APPENDIX I

Paleontological Resources Assessment

For the

Master Drainage Plan and Programmatic Environmental Impact Report
for the
Coachella Valley Water District for the Region I-Oasis Area
and Region II-Mecca/North Shore, Riverside and
Imperial Counties, California

Heather L. Clifford and Jessica L. DeBusk

Prepared by

Applied EarthWorks, Inc.
133 N. San Gabriel Blvd., Suite 201
Pasadena, CA 91107-3414

Prepared for

Tetra Tech
Attn: Aric Torreyson, P.E.
Program manager
800 W. 6th Street, Suite 380
Los Angeles, CA 90017

November 2014

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SUMMARY OF FINDINGS

At the request of Tetra Tech, on behalf of Albert A. Webb Associates, Applied EarthWorks, Inc. (Æ) performed a paleontological resource assessment in support of the Master Drainage Plan and Programmatic Environmental Impact Report (PEIR) for the Coachella Valley Water District (CVWD) for the Region I-Oasis Area and Region II-Mecca/North Shore (Project), in Riverside and Imperial Counties, California. The CVWD's Master Drainage Plan will address flooding hazards in the Region I-Oasis Area and the Region II-Mecca/North Shore Area. This report summarizes the methods and results of the paleontological resource assessment and provides Project-specific management recommendations.

This assessment included a comprehensive review of published and unpublished literature and museum collections records maintained by the online database of the University of California Museum of Paleontology. The purpose of the literature review and museum records search was to identify the geologic units underlying the Project area and to determine whether previously recorded paleontological localities occur either within the Project boundaries or within the same geologic units elsewhere. Using the results of museum records search and literature review, the paleontological resource potential of the Project area was determined in accordance to Society of Vertebrate Paleontology (2010) guidelines.

As a result of this study, the Project area is found to be underlain by Pliocene- to Holocene-age sedimentary deposits, which have been determined to have a low to high paleontological resource potential (i.e., sensitivity). Although review of available online museum records indicated that no paleontological resources have been found within the Project area, geologic units underlying the Project area have been known to yield significant fossils nearby. Consequently, the likelihood of impacts to scientifically significant vertebrate fossils as a result of Project development is low to high. Therefore, it is recommended that a qualified paleontologist be retained to develop and implement a Paleontological Resource Mitigation Plan (PRMP) during Project implementation. The plan would include mitigation measures that have been proven to be effective in reducing or eliminating adverse impacts to paleontological resources to a less than significant level pursuant to the requirements of the California Environmental Quality Act.

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1
INTRODUCTION

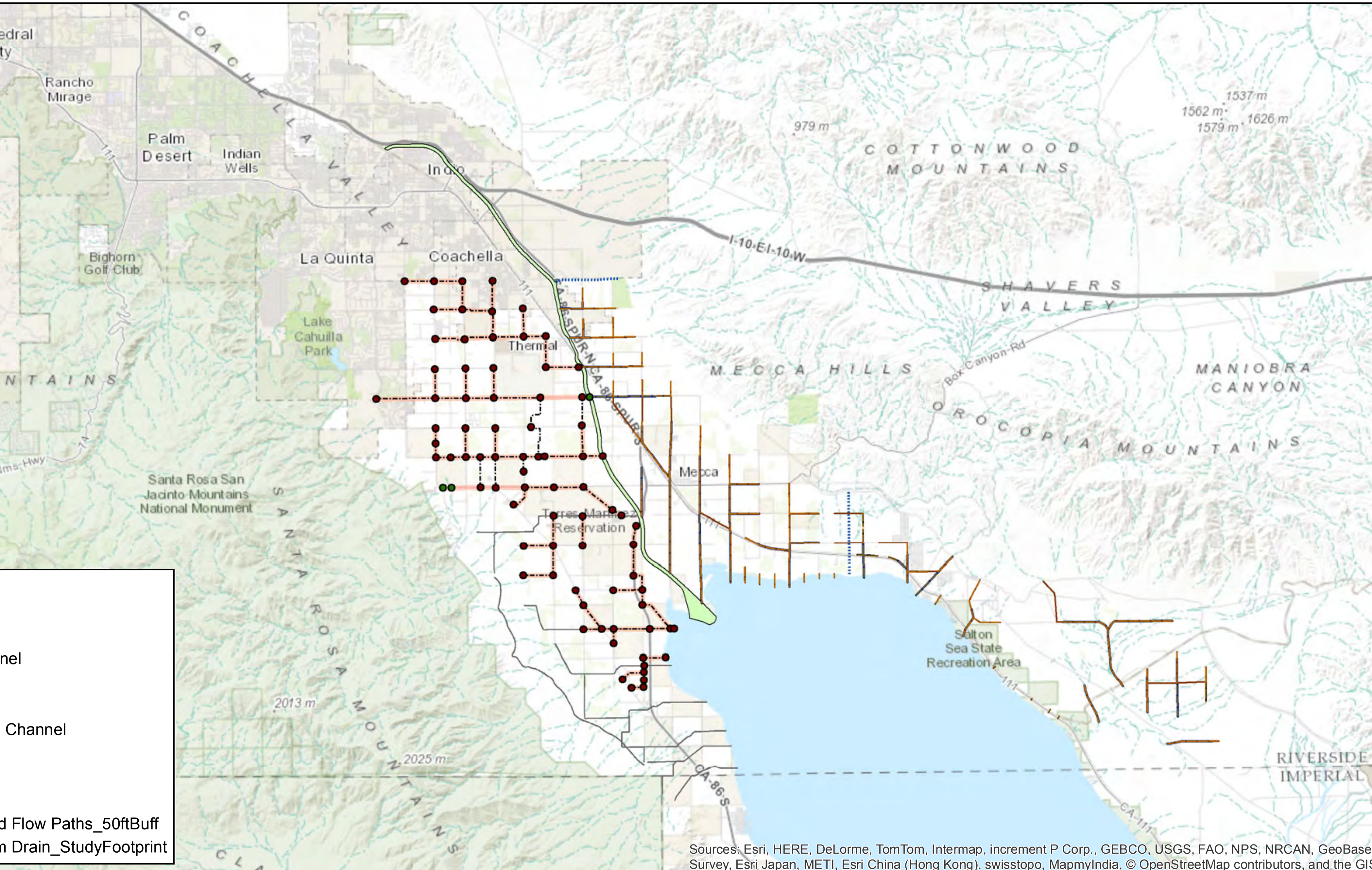
At the request of Tetra Tech, on behalf of Albert A. Webb and Associates, Applied EarthWorks, Inc. (Æ) performed a paleontological resource assessment in support of the Master Drainage Plan and Programmatic Environmental Impact Report (PEIR) for the Coachella Valley Water District (CVWD) for the Region I-Oasis Area and Region II-Mecca/North Shore (Project), in Riverside and Imperial Counties, California. The assessment consisted of a review of available online museum records; a comprehensive literature and geologic map review; and preparation of this report, which includes Project-specific management recommendations.

1.1 PROJECT LOCATION AND DESCRIPTION

The Project is located in the Coachella Valley, within the jurisdiction of the CVWD (Figure 1-1). The Project area encompasses portions of the cities of Indio and Coachella as well as unincorporated Riverside and Imperial Counties and is mapped within portions of the Indio, Thermal Canyon, Valerie, Mecca, Mortmar, Orocopia Canyon, Rabbit Peak, Oasis, Salton, and Durmid, CA 7.5-minute U.S. Geological Survey quadrangles. The CVWD's Master Drainage Plan will address flooding hazards in the Region I-Oasis Area and the Region II-Mecca/North Shore Area. For the Region I-Oasis Area, flooding from alluvial fans associated with the Santa Rosa Mountains, riverine flooding from the Coachella Valley Stormwater Channel, and local drainage area flooding represent potential flooding hazards. In the Region II-Mecca/North Shore Area, riverine flooding from the Coachella Valley Stormwater Channel and local drainage area flooding are potential flooding hazards. For the purposes of the PEIR, the "Project" includes the open channel and pipeline alignment of the proposed stormwater master plan, the alignments for the detention channel and the proposed Oasis flow paths, and the alternative pipeline and open channel alignments for each Region. In general, future construction activities within the Project area will be associated with pipeline and open channel installation and detention channel construction. Potential ground-disturbing activities associated with the Project include pipeline excavation, channel trenching, and grading. The Project is located on State, municipal, and privately held land and encompasses approximately 14,667 acres of potential ground disturbance within a 50-foot buffer (proposed: 3,814 acres; alternative 1: 5,448 acres; alternative 2: 5,405 acres).

