stratum of different depositional units are present, a detailed profile drawing will be completed for one entire wall of the trench, in order to document the context of any unique features.

The information collected in the soil recordation forms (Attachment 2) will be used to produce detailed written descriptions, appropriate to the character of each type of stratigraphic unit, of each lithostratigraphic and pedostratigraphic unit down a one-meter-wide, shaved profile section along the sidewall for which the measured representative profile drawing is made. Each measured profile sidewall will be photographed with a metric scale and north arrow.

A maximum of 14 radiocarbon samples will be submitted for analysis, in order to determine the depositional rates and approximate ages of the major process-related lithostratigraphic sequences present and constrain the dates of any paleosols or archaeological deposits that are found. Discrete, in-place charcoal or other organic carbon samples will be used for dating. In the absence of discreet datable material, enough soil humate will be collected to obtain reliable radiocarbon dates. One date will be obtained for each major stratigraphic unit identified within a given landform (e.g., a buried surface within Qa6) in order to date the master stratigraphic column for each landform and each major landform feature. Correlation of stratigraphic units observed *across* trenches within a given landform will be based on textural, color, and other pedogenic similarities. In addition to obtaining dates for the master stratigraphic column within each landform, if a single stratigraphic unit is observed to be composed of a series fine-grained laminated depositional sequence[2], a sufficient number of dates (2 to 4, depending on the total depth of the unit) will be obtained to determine the average rate at which the unit accreted. An allowance will be made for up to 3 priority service dates, which can return results while still in the field (3-6 days), in order to ascertain if potential sensitive stratigraphic units are of an appropriate age (i.e., less than ca. 16,000 BP) to warrant further investigation, and thus influence the ongoing investigation.

One issue with reliably dating surficial landforms is that soil humate accumulates over time. As such, dates obtained directly below the surface do not represent the time that the landform was ultimately deposited and stabilized, but rather the last time that organic material from the surface illuviated down the soil column. This means that these dates will consistently under value the true age of the landform. A more reliable method is to obtain a date from a paleosol that is buried beneath the surface landform, as this date will record the time that surficial organics stopped entering the system or, put another way, when the paleosol began to be buried by the overlying landform; thus providing a maximum date for the overlying landform. In the absence of a distinct buried surface, it may not be possible to reliably date each

[2] A series of thin fine-grain depositional lenses, as opposed to a single massive depositional package, would indicate that the development of the stratigraphic unit occurred through a series of low energy depositional events which although lacking pedogenic development, if the layers were deposited gradually enough, could be conducive to the preservation of buried archaeological deposits

landform. Such problems will be adequately considered in the selection of material for dating, and in the final analysis of results.

At least one additional archaeologist will be on-site to assist in the monitoring and sorting of spoils excavated from the geoarchaeological trenches. Rakes and other hand tools will be used to actively sort through material as it is excavated from each trench. The Project Geoarchaeologist will assist in identifying paleosols and sensitive depositional horizons and stratigraphic markers as they are excavated, and these will be targeted for monitoring. Additionally, a small (three 5-gallon buckets) sample of sediment from the major lithostratigraphic units in the measured profile, or, where lithostratigraphic units are not apparent, from arbitrary levels in each measured profile, every 0.5 meters of depth, will be screened through ¼-inch hardware mesh.

The Project Geoarchaeologist will mechanically excavate through any buried archaeological deposits encountered, unless such deposits contain human remains, using arbitrary levels no greater than 20 cm thick, screen the arbitrary levels through ¼-inch hardware mesh, and provenience all artifacts, ecofacts, and other material culture finds to those arbitrary levels.

4.2.4 Curation

Artifact and fossil collection, retention/disposal, and curation will occur in accordance with applicable State and Federal standard protocols and policies. The Applicant commits to curate all archaeological materials, in accordance with the California State Historical Resources Commission's *Guidelines for the Curation of Archaeological Collections*, into a retrievable storage collection in a public repository or museum. Additionally, the Applicant commits to curate all paleontological materials, in accordance with the Society for Vertebrate Paleontology guidelines, into a retrievable storage collection in a public repository or museum. Moreover, the Applicant commits to pay all curation fees for artifacts and fossils recovered and for related documentation.

