



**Paleontology Survey and Assessment for the Cadiz Valley Water
Conservation, Recovery, and Storage Project-Wellfield Survey Area
San Bernardino County, California**

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June 6th, 2012

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1.0 INTRODUCTION

This section presents the findings of the paleontological resources analysis completed for the Cadiz Valley Water Conservation, Recovery, and Storage Project (proposed Project), located in eastern San Bernardino County, California. The analysis includes a review of pertinent scientific literature and unpublished technical reports, published geologic maps, museum fossil locality records, and a field survey.

The field survey included all areas of proposed surface disturbance resulting from project construction that were not previously surveyed in October 2010. Included is the Wellfield area and Staging areas 1 through 8 (Phase II, Programmatic Facilities). The Wellfield area comprises the northern most end of the Project and is the location for Staging area 1. The additional Staging areas 2 through 8 are located towards the southern end of the Project. Only one project configuration was analyzed for impacts on paleontological resources (Figures 1 through 3), and field surveys of the pipeline alignment (Phase I, Project Level Facilities) areas were not conducted because these facilities were surveyed on October 18 through October 26 2010 (see Appendix A). Previous surveys of the Wellfield areas were completed as part of the previous EIS/EIR (2001), and numerous fossil localities were documented at that time. In the time elapsed, however, information regarding specific locations for these facilities was finalized, and a re-survey was necessary in order to fully evaluate potential impacts to paleontological resources.

Based on the results of the analysis, mitigation measures were developed to reduce potential adverse impacts to paleontological resources as a result of proposed Project construction to a less than significant level.

2.0 REGULATORY REQUIREMENTS

The paleontological analysis for the proposed Project is a requirement of the California Environmental Quality Act (CEQA). 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 18, 2010 (Title 14, Chapter 3, California Code of Regulations: 15000 et seq.). One of the questions listed in the CEQA Environmental Checklist (Section 15023, Appendix G, Section XIV, Part A) is: “Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?”

The State of California Public Resources Code (Chapter 1.7), Section 5097.5 and 30244, includes additional state level requirements for the assessment and management of paleontological resources. These statutes require reasonable mitigation of adverse impacts to paleontological resources resulting from development on state lands, define the removal of paleontological “sites” or “features” from state lands as a misdemeanor, and prohibit the removal of any paleontological “site” or “feature” from state land without permission of the applicable

jurisdictional agency. These protections apply only to State of California land. The proposed Project will be constructed entirely on privately-owned lands and within existing private easements. No portion of the project will occur on federal or state land.

No other state or local laws and regulations are believed to be applicable to the proposed Project.

2.1 CEQA SIGNIFICANCE THRESHOLDS

As stated in the Cadiz Groundwater Storage and Dry Year Supply Program Final EIS/EIR (MWD, 2001), paleontological resources are nonrenewable resources of important scientific value, which include fossils and fossiliferous deposits. For purposes of CEQA, a project would be considered to result in a significant adverse impact related to paleontological resources if it results in the disturbance or destruction of rock formations determined to have high potential for significant nonrenewable fossiliferous resources, as defined by the Society of Vertebrate Paleontology. The proposed Project area contains fossiliferous formations, and prior paleontological surveys in the general area, as well as museum records, reflect the potential for the presence of significant paleontological resources within Pleistocene age formations in the proposed Project area. Because these formations have high potential for containing important paleontological resources, the disturbance of Pleistocene age sediments would be considered a significant adverse impact resulting from the proposed Project because disturbance would have the potential to directly or indirectly destroy a unique paleontological resource or site or unique geologic feature (Section 15023, Appendix G, Section XIV, Part A). According to guidelines of the San Bernardino County Museum, fossils are considered to be of significant scientific interest if one or more of the following apply:

- The fossils provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct;
- The fossils provide data useful in determining the age(s) of the rock unit or sedimentary stratum, including data important in determining the depositional history of the region and the timing of geologic events therein;
- The fossils provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas;
- The fossils demonstrate unusual or spectacular circumstances in the history of life; and
- The fossils are in short supply and/or in danger of being depleted or destroyed by the elements, vandalism or commercial exploitation, and are not found in other geographic locations.