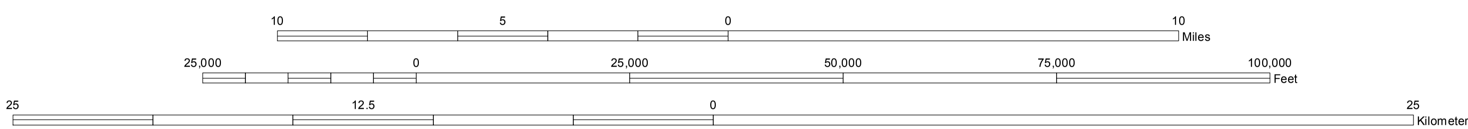
1.2 PURPOSE OF INVESTIGATION

The purpose of this investigation is to: (1) identify the geologic units within the Project area and assess their paleontological resource potential, (2) determine whether the Project has the potential to adversely impact known scientifically significant paleontological resources, and (3) provide Project-specific management recommendations for paleontological resource mitigation, as necessary. The study was conducted in accordance with professional standards and



PROJECT AREA

SCALE 1:250,000



Project Location.

guidelines set forth by the Society of Vertebrate Paleontology (SVP 2010) and meets the requirements of the laws and regulations described in Chapter 2.

1.3 KEY PERSONNEL

This paleontological assessment was prepared under the direction of Æ's Paleontology Program Manager, Jessica DeBusk, who served as Senior Paleontologist and provided a quality assurance review of this report. DeBusk served as primary author of this report with Associate Paleontologist Heather Clifford conducting the literature and geologic map review and authoring the geology and paleontology sections of this report. Ms. DeBusk has more than 11 years of professional experience as a consulting paleontologist and meets the SVP's definition of a qualified professional paleontologist. Geographic Information System (GIS) Specialists Michael Mirro and Ms. Clifford produced all graphics.

1.4 REPORT ORGANIZATION

This report documents the results of Æ's paleontological resource assessment of the Project area. Chapter 1 has introduced the scope of work, identified the Project location, described the Project, defined the purpose of the investigation, and presented key personnel. Chapter 2 outlines the regulatory framework governing the Project. Chapter 3 defines the paleontological significance and sensitivity of the Project. Chapter 4 describes methods, and Chapter 5 provides an overview of the geology and paleontology of the Project area. Chapter 6 presents an analysis and the results of the study. Chapter 7 provides management recommendations, while conclusions are presented in Chapter 8. Lastly, Chapter 9 lists references cited.

2
REGULATORY FRAMEWORK

Paleontological resources (i.e., fossils) are considered nonrenewable scientific resources because once destroyed, they cannot be replaced. As such, paleontological resources are afforded protection under the various federal, state, and local laws and regulations briefly discussed in this chapter.

2.1 FEDERAL

Federal laws and regulations apply when projects are located on federal lands or federally managed lands, or when they are federally funded. Paleontological resources are protected under numerous federal laws and regulations, including the Antiquities Act of 1906, the Federal-Aid Highway Act of 1935, the National Environmental Policy Act of 1969, the Federal Land Policy and Management Act of 1976, and Title 43 of the Code of Federal Regulations and the Paleontological Resources Preservation Act (PRPA), among others. Because the Project is under the jurisdiction of the State governing agencies of the CVWD, federal laws will not apply.

2.2 STATE

2.2.1 California Environmental Quality Act

The California Environmental Quality Act (CEQA) encourages the protection of all aspects of the environment by requiring state and local agencies to prepare multidisciplinary analyses of the environmental impacts of a proposed project and to make decisions based on the findings of those analyses. CEQA also takes into account the laws and procedures of local California jurisdictions.

CEQA includes in its definition of historical resources, “any object [or] site . . . that has yielded or may be likely to yield information important in prehistory” (Title 14, California Code of Regulations [CCR], Section 15064.5[3], subsequently 14 CCR 15064.5[3]), which is typically interpreted as including fossil materials and other paleontological resources. More specifically, destruction of a “unique paleontological resource or site or unique geologic feature” constitutes a significant impact under CEQA (CEQA Guidelines Appendix G). CEQA does not provide an explicit definition of a “unique paleontological resource,” but a definition is implied by comparable language within the act relating to archeological resources: “The procedures, types of activities, persons, and public agencies required to comply with CEQA are defined in: Guidelines for the Implementation of CEQA, as amended March 29, 1999” (14 CCR 15000 et seq.). One of the questions listed in the CEQA Environmental Checklist (Section 15023, Appendix G, Section XIV, Part A) is: “Will the proposed project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?” (Association of Environmental Professionals 2012).

Treatment of paleontological resources under CEQA is generally similar to treatment of cultural resources, requiring evaluation of resources in the project; assessment of potential impacts on significant or unique resources; and development of mitigation measures for potentially significant impacts, which may include avoidance, monitoring, or data recovery excavation.

2.2.2 Public Resources Code Section 5097.5

The California Public Resources Code Section 5097.5 affirms that no person shall willingly or knowingly excavate, remove, or otherwise destroy a vertebrate paleontological site or paleontological feature without the express permission of the overseeing public land agency. It further states under Public Resources Code Section 30244 that any development that would adversely impact paleontological resources shall require reasonable mitigation. These regulations apply to projects located on land owned by or under the jurisdiction of the state or city, county, district, or other public agency (California Public Resources Code Section 5097.5 [California Office of Historic Preservation 2005]).

2.3 LOCAL

2.3.1 Riverside County

Paleontological resources are addressed under the 2008 Multipurpose Open Space Element of the Riverside County General Plan, Policy OS 19.9, which states the following:

> This policy requires that when existing information indicates that a site proposed for development may contain paleontological resources, a paleontologist shall monitor site grading activities, with the authority to halt grading to collect uncovered paleontological resources, curate any resources collected with an appropriate repository, and file a report with the Planning Department [Riverside County Planning Department 2008].

The SABER Policy (**S**afeguard **A**rtifacts **B**eing **E**xcavated in **R**iverside County) enacted in October 2011 by the Riverside County Board of Supervisors mandates that any paleontological resources found or unearthed in the County of Riverside be curated at the Western Science Center in the city of Hemet. This new policy will be included as an amendment to the Multi-purpose Element of the General Plan Update.

2.3.2 Imperial County

Imperial County does not have mitigation requirements that specifically address potential adverse impacts to paleontological resources.

3
PALEONTOLOGICAL RESOURCE ASSESSMENT GUIDELINES AND SIGNIFICANCE CRITERIA

3.1 DEFINITION OF PALEONTOLOGICAL RESOURCES AND SIGNIFICANCE CRITERIA

Paleontological resources are the evidence of once-living organisms as preserved in the rock record. They include both the fossilized remains of ancient plants and animals and the traces thereof (trackways, imprints, burrows, etc.). In general, fossils are considered to be greater than 5,000 years old (older than Middle Holocene) and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks formed under certain conditions (SVP 2010).

Significant paleontological resources are defined as "identifiable" vertebrate fossils, uncommon invertebrate, plant, and trace fossils that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, or biochronological data (SVP 2010). These data are important because they are used to examine evolutionary relationships, provide insight on the development of and interaction between biological communities, and establish time scales for geologic studies, and for many other scientific purposes (Scott and Springer 2003; SVP 2010).

3.2 PROFESSIONAL STANDARDS AND PALEONTOLOGICAL RESOURCE SENSITIVITY

Absent specific agency guidelines, most professional paleontologists in California adhere to guidelines set forth by SVP in *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (SVP 2010). These guidelines establish detailed protocols for the assessment of the paleontological resource potential (i.e., "sensitivity") of a project area and outline measures to follow in order to mitigate adverse impacts to known or unknown fossil resources during project development. In order to prevent project delays, SVP highly recommends that the owner or developer retain a qualified professional paleontologist in the advance planning phases of a project to conduct an assessment and to implement paleontological mitigation during construction, as necessary.

Using baseline information gathered during a paleontological resource assessment, the paleontological resource potential of the geologic unit(s) (or members thereof) underlying a Project area can be assigned to one of four categories defined by SVP (2010). These categories include high, undetermined, low, and no potential. The criteria for each sensitivity classification and the corresponding mitigation recommendations are summarized in Table 3-1 below.

If a project area is determined to have high or undetermined potential for paleontological resources following the initial assessment, then SVP recommends that a Paleontological Resources Mitigation Plan (PRMP) be developed and implemented during the construction phase of a project. The mitigation plan describes, in detail, when and where paleontological monitoring will take place and establishes communication protocols to be followed in the event that an unanticipated fossil discovery is made during project development. If significant fossil resources are known to occur within the boundary of the project and have not been collected, then the plan will outline the procedures to be followed prior to any ground-disturbing activities (i.e., preconstruction salvage efforts or avoidance measures, including fencing off a locality). Should microfossils be known to occur in the geologic unit(s) underlying the Project area or suspected to occur, then the plan will describe the methodology for matrix sampling and screening.