SECTION 5 TECHNICAL REPORT

A report describing the results of the geoarchaeological field study set out here, and of the implications of these results on the assumptions made during the initial geoarchaeological assessment, will be produced. This report will include: revised mapping of the surface geomorphology of the project area (map scale of ≥1:12,000); maps and descriptions of all excavated trench locations; graphic and written descriptions of the stratigraphic profiles of the project area including an analysis of the depth and extent of any potentially sensitive paleosols; a graphic showing the correlation of stratigraphic units across the project area; a processual geologic interpretation and the approximate age of subdivisions of the master column that reflect shifts in local depositional regimes or depositional history, and that reflect time ranges that correspond to the prehistory and history of the region, as presently understood; DPR 523 forms, and descriptions and preliminary interpretations of any encountered archaeological deposits. Formal reporting of radiocarbon analysis results will be included as an appendix. The report will also provide: an interpretation of the character of the prehistoric or historic land use that each encountered archaeological deposit represents; an interpretation, with reference to the information gathered and developed above, of the likelihood that buried archaeological deposits are present in each of the identified landforms or portions thereof; on the basis of the current understanding of the prehistory and history of the region, what site types are most likely to be found; and recommendations, based on the present geoarchaeological study, on the locations and extent (horizontal and vertical) of potential mitigation measures that would be most consistent with CEQA requirements for mitigation of impacts through avoidance, when possible, and with the historic preservation goal of recovering valid scientific data from CRHR-eligible archaeological deposits whose destruction cannot be avoided.

This report will also seek to more securely establish the physical contexts of the surface archaeological sites in the proposed project area, and to reliably assess both the likelihood that project area landforms may contain buried archaeological deposits and the likely character of any such deposits. The results of the geoarchaeological study should allow the CEC to better assess the potential impacts of the proposed project to buried archaeological resources, and to design a more targeted, limited, and effective mitigation monitoring plan (if warranted by the results of the geoarchaeological study).

Buried archaeological deposits found during the trenching activities will be recorded on DPR 523 forms by the Archaeological Monitor. Formal evaluation of site eligibility and/or data recovery is beyond the scope of the present. The geoarchaeological study is not designed to assess the eligibility of buried archaeological sites identified during trenching. Additional scoping and consultation with the CEC and BLM will be necessary to complete a Phase II analysis of any identified archaeological deposits.

SECTION 6 PROJECT PERSONNEL AND MANAGEMENT

All cultural resources work will be carried out under the direct supervision of archaeologists who meet the Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation, and will be consistent with the procedures for compliance with NEPA, Section 106 of the NHPA, and CEQA Section 15064.5. All decisions on level of effort or discretionary actions described in the present Research Design will be approved by Energy Commission staff prior to implementation. Any such decisions that affect work on land managed by the BLM shall also be subject to BLM approval, solely for that portion of the work that is to occur on BLM land.

The key cultural resources personnel who will conduct the study and prepare the technical report are:

- Jay Rehor, M.A. (URS Principal Investigator)