As defined, significant paleontologic resources are determined to be fossils or assemblages of fossils which are unique, unusual, rare, uncommon, diagnostically or stratigraphically important,

and/or those which add to an existing body of knowledge in specific areas-stratigraphically, taxonomically and/or regionally. They can include fossil remains of large to very small aquatic and terrestrial vertebrates, remains of plants and animals previously not represented in certain portions of the stratigraphy, and assemblages of fossils that might aid in stratigraphic corrections, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology and the relationships of aquatic and terrestrial species.

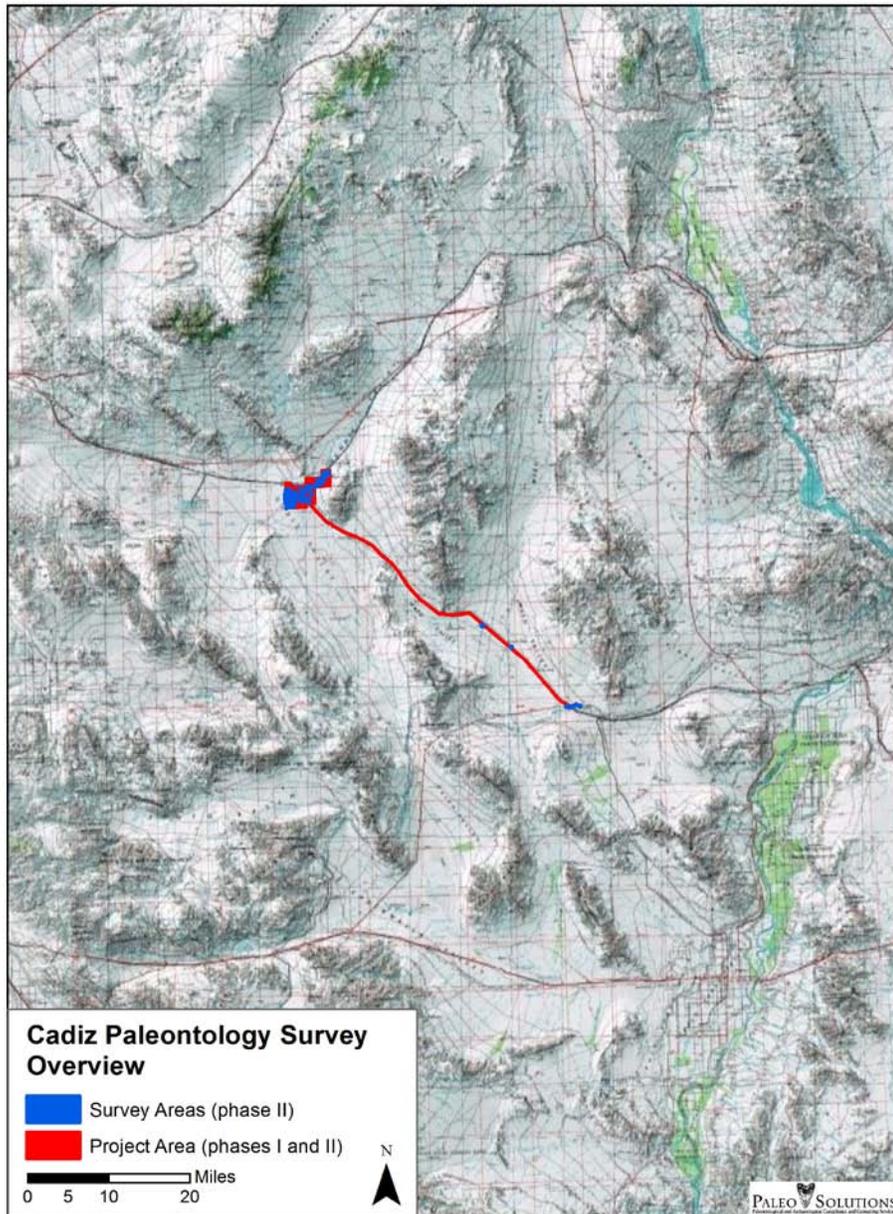


Figure 3. Location map of the proposed Project showing the survey areas (in blue). A field survey was conducted for paleontological resources in May 2012.