Table 3-1
Paleontological Sensitivity Categories

Resource Potential*	Criteria	Mitigation Recommendations
No Potential	Rock units that are formed under or exposed to immense heat and pressure, such as high-grade metamorphic rocks and plutonic igneous rocks.	No mitigation required.
Low Potential	Rock units that have yielded few fossils in the past, based upon review of available literature and museum collections records. Geologic units of low potential also include those that yield fossils only on rare occasion and under unusual circumstances.	Mitigation is not typically required.
Undetermined Potential	In some cases, available literature on a particular geologic unit will be scarce and a determination of whether or not it is fossiliferous or potentially fossiliferous will be difficult to make. Under these circumstances, further study is needed to determine the unit's paleontological resource potential (i.e., field survey).	A field survey is required to further assess the unit's paleontological potential.
High Potential	Geologic units with high potential for paleontological resources are those that have proven to yield vertebrate or significant invertebrate, plant or trace fossils in the past or are likely to contain new vertebrate materials, traces, or trackways. Rock units with high potential also may include those that contain datable organic remains older than late Holocene (e.g., animal nests or middens).	Typically, a field survey as well as on-site construction monitoring will be required. Any significant specimens discovered will need to be prepared, identified, and curated into a museum. A final report documenting the significance of the finds will also be required.

* - Adapted from SVP (2010).

The PRMP should be prepared by a qualified professional paleontologist and developed using the results of the initial paleontological assessment and survey. Elements of the plan can be adjusted throughout the course of a project as new information is gathered and conditions change, so long as the lead agency is consulted and all parties are in agreement. For example, if after 50 percent of earth-disturbing activities have occurred in a particular unit or area and no fossils whatsoever have been discovered, then the project paleontologist can reduce or eliminate monitoring efforts in that unit or area.

4
METHODS

4.1 LITERATURE REVIEW AND RECORDS SEARCH

Paleontological resources are not found in “soil” but are contained within the geologic deposits or bedrock that underlies the soil layer. Therefore, in order to ascertain whether or not a particular project area has the potential to contain significant fossil resources at the subsurface, it is necessary to review relevant scientific literature and geologic mapping to determine the underlying geology and stratigraphy of the area. Further, in order to delineate the boundaries of an area of paleontological sensitivity, it is necessary to determine the extent of the entire geologic unit because paleontological sensitivity is not limited to surface exposures of fossil material.

To determine whether or not fossil localities have been previously discovered within a project area or a particular rock unit, a search of pertinent local and regional museum repositories for paleontological localities within and nearby the project area should be performed. For this Project, a museum records search was conducted using the University of California Museum of Paleontology’s (UCMP) online database, which contains paleontological records for Riverside and Imperial Counties.

5
GEOLOGY AND PALEONTOLOGY

5.1 REGIONAL GEOLOGY

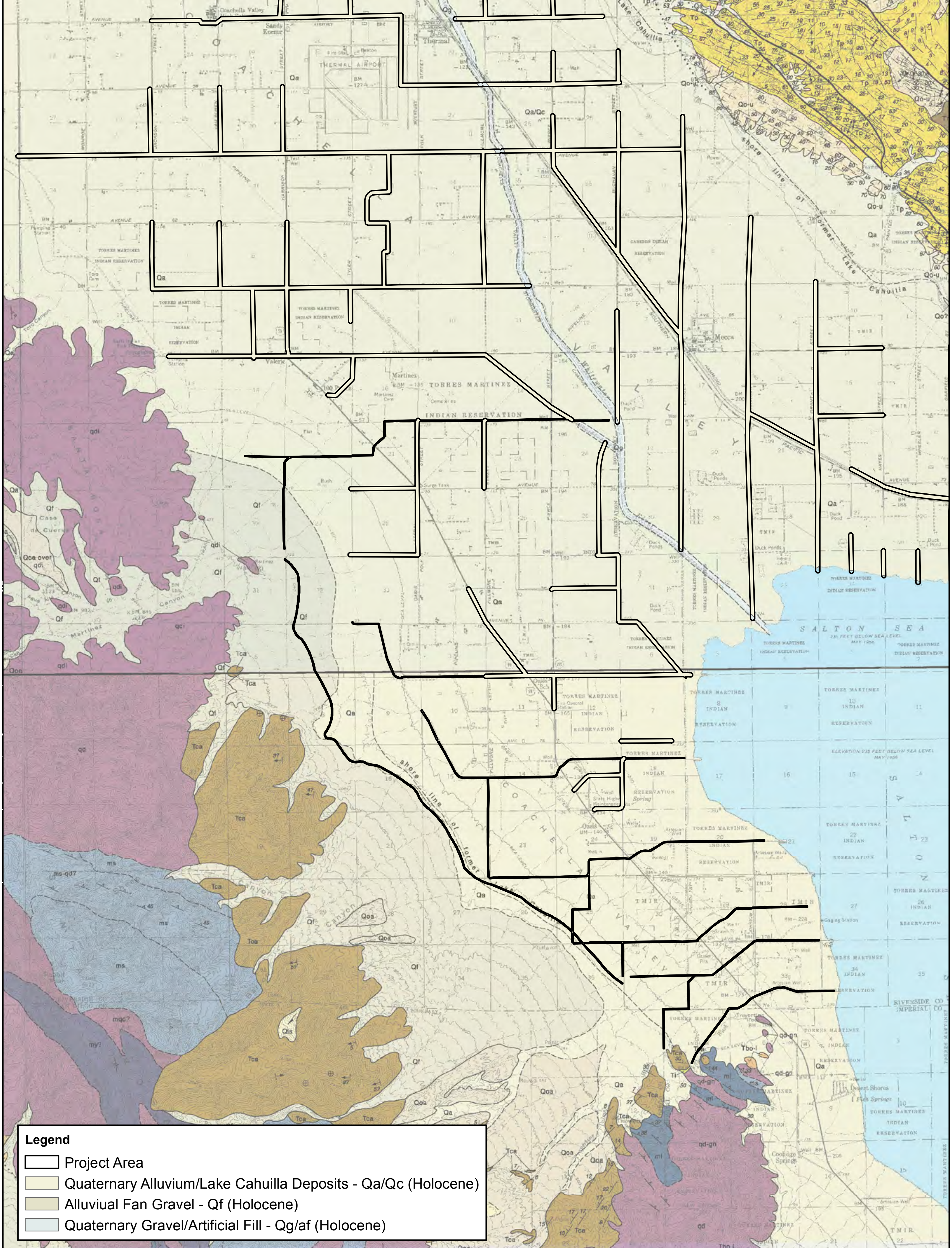
The Project area is located in the Coachella Valley within the Colorado Desert geomorphic province in California. The Colorado Desert extends from the Mojave Desert to the north, the Colorado River on the east, the Peninsular Ranges on the west, and south into Mexico. Dominant features within the Colorado Desert include the Salton Trough; the Colorado River; and the Orocopia, Chocolate, Palo Verde, and Chuckwalla mountains (Norris and Webb 1976). The Coachella Valley is located north of the Imperial Valley and within the Salton Trough, a large structural depression that extends from the San Gorgonio Pass in the north to the Gulf of Mexico in the south (Norris and Webb 1976). The Salton Trough is a graben structure, bounded by roughly parallel north-west-trending faults, including the San Andreas Fault Zone to the northeast and the San Jacinto and Elsinore faults to the southeast (Alles 2011). During the Pliocene, the Salton Trough formed due to spreading and subsidence associated with the rift system that opened the Gulf of California, which still continues to undergo approximately 48 millimeters per year of spreading. The Salton Trough, including the Coachella and Imperial valleys, would currently be under water as part of the Gulf of California if not for millions of years of sedimentation from the Colorado River (Alles 2011). During the Pliocene to Early Pleistocene, sedimentation along the Colorado River resulted in the build-up of a substantial delta, which eventually separated the marine waters of the Gulf of California from the brackish and fresh waters of the Salton Trough (Ingwall 2008). Since the Late Pleistocene, the Salton Trough was periodically occupied by the freshwater Lake Cahuilla. The lake formed, drained, and reformed between approximately 37,000 to 300 years before present (B.P.) as a result of fluctuations in the course of the Colorado River and the subsequent diversion of the river's mouth from the Gulf of California to the Salton Trough (Deméré 2002; Norris 1979). Lake Cahuilla reached a maximum depth of 300 feet, 105 miles long, and 35 miles across at its last high stand at approximately 45 feet above sea level in the Coachella Valley.