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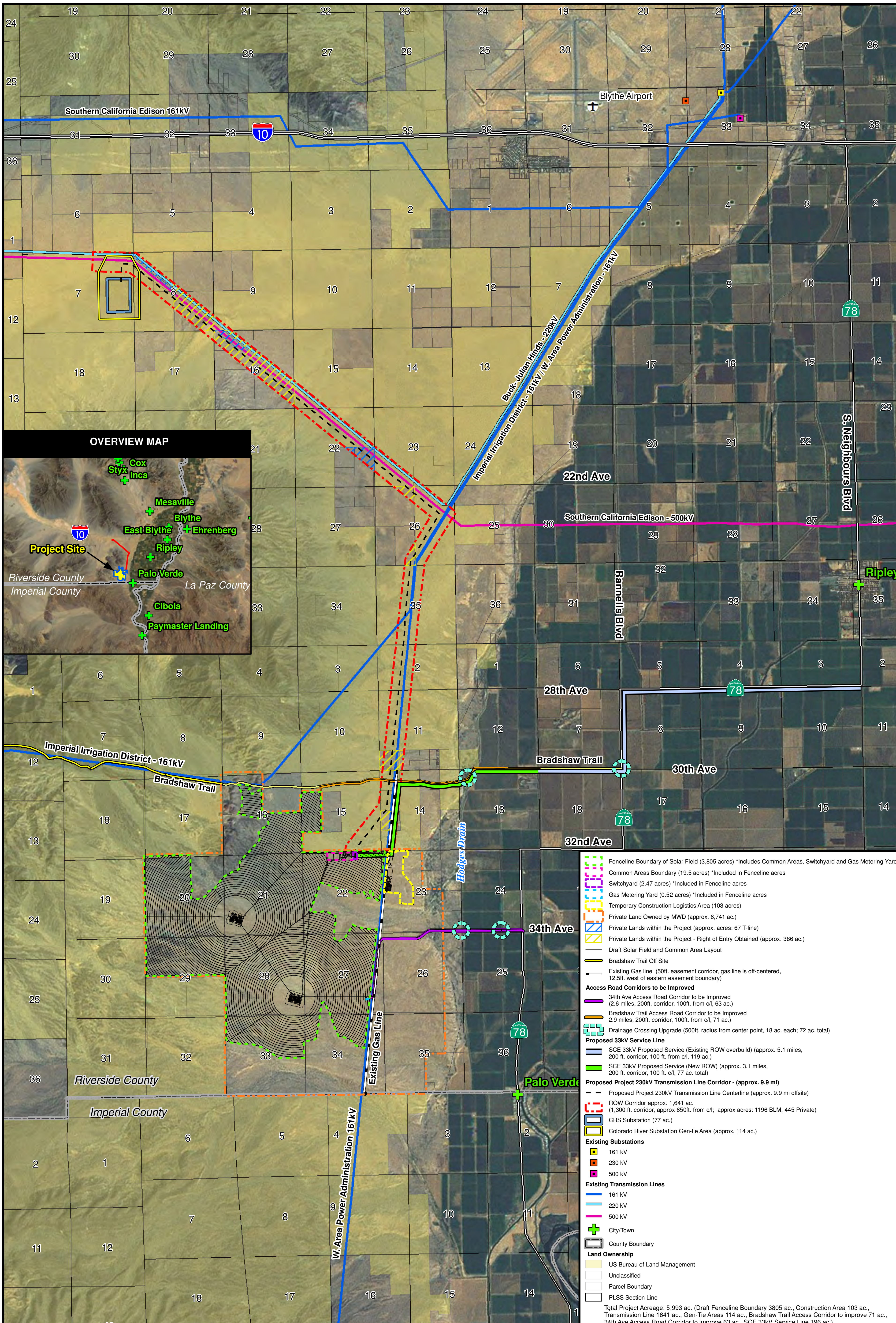
Non-Confidential Figures



SOURCES: Draft Solar Field Layout & Fenceline, MWD Land (Bechtel, 6-13-2012). Transmission Line Corridor (URS, 6-14-2012). Private Lands (BSE, 2012). Existing Gasline, Transmission Line Centerline, Buck-Julian Hinds 220kV (Power Engineers, 6-14-2012). CRS Substation, Potential Gen-tie Area (Power Engineers, 5-7-2012). Aerial Imagery (NAIP, 5-25-2009). County, State Boundaries, Roads, Bradshaw Trail (ESRI, 2007). Parcels (BLM, 2006). Land Ownership (BLM, 3-03-2011). Existing Transmission Lines, Existing Substations (Platts, 2009). PLSS Sections (BLM, 12-11-2007). Improved Access Roads, Drainage Crossing Upgrade (URS, 3-18-2011). 33kV Proposed Service Transmission Lines (BSE, 2011).