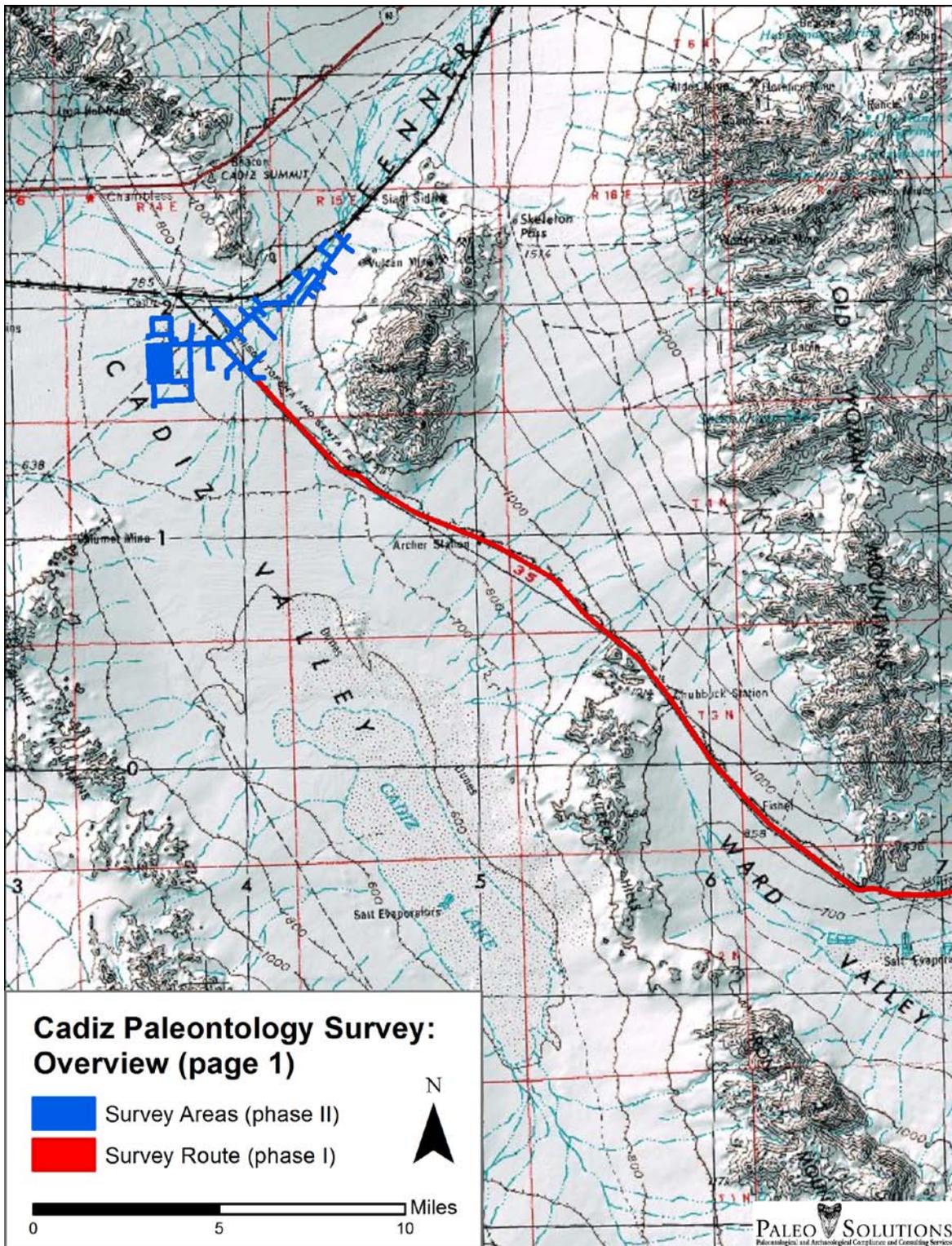


Figure 4. Location map of the proposed Project (north end). The surveyed Wellfield area is shown in blue. See Table 1 for geologic unit abbreviations.