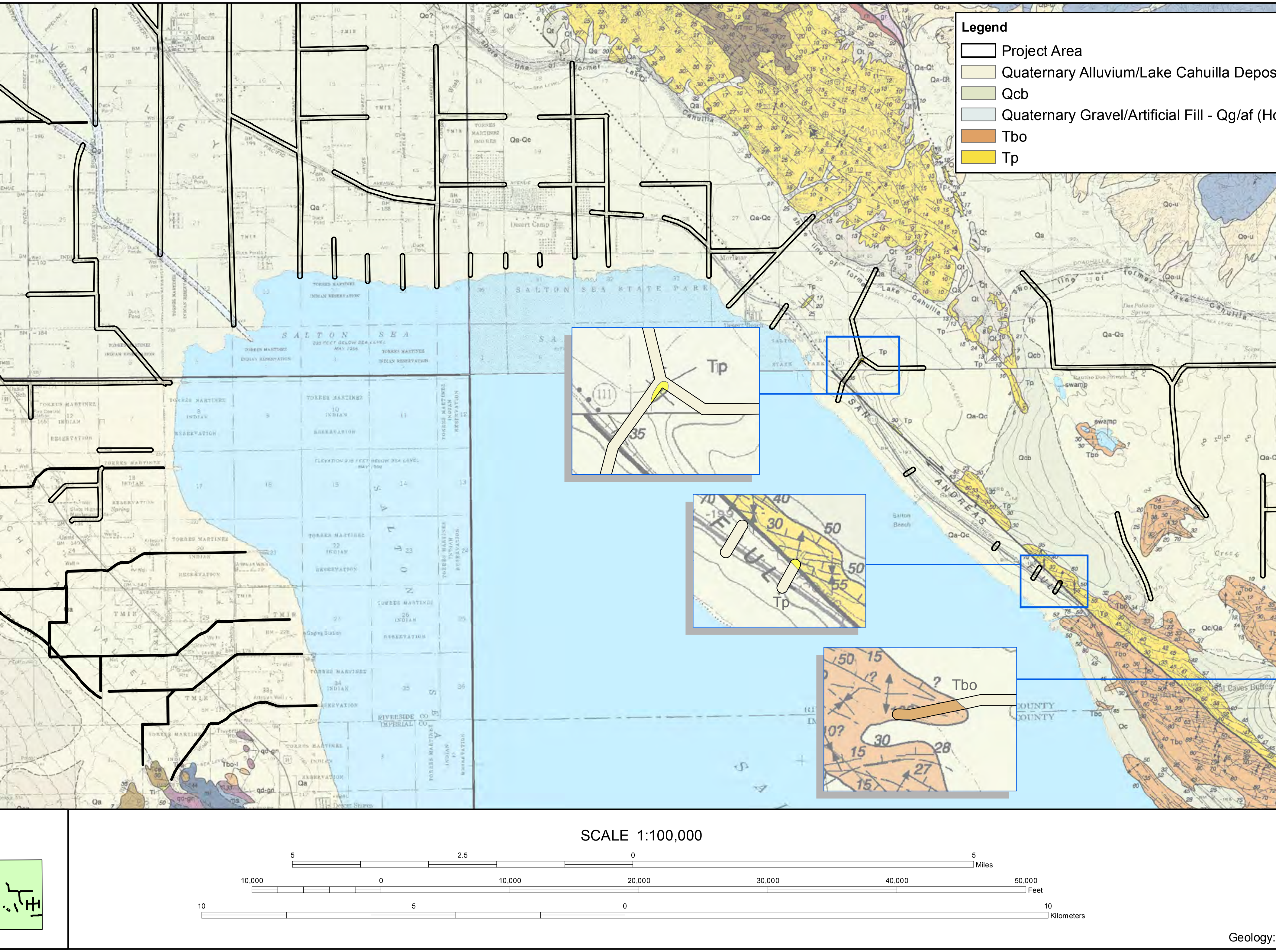
5.2 GEOLOGY AND PALEONTOLOGY OF THE PROJECT AREA

The Project area is mapped at a scale of 1:62,500 by Dibblee and Minch (2008a-d). According to these published maps, the Project area is directly underlain by sedimentary rock units of Pliocene to Holocene age, including the Palm Spring Formation, Borrego Formation, and Quaternary surficial sediments. The geology and paleontology of these units is described in the following sections and the geology is depicted in Figure 5-1.

5.2.1 Palm Spring Formation

The Pliocene-Pleistocene Palm Spring Formation (Tp) was deposited at least 3.58 million years ago (Ma) to 0.78 Ma, based on biostratigraphic correlation (Cassiliano 1999). The Palm Spring Formation records sedimentation of the ancient Colorado River delta and is one of the several terrestrial deposits in the Colorado Desert that record nearly continuous sedimentation


Legend
Project Area
Quaternary Alluvium/Lake Cahuilla Deposits - Qa/Qc (Holocene)
Alluviual Fan Gravel - Qf (Holocene)
Quaternary Gravel/Artificial Fill - Qg/af (Holocene)



nits in the Project Area.

from the Miocene to the Pleistocene (Dibblee 1954). The Palm Spring Formation was named by Woodring (1931) for its type section near a spring along Vallecito Creek in Anzo Borrego Desert State Park, within eastern San Diego County. The Palm Spring Formation is well exposed throughout the Salton Trough where it is 1,800 feet to 6,500 feet thick and up to approximately 4,000 feet thick near the Project area (Dibblee 1954). In the vicinity of the Project area, the Palm Spring Formation is conformably underlain by the Imperial Formation and conformably overlain by the Borrego Formation.

The Palm Spring Formation is generally composed of resistant, fine to medium-grained, red to gray-buff arkose with interbedded green and red mudstone (Dibblee 1954). On the basis of lithologic characteristics and depositional environment, the Palm Spring Formation has been informally divided into four members (from oldest to youngest): the Olla, Diablo, Tapiado, and Huesos members (Cassiliano 1999; Winker 1987; Woodard 1963). The Olla and Diablo members primarily consist of Colorado River delta and braided river facies composed of orange, friable, massive to thickly-bedded, fine-grained sandstone and siltstone with interbedded red-brown claystone. The lithology of the Olla and Diablo members consists of fining upward sandstone sequences with basal conglomerate lag. Clasts within the conglomerate and coarse sandstone consist of lithic pebbles, silicified wood, fossil plant material, and reworked Paleozoic limestone pebbles derived from the Colorado Plateau embedded with bryozoan, brachiopod, and coral invertebrate fossils (Winker 1987). The Diablo member is the most widespread unit of the Palm Spring Formation and is likely exposed within the Project area. The Tapiado member is of lacustrine origin and is predominately composed of green-gray claystone with subordinate limestone and tuff deposits (2.3 + 0.4 Ma [zircon; Johnson et al. 1983]). The Huesos member consists of fluvial facies composed of tan, buff, and gray arkose; micaceous sandstone; and siltstone, with subordinate claystone, limestone, and conglomerate, derived from local streams (Cassiliano 1999; Winker 1987).

The Palm Spring Formation has previously yielded over a hundred vertebrate species and thousands of marine and terrestrial vertebrate specimens from localities within Southern California (Woodard 1963). The majority of the vertebrate fossils have been recorded from exposures of the Huesos member, with smaller quantities identified within the Diablo and Olla members. Fossils are not common within the Tapiado member. Diversity and abundance of specimens within the Huesos member is likely the result of taphonomic processes, whereby sediments within the unit were typically derived from local sources and transported short distances under relatively quiet conditions (Cassiliano 1999).