COMPOSITE MAP
RIO MESA SOLAR
ELECTRIC GENERATING FACILITY

URS

SCALE: 1" = 6000' (1:72,000)
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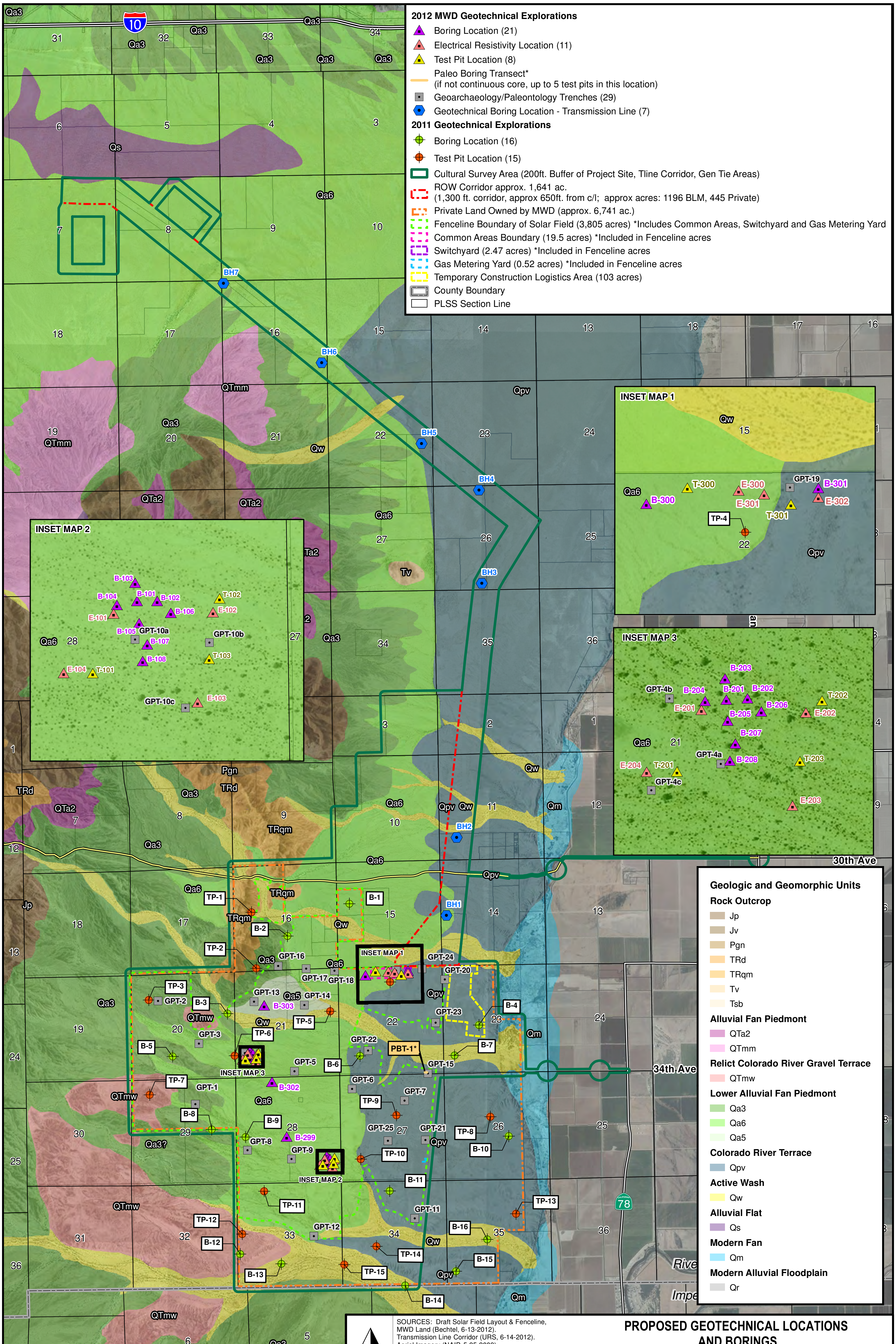