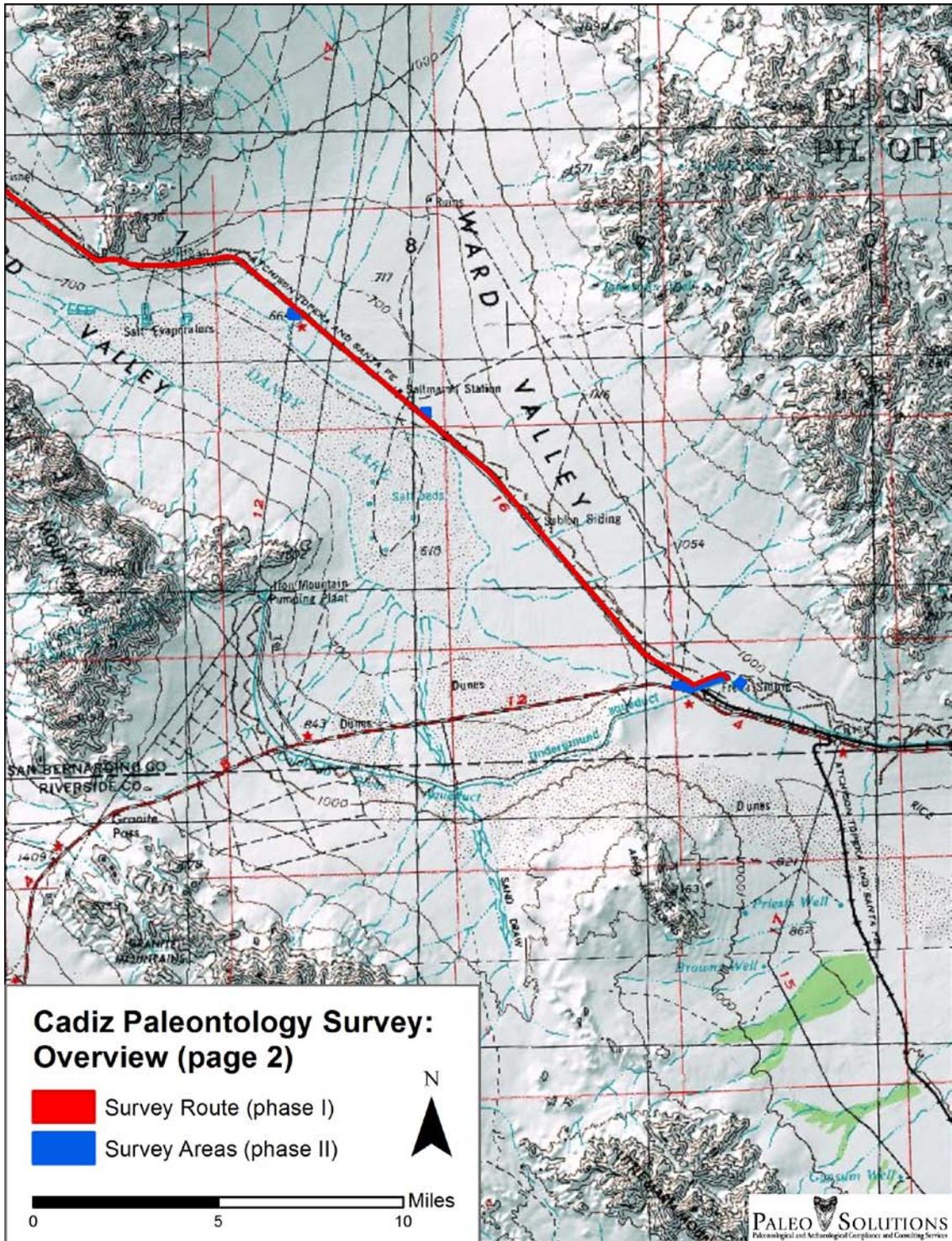


Figure 3. Location map of the proposed Project (south end). The surveyed staging areas are shown in blue. See Table 1 for geologic unit abbreviations.

3.0 RESOURCE ASSESSMENT CRITERIA

This paleontological resources analysis utilizes the Potential Fossil Yield Classification System (PFYC). This system is accepted by most federal and many state agencies and is widely utilized by professional paleontologists for the purpose of paleontological resource management. The PFYC follows, and is excerpted directly from BLM IM 2008-009 (2007):

Occurrences of paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

However, it is impossible to predict the specific types of fossils that will be found or their exact locations in a geologic formation.

Using the PFYC system, geologic units are classified based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts, with a higher class number indicating a higher potential. This classification is applied to the geologic formation, member, or other distinguishable unit, preferably at the most detailed mappable level. It is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment.

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis, and should be used to assist in determining the need for further mitigation assessment or actions.

The descriptions for the classes below are written to serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual units or preservational conditions should be considered when determining the appropriate class assignment. Assignments are best made by collaboration between land managers and knowledgeable researchers.

Class 1 – Very Low. Geologic units that are not likely to contain recognizable fossil remains.

- Units that are igneous or metamorphic, excluding reworked volcanic ash units.
- Units that are Precambrian in age or older.

(1) Management concern for paleontological resources in Class 1 units is usually negligible or not applicable. (2) Assessment or mitigation is usually unnecessary except in very rare or isolated circumstances.

The probability for impacting any fossils is negligible. Assessment or mitigation of paleontological resources is usually unnecessary. The occurrence of significant fossils is non-existent or extremely rare.