Three Local Faunas (LF) have been identified within the Palm Spring Formation. The Layer Cake LF, Arroyo Seco LF, and Vallecito Creek LF were named for specimens recovered from the Fish Creek-Vallecito Creek area of Anzo-Borrego Desert State Park, approximately 30 to 60 miles southwest of the Project area (Cassiliano 1999; Downs and White 1968). The Layer Cake LF (4.38 Ma to 3.58 Ma; early Blancan North American Land Mammal Age [NALMA]) includes taxa recorded within the Diablo and Olla members of the Palm Spring Formation as well as those identified from the uppermost Imperial Formation. Taxa of the Layer Cake LF include Telostei (ray-finned fish), *Gopherus agassizii* (desert tortoise), *Cnemidophorus* sp. (whiptail lizard), *Dipsosaurus dorsalis* (desert iguana), *Gambelia corona* (leopard lizard), *Pumilia noveceki* (lizard), *Teratornis incredibilis* (Teratorns; large birds of prey), *Pelecanus erythrorhynchus* (white pelican), *Puffinus* sp. (seabird), Soricidae (shrew), *Hypolagus vetus* (rabbit), *Pewelagus dawsonae* (rabbit), Rodentia (rodent), Sciuridae (squirrel), *Lynx rufus* (bobcat), Mustelidae (terrestrial carnivore), *Dinohippus* sp. (horse), Cervidae (deer), and *Hemiauchenia* sp (camelid). The Arroyo Seco LF (3.58 Ma to 2.58 Ma; late Blancan NALMA) includes taxa recorded within the Diablo, Olla, Tapiado, and Huesos members of the Palm Spring Formation. Taxa of the Arroyo Seco LF include Batoidea (rays), Catostomidae (sucker fish), Clupeidae (e.g., sardines and herrings), Anura (frog), *Clemmys* sp. (turtle), *Pseudemys scripta* (red-eared slider turtle), *Geochelone* sp. (tortoise), Squamata (scaled reptile), *Grus Canadensis* (sandhill crane), *Notiosorex jacksoni* (shrew), Soricidae, Talpidae (mole), *Anzanycteris anzensis* (vesper bat), *Megalonyx sp.* (ground sloth), Leporidae (rabbit and hare), Rodentia, *Canis latrans* (coyote), *Urocyon* (fox), *Vulpes* (fox), Felidae (cats), Mustilidae, *Bassariscus astutus* (ring-tailed cat), *Tremarctos floridanus* (Florida spectacled bear), *Equus* sp. (horse), *Dinohippus* sp., Artiodactyla (even-toed ungulate), and Proboscidea (e.g., elephant and mammoth). The Vallecito Creek LF (2.58 Ma to 0.78 Ma; late Blancan to Irvingtonian NALMA) includes taxa recorded within the Diablo, Olla, Tapiado, and Huesos members of the Palm Spring Formation. Taxa of the Vallecito LF include *Bufo* sp. (toad), *Clemmys* sp., *Pseudemys scripta*, *Geochelone* sp., *Gopherus agassizii, Kinosternon* sp. (mud turtles), Squamata, Aves (bird), *Notiosorex* sp., *Sorex* sp (shrew), *Scapanus malatinus* (mole), *Glossotherium* (ground sloth), *Megalonyx wheatleyi* (Wheatley's ground sloth), *Northrotheriops shastensis* (ground sloth), Lagomorpha, Rodentia, *Borophagus diversidens* (canid), *Canis latrans, Urocyon* sp., *Felis concolors* (mountain lion), *Felis lacustris* (lake cat), *Lynx rufus, Panthera onca* (Jaguar), *Smilodon* sp. (saber-toothed cats), *Gulo sp.* (wolverine), *Mustela freneta* (long-tailed weasel), *Spilogale putorius* (eastern spotted skunk), *Taxidea taxus* (North American badger), *Nasua* sp. (raccoons), *Procyon* sp. (raccoon), Arctodus (short-faced bear), *Tremarctos* sp. (bear), *Ursus americanus* (American black bear), *Equus sp., Tapirus merriami* (tapir), Artiodactyla, *Camelops sp.*(camel), and *Mammut* (mastodon).

5.2.2 Borrego Formation

The Pliocene to Pleistocene Borrego Formation (Tbo) is exposed in the southeastern Project area (Dibblee and Minch 2008a-d). The Borrego Formation was named by Tarbet and Holman (1944) for the type section in the Borrego Badlands in eastern San Diego County, where it is up to 6,000 feet thick and thins to approximately 2,500 feet near the Project area (Deméré and Walsh 1993; Dibblee 1954). The deposit is conformable with the overlying Ocotillo Conglomerate and Brawley Formation and forms a gradational contact with the underlying Palm Spring Formation. In addition to the type section in the Borrego Badlands in the Anzo-Borrego Desert State Park, the Borrego Formation is intermittently exposed in the Salton Trough between Ocotillo Wells and Borrego Springs and along portions of the northeast and southwest margins of the Salton Sea. The Borrego Formation consists of commonly rippled lacustrine sediments composed of light-gray, well-bedded mudstone and claystone, with thin interbeds of local and Colorado River-derived siltstone and sandstone as well as intermittent deposits of sodium sulfate evaporates up to 5 feet thick (Dibblee 1954; Dorsey 2005; Winker 1987). The massive siltstone and sandstones are pale orange in color and are locally abundant.

The Palm Spring Formation has previously yielded numerous localities, which have contained specimens of terrestrial vertebrate, invertebrate, and microfossils (Winker 1987). Invertebrate and microfossil specimens recorded at the type section include mollusks, small crustaceans, mussel shrimp, and rare foraminifera (Dorsey 2005). Vertebrate localities within the fine-grained lacustrine deposits exposed near the Borrego Badlands have been known to contain well-preserved, unspecified specimens of terrestrial vertebrates (Deméré and Walsh 1993).

5.2.3 Quaternary Surficial Sediments

According to published geologic maps, the Project area is immediately underlain by undifferentiated Quaternary alluvial (Qa), alluvial fan (Qf), and lacustrine (Qc) deposits of Holocene age (Dibblee and Minch 2008a-d). The Holocene-age lacustrine sediments consist of Lake Cahuilla deposits that are 3 to 5 feet thick on average and up to 300 feet thick. The deposits are composed of undissected to dissected, weakly consolidated silts and clays, with abundant, non-mineralized mollusk fragments. Holocene-age Lake Cahuilla sediments also consist of local deposits of sandy beach, gravel bar (Qcb), and spit deposits (Dibblee and Minch 2008a-d; Norris 1979). The Quaternary alluvium consists of gravel, silt, sand, and clay derived from alluvial fans and streams. Aeolian deposits are also a common constituent of the Quaternary alluvium. Based on previous stratigraphic, archaeological, paleontological, hydrogeological, and tectonic studies, where not explicitly mapped at the surface, Holocene-age Lake Cahuilla lacustrine silt deposits are known to underlie surficial alluvial deposits at shallow depth (Alles 2011; Deméré 2002; Norris 1979; Scott 2014; Waters 1983; Whistler et al. 1995). In turn, older Pleistocene-age ancient Lake Cahuilla deposits underlie the surficial to shallowly-buried Holocene-age lacustrine silt at moderate depth. The depth of the contact between the Holocene-age and Pleistocene-age Lake Cahuilla deposits in the Project area is unknown; however, radiocarbon dating derived from Lake Cahuilla deposits located approximately 5 miles south of Indio indicate that lacustrine silt sediments at a depth of 20 feet below ground surface have an age of approximately 4,000 B.P. (Waters 1983). Therefore, Pleistocene-age ancient Lake Cahuilla sediments are likely present at a relatively shallow depth below the Holocene lacustrine deposits. The Pleistocene-age Lake Cahuilla deposits are generally composed of weakly consolidated, lacustrine sands, silts and clays, with tufa and travertine rock coatings, coarse alluvial deposits, and beach sands (Norris 1979; Waters 1983). The Pleistocene- to Holocene-age Lake Cahuilla sediments range from several feet deep at the margin of the Coachella Valley to as much as 300 feet thick in the center of the Salton Trough (Arnal 1961; Norris and Webb 1976).

Late Quaternary-age lacustrine deposits derived from ancient Lake Cahuilla have proven to yield scientifically significant mollusk shells within the Salton Trough (Scott 2014; Whistler et al. 1995). Fossil specimens of diatoms, spores, pollen, land plants, sponges, ostracods, freshwater gastropods, fresher bivalves, fish, and small terrestrial vertebrate have been recovered from the Pleistocene-age Lake Cahuilla beds (Scott 2014). In addition, Holocene-age, non-mineralized (non-fossil) mollusk shells are also found in the Lake Cahuilla silt deposits; their recovery and subsequent dating have helped researchers with studies in archaeology, geology, and seismology (Norris and Webb 1976).

6
ANALYSIS AND RESULTS

6.1 MUSEUM RECORDS SEARCH RESULTS

Records retrieved from the UCMP database do not provide the exact location of recovered fossil specimens; only a general description of the locality is given. As such, locality queries were performed for the entirety of Riverside and Imperial Counties. Museum collections records maintained by the UCMP online database do not contain records for previously documented vertebrate fossil localities within the Project area or have any localities been recorded in the vicinity of the Project. However, the Palm Spring Formation and Borrego Formation have yielded vertebrate fossils in San Diego County, approximately 30 to 60 miles southwest of the Project area. A review of the UCMP online database reveals that there are five previously recorded vertebrate fossil localities from within the Palm Spring and Borrego formations, which yielded fossil specimens of *Odocoileus casensis* (deer), *Equus* sp. (horse), and other unspecified vertebrates (UCMP 2014). The UCMP online database does not contain records for Holocene-age Lake Cahuilla deposits (please note that the San Bernardino County Museum [SBCM], Western Science Center [WSC], or Natural History Museum of Los Angeles County may contain additional records). The results of the online museum records search are presented below in Table 6-1.

Table 6-1
Vertebrate Localities Reported from within Geologic Units Underlying the Project Area[a]

Locality No.	Geologic Unit	Age	Taxa
UCMP V78104	Palm Spring Formation	Pliocene- Pleistocene	*Odocoileus casensis*
UCMP V6847	Palm Spring Formation	Pliocene- Pleistocene	Equus *sp.*
UCMP V65686	Palm Spring Formation	Pliocene- Pleistocene	Unspecified vertebrates
UCMP V5210	Palm Spring Formation	Pliocene- Pleistocene	Unspecified vertebrates
UCMP V5209	Borrego Formation	Pliocene- Pleistocene	Unspecified vertebrates

a - UCMP 2014.