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PROPOSED GEOTECHNICAL LOCATIONS AND BORINGS
RIO MESA SOLAR ELECTRIC GENERATING FACILITY

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Confidential Figures

(Confidential figures and will be submitted under separate cover)

Attachment 1
Blank Soil Form

Table A-2.—Work sheet for recording soil properties in the field
[In the note column, one can record properties not universal to all soils. Courtesy of D. Jorgenson, 1989]

Soil Description: Location ______________________________

Site No. _____ Date _________ Time ___________ Vegetation ______________________________

Elevation __________ Slope ____________ Aspect _________ Geomorphic Surface ______________________________

Parent Material(s) ______________________________ Described by ______________________________

Depth (cm)	Horizon	Color moist / dry	Structure	Gravel %	Consistence Wet	Consistence Moist	Consistence Dry	Texture	pH	Clay films	Boundaries	notes
		- - - - - - - - - - - -	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	0 50 <10 75 10 >75 25	so po ss ps s p vs vp	lo vfr fr fi vfi efi	lo so sh h vh eh	S SiCL LS SiL SL Si SCL SiC L C CL SC		v1 f pf 1 po 2 d br 3 co p cobr	a s c w g i d b	
		- - - - - - - - - - - -	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	0 50 <10 75 10 >75 25	so po ss ps s p vs vp	lo vfr fr fi vfi efi	lo so sh h vh eh	S SiCL LS SiL SL Si SCL SiC L C CL SC		v1 f pf 1 po 2 d br 3 co p cobr	a s c w g i d b	
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		- - - - - - - - - - - -	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	0 50 <10 75 10 >75 25	so po ss ps s p vs vp	lo vfr fr fi vfi efi	lo so sh h vh eh	S SiCL LS SiL SL Si SCL SiC L C CL SC		v1 f pf 1 po 2 d br 3 co p cobr	a s c w g i d b	
		- - - - - - - - - - - -	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	0 50 <10 75 10 >75 25	so po ss ps s p vs vp	lo vfr fr fi vfi efi	lo so sh h vh eh	S SiCL LS SiL SL Si SCL SiC L C CL SC		v1 f pf 1 po 2 d br 3 co p cobr	a s c w g i d b	
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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 RIO MESA SOLAR ELECTRIC GENERATING FACILITY

DOCKET NO. 11-AFC-04
PROOF OF SERVICE
(Revised 10/16/12)

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DECLARATION OF SERVICE

I, Kathleen McDowell , declare that on October 25 , 2012, I served and filed a copy of the attached document Final Geoarcheology Research Design (Data Request Set 1B [No. 97]) , dated October, 2012. This document is accompanied by the most recent Proof of Service list, located on the web page for this project at: **http://www.energy.ca.gov/sitingcases/riomesa/index.html**.

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit or Chief Counsel, as appropriate, in the following manner:

(C*heck all that Apply*)

For service to all other parties:

_X_ Served electronically to all e-mail addresses on the Proof of Service list;

____ Served by delivering on this date, either personally, or for mailing with the U.S. Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses marked ***"hard copy required"** or where no e-mail address is provided.

AND

For filing with the Docket Unit at the Energy Commission:

_X_ by sending electronic copies to the e-mail address below (preferred method); ***OR***

____ by depositing an original and 12 paper copies in the mail with the U.S. Postal Service with first class postage thereon fully prepaid, as follows:

CALIFORNIA ENERGY COMMISSION – DOCKET UNIT
Attn: Docket No. 11-AFC-04
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.ca.gov

OR, if filing a Petition for Reconsideration of Decision or Order pursuant to Title 20, § 1720:

____ Served by delivering on this date one electronic copy by e-mail, and an original paper copy to the Chief Counsel at the following address, either personally, or for mailing with the U.S. Postal Service with first class postage thereon fully prepaid:

California Energy Commission
Michael J. Levy, Chief Counsel
1516 Ninth Street MS-14
Sacramento, CA 95814
michael.levy@energy.ca.gov

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

original signed by
Kathleen McDowell

*indicates change