Class 2 – Low. Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.

- Vertebrate or significant invertebrate or plant fossils not present or very rare.
- Units that are generally younger than 10,000 years before present.
- Recent aeolian deposits.
- Sediments that exhibit significant physical and chemical changes (i.e., diagenetic alteration).

(1) Management concern for paleontological resources is generally low. (2) Assessment or mitigation is usually unnecessary except in rare or isolated circumstances.

The probability for impacting vertebrate fossils or scientifically significant invertebrate or plant fossils is low. Assessment or mitigation of paleontological resources is not likely to be necessary. Localities containing important resources may exist, but would be rare and would not influence the classification. These important localities would be managed on a case-by-case basis.

Class 3 – Moderate or Unknown. Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence; or sedimentary units of unknown fossil potential.

- Often marine in origin with sporadic known occurrences of vertebrate fossils.
- Vertebrate fossils and scientifically significant invertebrate or plant fossils known to occur intermittently; predictability known to be low. (or)
- Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.

Class 3a – Moderate Potential. Units are known to contain vertebrate fossils or scientifically significant non-vertebrate fossils, but these occurrences are widely scattered. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for hobby collecting. The potential for a project to be sited on or impact a significant fossil locality is low, but is somewhat higher for common fossils.

Class 3b – Unknown Potential. Units exhibit geologic features and preservational conditions that suggest significant fossils could be present, but little information about the paleontological resources of the unit or the area is known. This may indicate the unit or area is poorly studied, and field surveys may uncover significant finds. The units in this Class may eventually be placed in another Class when sufficient survey and research is performed. The unknown potential of the units in this Class should be carefully considered when developing any mitigation or management actions.