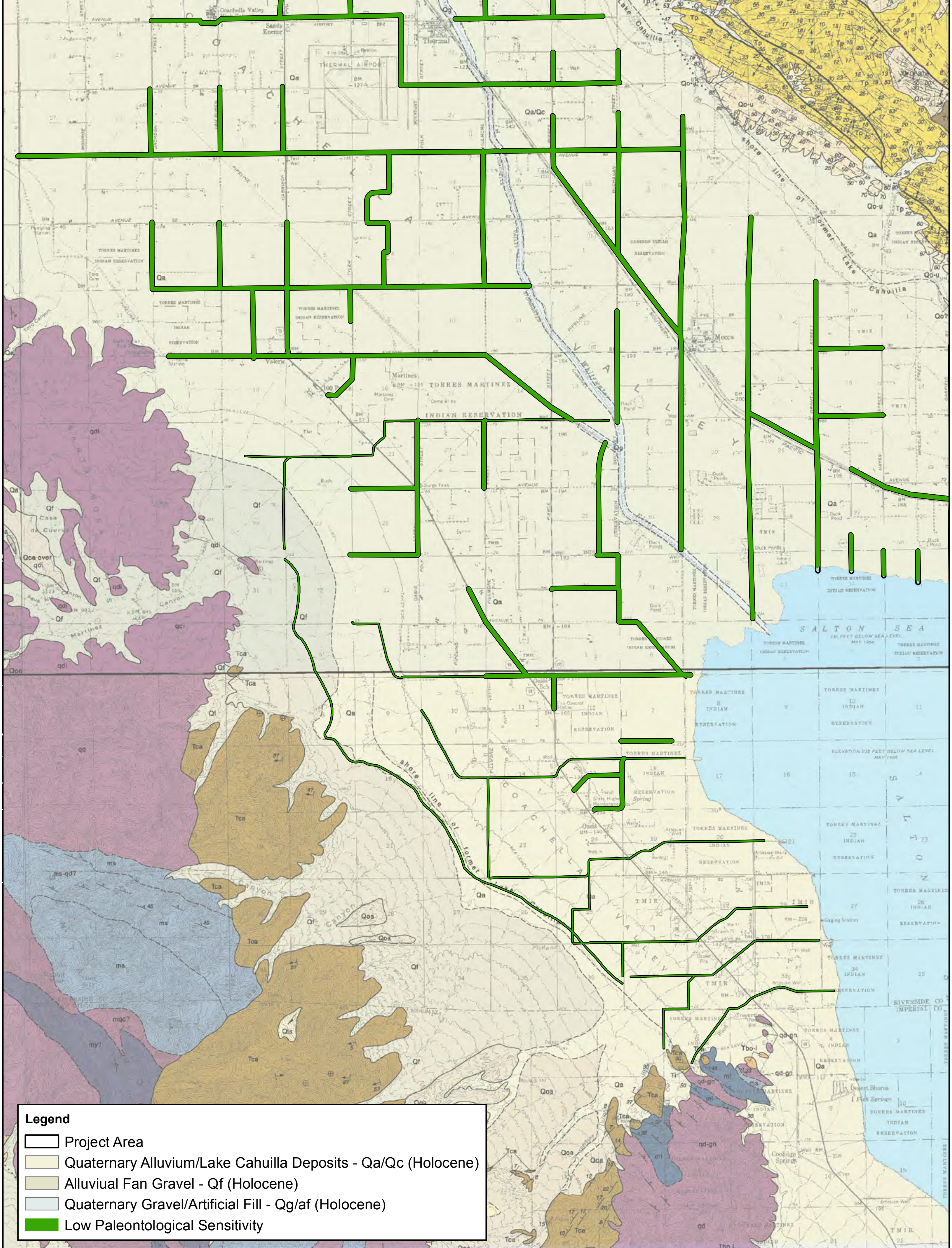
6.2 PALEONTOLOGICAL RESOURCE POTENTIAL FOR GEOLOGIC UNITS WITHIN THE PROJECT AREA

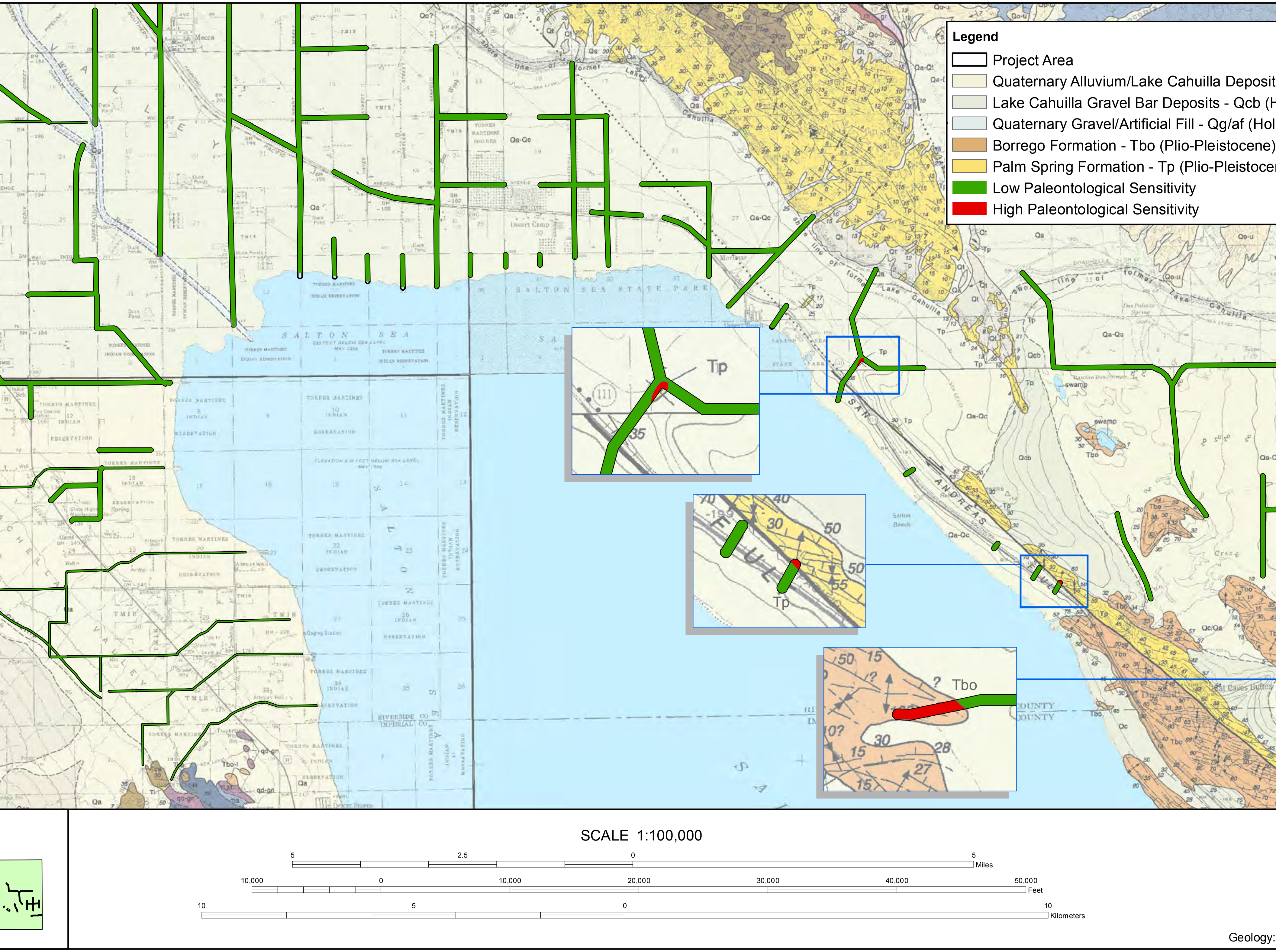
Based on the literature review and museum records search results, the geologic units underlying the Project area have a paleontological resource potential ranging from low to high in accordance with criteria set forth by SVP (2010). The Palm Spring Formation and Borrego Formation mapped within the Project area have a high paleontological resource potential because they have proven to yield an abundant and diverse vertebrate fauna from exposures within southeastern California. The Quaternary alluvium and lacustrine deposits mapped within the Project area have a low potential to contain intact paleontological resources because they are typically too young to contain fossilized remains; however, these sediments may be underlain at moderate depth by the Pleistocene-age ancient Lake Cahuilla deposits. Therefore, further paleontological resource management is recommended during Project development as discussed in Chapter 7. The geologic units underlying the Project area and their determined sensitivity ratings are shown in Table 6-2 and depicted in Figure 6-1.