(1) Management concern for paleontological resources is moderate; or cannot be determined from existing data. (2) Surface-disturbing activities may require field assessment to determine appropriate course of action.

This classification includes a broad range of paleontological potential. It includes geologic units of unknown potential, as well as units of moderate or infrequent occurrence of significant fossils. Management considerations cover a broad range of options as well, and could include pre-disturbance surveys, monitoring, or avoidance. Surface-disturbing activities will require sufficient assessment to determine whether significant paleontological resources occur in the area of a proposed action, and whether the action could affect the paleontological resources. These units may contain areas that would be appropriate to designate as hobby collection areas due to the higher occurrence of common fossils and a lower concern about affecting significant paleontological resources.

Class 4 – High. Geologic units containing a high occurrence of significant fossils. Vertebrate fossils or scientifically significant invertebrate or plant fossils are known to occur and have been documented, but may vary in occurrence and predictability. Surface disturbing activities may adversely affect paleontological resources in many cases.

Class 4a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two acres. Paleontological resources may be susceptible to adverse impacts from surface disturbing actions. Illegal collecting activities may impact some areas.

Class 4b – These are areas underlain by geologic units with high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has high potential, but a

protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.

- Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.

- Areas of exposed outcrop are smaller than two contiguous acres.

- Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.

- Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 4 is moderate to high, depending on the proposed action. (2) A field survey by a qualified paleontologist is often needed to assess local conditions. (3) Management prescriptions for resource preservation and conservation through controlled access or special management designation should be considered. (4) Class 4 and Class 5 units may be combined as Class 5 for broad applications, such as planning efforts or preliminary assessments, when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations are similar at this level of analysis, and impacts and alternatives can be addressed at a level appropriate to the application.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation considerations must include assessment of the disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access resulting in greater looting potential. If impacts to significant fossils can be anticipated, on-the-ground surveys prior to authorizing the surface disturbing action will usually be necessary. On-site monitoring or spot-checking may be necessary during construction activities.

Class 5 – Very High. Highly fossiliferous geologic units that consistently and predictably produce vertebrate fossils or scientifically significant invertebrate or plant fossils, and that are at risk of human-caused adverse impacts or natural degradation.

Class 5a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two contiguous acres. Paleontological resources are highly susceptible to adverse impacts from surface disturbing actions. Unit is frequently the focus of illegal collecting activities.

Class 5b – These are areas underlain by geologic units with very high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has very high potential, but a protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.

- Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.

- Areas of exposed outcrop are smaller than two contiguous acres.

- Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.

- Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 5 areas is high to very high. (2) A field survey by a qualified paleontologist is usually necessary prior to surface disturbing activities or land tenure adjustments. Mitigation will often be necessary before and/or during these actions. (3) Official designation of areas of avoidance, special interest, and concern may be appropriate.

The probability for impacting significant fossils is high. Vertebrate fossils or scientifically significant invertebrate fossils are known or can reasonably be expected to occur in the impacted area. On-the-ground surveys prior to authorizing any surface disturbing activities will usually be necessary. On-site monitoring may be necessary during construction activities.

4.0 LITERATURE AND MUSEUM RECORDS SEARCH RESULTS

A records search was conducted for the proposed Project area and vicinity. Surficially, the Project occurs mostly on alluvium and lake deposits of Quaternary (Holocene and Pleistocene age). Igneous and metamorphic bedrock units of Precambrian to Mesozoic age also occur (Bishop, 1963; Howard, 2002; Bedford et al, 2010). For the purpose of this analysis, geologic maps with the highest resolution (smallest scale) were used when possible. These include the geologic map of the Amboy 30' x 60' Quadrangle (Bedford et al., 2010), and the geologic map of the Sheep Hole Mountains 30' x 60' Quadrangle (Howard, 2002). The geologic map of the Needles 1 x 2 Degree Quadrangle (Bishop, 1963) was used for portions of the Project area that are not covered by the 30' x 60' maps.

4.1 GEOLOGIC SETTING

The proposed project is located to the west of the Old Women Mountains and north of the Iron Mountains, mostly adjacent to lake playas, which include the Cadiz, Danby, and Bristol dry lakes. The proposed project is approximately 40 miles northeast of Twenty Nine Palms and 60 miles west of the California-Arizona border in San Bernardino, County. It is situated in the Mojave Desert in the southwestern-most part of the Basin and Range Province (Norris and Webb, 1990; Sharp, 1976). The Mojave Desert is roughly 65,000 square kilometers in size, landlocked, and bordered on the southwest by the San Andreas Fault, the Transverse Ranges and the Garlock Fault on the north. Its arbitrary eastern border is defined as the Nevada-California and Arizona-California state lines (Norris and Webb, 1990). The Mojave region is dominated by

broad alluvial basins generally receiving sediments that have been shed from adjacent hills and mountain ranges (Norris and Webb, 1990).

Precambrian/Late Proterozoic basement rocks in this area are often overprinted by subsequent geologic actions, including mid to high-level metamorphism and orogenic-related thrust-and-fold belts, which generally date from 1,700 (Ivanpah Orogeny) or 1,400 million years ago (Anderson et al, 1993; Burchfiel and Davis, 1980). The Precambrian crystalline basement rocks of the Mojave area were also intruded by granitic rocks from approximately 1,400 to 1,200 million years ago (Burchfiel and Davis, 1980).

At the end of the Paleozoic Era (approximately 250 million years ago), the passive margin that was the westernmost border of what is now North America became a more active margin, resulting in significantly increased tectonism and igneous activity (Glazner et al, 2002). This region was part of an evolving and shifting magmatic arc complex that is thought to be the result of shifting convergent plate boundaries along the then-western border of the continent (Burchfiel and Davis, 1980).

During the Mesozoic Era (approximately 250 million to 65 million years ago), the basement rocks of the area were intruded again by significant amounts of igneous, silicic-granitic plutons that are exposed to the north of the Project area in the Old Woman Mountains, as well as a small pluton in the Chubbuck area. Some of the Proterozoic/Precambrian basement rocks were locally metamorphosed by these intrusions and ductile tectonic thrust-fault activity, which accompanied these intrusions (Karlstrom et al, 1993). Triassic (250-200 million years ago) and Jurassic (200-145 million years ago) plutonic rocks are exposed adjacent to the Project area, and the proposed pipeline alignment passes through Jurassic age quartz diorite and granite in the Chubbuck area, as well as Triassic schist and gneiss adjacent to the Old Woman Mountains. These rocks are the result of eastward Andean-type convergent tectonic activity (Burchfiel and Davis, 1980, Glazner et al, 2002a).

Active subduction continued through Triassic, Jurassic and Cretaceous times, though by the end of the Cretaceous the intrusions were generally granitic. As the east-subducting Farallon plate continued to subduct under the North American plate, igneous activity continued (Norris and Webb, 1990). However, in the mid-Cenozoic, the eastern-directed subduction of the Farallon plate largely ceased, as the spreading center that drove the subduction was itself subducted. This caused the westernmost portion of what is now California to 'hang', and the resultant stresses between the plates created the San Andreas Fault. Simultaneously, subduction to the west ceased, and this caused the volcanic activity in this area to largely cease as well (Norris and Webb, 1990). Tectonic activity in the Mojave Desert region is now largely controlled by the San Andreas Fault and its related faults. Volcanism in the area, however, continued sporadically until the Late Pleistocene, as shown by the Amboy Lava Fields just to the north of the Project area (Norris and Webb, 1990). The age of the Amboy fields is debated, with many young-

appearing cones in the center of this complex dating via K-Ar and fission-track methods to around 2 million years old. However, Amboy Crater, which lies upon the sediments of prehistoric Bristol Lake, may be less than 10,000 years old - a relatively recent date of 6,000 years is possible, depending on the timing of the last major depositional event in Bristol Lake (Hazlett, 1992).