Table 6-2
Geologic Units in the Project Area and Their Recommended Paleontological Sensitivity

Geologic Unit*	Map Abbreviation	Age	Typical Fossils	Paleontological Resource Potential
Palm Spring Formation	Tp	Pliocene-Pleistocene	Terrestrial mammals, rodent, birds, reptiles, and amphibians	High
Borrego Formation	Tbo	Pliocene-Pleistocene	Terrestrial mammals	High
Quaternary surficial sediments	Qa, Qc, Qcb, Qf	Holocene	None	Low to High, dependent on depth

* - Geology taken from Dibblee and Minch (2008a, 2008b, 2008c, 2008d).


Legend
Project Area
Quaternary Alluvium/Lake Cahuilla Deposits - Qa/Qc (Holocene)
Alluviual Fan Gravel - Qf (Holocene)
Quaternary Gravel/Artificial Fill - Qg/af (Holocene)
Low Paleontological Sensitivity
Coachella Valley
Thermal
THERMAL AIRPORT
Mecca
TORRES MARTINEZ
INDIAN RESERVATION
SALTON SEA
shore line of former Lake Cahuilla
RIVERSIDE CO
IMPERIAL CO
Desert Shores
Coolidge Springs
Martinez Canyon



Geology:

gical Sensitivity in the Project Area.

7
MANAGEMENT RECOMMENDATIONS

The following management recommendations have been developed in accordance with SVP guidelines and, if implemented, will satisfy the requirements of CEQA. These measures have been used by professional paleontologists for many years and have proven to be effective in reducing or eliminating adverse impacts to paleontological resources as a result of private and public development projects throughout California and elsewhere.

7.1 PRECONSTRUCTION SURVEY

A qualified paleontologist (Project Paleontologist) should be retained to conduct a field reconnaissance survey of the Project area prior to any ground-disturbing activities. The purpose of the field survey will be to visually inspect the ground surface for exposed fossils or traces thereof and to evaluate geologic exposures for their potential to contain preserved fossil material at the subsurface. Because sensitive Pleistocene-age units are known to be shallowly buried beneath Holocene-age deposits, all geologic units within the Project area will be subject to a pedestrian walkover, excluding those that have been visibly disturbed or are obscured by developments (e.g., existing roadway, canal, building, heavy vegetation, etc.). Particular attention will be paid to rock outcrops, both within and in the vicinity of the Project area, and any areas where geologic sediments are well exposed.

All fossil occurrences observed during the course of fieldwork, significant or not, should be adequately documented and recorded at the time of discovery. The data collected for each fossil occurrence should include, at minimum, the following information: Universal Transverse Mercator (UTM) coordinates, approximate elevation, description of taxa, lithologic description, and stratigraphic context (if known). In addition, each locality should be photographically documented with a digital camera. If feasible, all significant or potentially significant fossils should be collected at the time they are observed in the field with prior consent of the landowner(s). This is because if left exposed to the elements, fossil materials are subject to erosion and weathering. If the fossil discovery is too large to collect during the survey (e.g., a whale skeleton or bone bed) and requires a large-scale salvage effort, then it will be documented and a mitigation strategy will be devised pursuant to SVP (2010) guidelines.

7.2 WORKER'S ENVIRONMENTAL AWARENESS TRAINING

Prior to any ground-disturbing activities, all field personnel will receive a worker's environmental awareness training module on paleontological resources. The training will provide a description of the fossil resources that may be encountered in the Project area, outline steps to follow in the event that a fossil discovery is made, and provide contact information for the Project Paleontologist and on-site monitor(s). The training will be developed by the Project Paleontologist and may be conducted concurrent with other environmental training (e.g., cultural and natural resources awareness training, safety training, etc.). The training also may be videotaped or presented in an informational brochure for future use by field personnel not present at the start of the Project.

7.3 PALEONTOLOGICAL MITIGATION MONITORING

Prior to the commencement of ground disturbing activities, a Project Paleontologist will be retained to prepare and implement a PRMP for the Project. Initially, full-time monitoring will be required in previously undisturbed Project areas determined to have a high paleontological sensitivity (i.e., the Palm Spring Formation and the Borrego Formation) during all ground-disturbing activities. Part-time monitoring or spot checking will occur during ground disturbances impacting the Holocene-age Quaternary alluvium and Lake Cahuilla sediments to determine if underlying sensitive geologic deposits are being impacted by construction and at what depth. The frequency of monitoring can be reduced at the discretion of the Project Paleontologist if, after one-half of work is completed, no significant fossil resources are encountered. Monitoring can also be reduced or eliminated if it is observed that only previously disturbed geologic deposits are being impacted by construction.

7.3.1 Monitoring Locations, Tasks, and Procedures

Monitoring will consist of the visual inspection of excavated or graded areas and trench sidewalls. Screening of sedimentary matrix will be conducted as necessary and at no time will a monitor enter an unsafe cut or unshored trench. All paleontological work will be directed by the Project Paleontologist and reported on a Daily Monitoring Record; additional data will be recorded in waterproof field notebooks. At a minimum, information in the report will include areas monitored, monitor name(s), and a summary of monitoring activities. Recording of stratigraphic data will be an ongoing task during monitoring in order to provide context for any eventual fossil discoveries. In paleontologically sensitive areas or in peripheral areas that can provide context for the geology and paleontology, outcrops and cut exposures will be examined, and observed geologic features will be recorded in field notes. The goal of this work is to define the nature of fossil-bearing sedimentary units within the Project area, determine their areal extent and depositional contacts, and record any evidence of sediment structures or deformation. Standard geologic and stratigraphic data collected include lithologic descriptions (e.g., color, sorting, texture, structures, and grain size, and compositional percentages), stratigraphic relationships (e.g., bedding type, thickness, and contacts), and geographic position (e.g., Universal Transverse Mercator [UTM] coordinates). Stratigraphic sections will be routinely measured in areas where fossiliferous sediments are recovered.

7.3.2 Fossil Discovery and Salvage

In the event that a paleontological resource is discovered, the monitor will be empowered to temporarily divert the construction equipment around the find until it is assessed for scientific significance. Diversion and adjustment of construction activities will only occur in coordination with construction personnel, once the Construction Supervisor has determined it is safe to do so. A temporary construction exclusion zone of at least 50 feet, consisting at a minimum of lath and flagging tape, will be erected around the discovery. The exclusion zone acts as a buffer around the discovery and is maintained for safety. The monitor will immediately report the discovery to the Construction Supervisor and the Project Paleontologist so that appropriate notifications can be immediately issued. Construction activities can occur outside the buffer if it is safe to do so. The size of the buffer may be increased or decreased once the monitor adequately explores the discovery to determine its size and significance.

If the discovery is considered scientifically significant, the monitor will collect the fossil specimen(s) and associated data. For this Project, the SVP (2010) criteria of scientific significance will be used to make this determination in the field. In general, small unidentifiable vertebrate fossils will not be collected and only well-preserved or representative invertebrates or plants will be salvaged if avoidance is not feasible. At each fossil locality, the monitor will document UTM coordinates, describe the encasing sediments in detail, record stratigraphic context and fossil orientation, and photo document the fossil(s). Upon the landowner's approval, the fossil(s) will then be collected and placed in bags or trays for transport to Æ's paleontology laboratory. At the discretion of the Project Paleontologist, matrix samples also may be collected for subsequent laboratory studies (i.e., microfossil analysis). Immediately following fossil collection, the temporary construction exclusion zone will be removed and the monitor or Project Paleontologist will notify the Construction Supervisor that Project activities may resume in the area of the find.

7.3.3 Microfossil Screening

Monitoring is largely a visual inspection of sediments; therefore, the most likely fossils to be observed will be macrofossils of vertebrates (bones, teeth, tusks) or invertebrates (shells). However, at the discretion of the Project Paleontologist, the monitor may periodically screen sediments to check for the presence of microfossils that can be seen with the aid of a hand lens (i.e., microvertebrates). Should microvertebrate fossils be encountered during the screening process, bulk matrix samples will be taken for processing off site. For each fossiliferous horizon or paleosol, a standard sample (4.0 cubic yards or 6,000 pounds) will be collected for subsequent "wet-screening" per SVP (2010) guidelines.

7.3.4 Equipment and Supplies

The paleontological monitor will have a tablet computer equipped with technical software, including GPS applications, a Theodolite digital camera, compass, and reporting applications. The monitor will also be supplied with a tool kit that contains specimen containers, matrix bags, field labels, tools (shovel, pick, awls, chisels, dental picks, pin vises, brushes, etc.), chemical preservatives (e.g., Vinac), and plaster. The monitor will also have fluorescent flagging tape and survey stakes to delineate temporary construction exclusion zones. For microfossil screening, the monitor will have hand sieves, 5-gallon buckets, and an eye loupe. At all times, the monitor will wear the appropriate personal protective equipment (PPE) in compliance with the CVWD or the on-site contractor PPE work rules, including a hard hat, heavy footwear, sleeved shirt, long pants, safety glasses, and a high-visibility safety vest.

7.4 LABORATORY WORK

Upon completion of fieldwork, all significant fossil specimens will be prepared in a paleontology laboratory to a point ready for curation. Preparation will include the careful removal of excess matrix from fossil materials using manual devices such as dental picks or pin vises; for harder materials, a pneumatic air scribe may be used. For microfossil screening, chemicals such as detergents or weak acids may be used to further break down the matrix so that it can be picked for fossils under a microscope. All fossil specimens will be stabilized with glues and consolidants as needed and repaired, as necessary. Especially fragile specimens may need a support cradle constructed out of specialty plaster. Microvertebrates may require pin-mounting, a process by which the specimen is mounted using glue or wax onto a pinhead that is embedded in a cork and stored in a glass vial. Following laboratory preparation, all fossil specimens will be identified to the lowest taxonomic level, analyzed within a stratigraphic context, organized into a faunal list, cataloged, and inventoried into an electronic database.

7.5 CURATION

Upon completion of laboratory preparation and fossil identification, all scientifically significant specimens recovered as a result of the Project will be delivered to an appropriate accredited museum repository such as the San Bernardino County. The fossil specimens will be accompanied by field notes, photographs, locality data, a signed deed of gift from the landowner, and a copy of the final technical report. The cost of curation is assessed by the repository and is the responsibility of the CVWD.

7.6 REPORTING

At the completion of preconstruction and grading activities, a final report will be prepared describing the results of the paleontological monitoring efforts associated with the Project. The report will include a summary of the field and laboratory methods; an overview of the Project area geology and paleontology; a stratigraphic column; a description of the site and its relationship to other nearby or similar fossil localities; a list of taxa recovered (if any); an analysis of fossils recovered (if any) and their scientific significance; recommendations; and a list of references used. A complete set of field notes, photographs, and any newly developed geologic field maps should also be included. In addition, a map will be appended to the report depicting areas that were monitored for paleontological resources; the map also will delineate any Project areas that will require monitoring should any future site developments occur. The final report will be submitted to the CVWD. If the monitoring efforts produced fossils, then a copy of the report also will be submitted to the designated museum repository.

8
CONCLUSIONS

This assessment is based on the results of a museum records search and review of available geologic and paleontologic literature. Therefore, only fossils that have already been inventoried or collected are available for this analysis. In addition to unrecorded surface fossils, there is the potential for an unknown number of paleontological resources buried within those geologic units underlying the Project area. These nonrenewable scientific resources may be at risk of being adversely impacted by ground-disturbing activities during construction of the Project. By implementing the management recommendations presented in Chapter 7, adverse impacts to paleontological resources can be reduced to a less than significant level pursuant to the requirements of CEQA.

9
REFERENCES CITED

Alles, D. L.

2011 Geology of the Salton Trough. Western Washington University. Unpublished manuscript, 31 p. Electronic document available for download at http://fire.biol.wwu.edu/trent/alles/GeologySaltonTrough.pdf, accessed October, 17, 2014.

Arnal, Robert E.

1961 Limnology, Sedimentation, and Microorganisms of the Salton Sea, California. *Geological Society of America Bulletin*, vol. 72, no. 3. p. 427–478.

Association of Environmental Professionals

2014 *California Environmental Quality Act (CEQA) Statutes and Guidelines*. Electronic document available for download at http://www.califaep.org/component/rsfiles/download?path=CEQA-complete-book-02.26.14.pdf&Itemid=258, accessed October 2014.

California Office of Historic Preservation

2005 *California State Law & Historic Preservation: Statutes, Regulations & Administrative Policies Regarding the Preservation & Protection of Cultural & Historical Resources*. California Office of Historic Preservation, Department of Parks and Recreation Technical Assistance Series 10.

Cassiliano, Michael, L.

1999 Biostratigraphy of Blancan and Irvingtonian Mammals in the Fish Creek-Vallecito Creek Section, Southern California, and a Review of the Blancan-Irvingtonian Boundary. *Journal of Vertebrate Paleontology*, v. 19, no. 1, p. 169-186.

County of Riverside

2008 County of Riverside General Plan, Updated 2008. Figure OS-8, Paleontological Sensitivity.

Deméré, Thomas. A.

2002 Silent Beaches - Ancient Lake Cahuilla and its geologic setting, Biodiversity Research Center of the Californias, Paleontology, June 2002. San Diego Natural History Museum. Electronic document available for download at http://www.sdnhm.org/archive/research/paleontology/lakecahuilla.html, accessed October 17, 2013.

Deméré, Thomas. A., and Stephen L. Walsh

1993 Paleontological Resources, County of San Diego California. Department Of Paleontology San Diego Natural History Museum, revised April 7, 2003.

Dibblee, Thomas W

1954 Geology of the Imperial Valley region, California. *In* Richard H. Jahns (ed.), Geology of southern California. California Division of Mines, Bulletin 170, p. 21-28.

Dibblee, Thomas W., Jr. and John A. Minch

2008a Geologic map of the Palm Desert & Coachella 15 minute quadrangles, Riverside County, California. Dibblee Geological Foundation, Dibblee Foundation Map DF-373, scale 1:62,500.

2008b Geologic map of the Clark Lake & Rabbit Peak 15 minute quadrangles, Riverside, San Diego, and Imperial Counties, California. Dibblee Geological Foundation, Dibblee Foundation Map DF-374, scale 1:62,500.

2008c Geologic map of the Cottonwood Spring & Canyon Spring 15 minute quadrangles, Riverside County, California. Dibblee Geological Foundation, Dibblee Foundation Map DF-375, scale 1:62,500.

2008d Geologic map of the Durmid 15 minute quadrangle, Riverside and Imperial Counties, California. Dibblee Geological Foundation, Dibblee Foundation Map DF-376, scale 1:62,500.

Downs, T., and J. A. White.

1968 A vertebrate faunal succession in superposed sediments from late Pliocene to middle Pleistocene in California. XXIII International Geological Congress, Section 10, p. 41-47.

Ingwall, Richard

2008 *Park Paleontology*. Anza-Borrego Desert State Park Paleontology. Electronic document available for download at http://www.anzaborregopaleo.org/park_paleontology.html, accessed October 2014.

Johnson, N. M., C. B. Officer, N. D. Opdyke, G. D. Woodard, P. K. Zeither, and E. H. Lindsay.

1983 Rates of late Cenozoic tectonism in the Vallecito-Fish Creek basin, western Imperial Valley, California. *Geology*, v. 11, p. 664-667.

McLeod, Samuel A.

2014 Unpublished museum collections records. Natural History Museum of Los Angeles County.

Norris, R. M.

1979 Lake Cahuilla High Shorelines. *In* Rifting, Transpression, and Neotectonics in the Mecca Hills, Salton Trough, ed. A.G. Sylvester. Fall Field Trip Guide Book, September 25-26, 1999. Society for Sedimentary Geology, Pacific Section.

Norris, Robert M., and Robert W. Webb

1976 *Geology of California.* John Wiley & Sons, New York.

Riverside County Planning Department
2008 *Multipurpose Open Space Element, County of Riverside General Plan*. Electronic document, http://planning.rctlma.org/ZoningInformation/GeneralPlan/RiversideCountyGeneralPlan2008.aspx, accessed October 2014.

Scott, Eric
2014 Unpublished museum collections records. San Bernardino County Museum.

Scott, Eric, and Kathleen Springer
2003 CEQA and Fossil Preservation in California. *The Environmental Monitor* Fall 2003. Association of Environmental Professionals, Sacramento, California.

Society of Vertebrate Paleontology (SVP)
2010 Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Society of Vertebrate Paleontology Impact Mitigation Guidelines Revision Committee.

Tarbet, L.A., and W.H. Holman
1944 Stratigraphy and micropaleontology of the west side of Imperial Valley, California. American Association of Petroleum Geologists, Bulletin 28, p. 1781-1782.

University of California Museum of Paleontology (UCMP) Online Database
2014 UCMP Specimen Search Portal, http://ucmpdb.berkeley.edu/, accessed October 2014.

Waters, M. R.
1983 Late Holocene lacustrine chronology and archaeology of ancient Lake Cahuilla, California. Quaternary Research, v. 19, Issue 3, p. 373–387.

Whistler, D. P., E. B. Lander, and M. A. Roeder
1995 A diverse record of microfossils and fossil plants, invertebrates, and small vertebrates from the late Holocene Lake Cahuilla beds, Riverside County, California. *In* Remeika, P. and A. Sturz eds., Paleontology and Geology of the Western Salton Trough Detachment, Anza-Borrego Desert State Park, California, p. 109–118.

Woodard, G. D.
1963 The Cenozoic succession of the west Colorado Desert, San Diego and Imperial Counties, southern California. Ph.D. dissertation, University of California, Berkeley, 173 p.

Woodring, W. P.
1932 Distribution and age of the marine Tertiary deposits of the Colorado Desert. U.S. Carnegie Institute of Washington, Publication 418, p. 1-25.