The linear, north to-northeast trending valleys and mountains in the vicinity of the Project area are characteristic of the Basin and Range province, and these valleys contain alluvial sediments that may exceed 3,500 feet in thickness (MWD, 2001). The valleys were partially formed during the middle Miocene from the extensional tectonics that produced portions of the Basin and Range's distinctive geology (Miller et al., 1982; Glazner et al, 2002b). The basins that contain the dry lake deposits in this area are thought to have been part of a trough complex running from prehistoric Lake Manix to the southeast along these fault-delineated valleys and mountain ranges (Reynolds and Reynolds, 1992).

The Cadiz, Danby and Bristol dry lakes are theorized to have been part of an extensive, permanent lake system of Pleistocene age that drained into the Colorado River (Reynolds and Reynolds, 1992) and was sourced from the Pleistocene-aged Mojave River (Sharp, 1976) that is currently intermittently active depending on water flow. These dry lake beds, including the area designated for the Cadiz Groundwater Project Well Field, consist in part of Pleistocene age playa lake sediments including carbonate evaporite beds interbedded with fine silts. These Cadiz Playa deposits are known to contain numerous Pleistocene (Blancan to Irvingtonian North American Land Mammal "Age") vertebrate fossil localities (MWD, 2001; Scott, 2010). The Cadiz Playa is referenced in the Cadiz Groundwater Storage and Dry-Year Supply Program EIR/EIS (MWD, 2001) as occurring on Cadiz Company lands east of Bristol Lake and north of Cadiz Lake.

4.2 GEOLOGY AND PALEONTOLOGY

This portion of the analysis applies to the Phase II (Programmatic) Facilities. Based on the geologic map review completed for this analysis, the proposed Project area contains 19 mapped geologic units (see Table 1). In areas of overlap, the Amboy 30' x 60' Quadrangle (Bedford et al., 2010) and the Sheep Hole Mountains 30' x 60' Quadrangle (Howard, 2002) were used preferentially over the Needles 1 x 2 Degree Quadrangle (Bishop, 1963) because these quadrangles were mapped at a smaller, higher resolution scale.

The findings of this analysis are consistent with the previously completed paleontological resource review (MWD, 2001). Four of the geologic units within the Project area have very low paleontological sensitivity (PFYC Class 1) because they consist of igneous or metamorphic rocks that were formed at extremely high temperatures or high pressures, and do not typically contain recognizable fossil remains. Six of the geologic units have low paleontological sensitivity (PFYC Class 2) because they consist of surficial sedimentary deposits that were formed during

the Holocene (less than 10,000 years ago), and as such, are too young to contain in-situ fossil remains. It should be noted that although PFYC Class 2 units have low paleontological sensitivity at the surface, they are often underlain at varying depths by older Pleistocene surficial deposits that may contain scientifically significant fossil remains, and these deposits and contained fossils can be adversely impacted by ground disturbing projects that penetrate through the overlying low sensitivity Holocene age deposits. Because of their low potential to produce scientifically significant fossil remains, the PFYC Class 1 geologic units are not discussed further in this section. Three geologic units are considered to have moderate paleontological sensitivity (PFYC Class 3) because they consist of Holocene and Pleistocene age sedimentary deposits (and other lithologies, see Table 1) that were deposited on hillslopes or consist of older stabilized sand dunes, and thus have lower sensitivity than other sedimentary deposits of Pleistocene age such as alluvium. Note that for geologic units that are mapped as being both Pleistocene and Holocene age, the PFYC Class for the higher sensitivity Pleistocene deposits is applied to the entire unit. Four geologic units have high paleontological sensitivity (PFYC Class 4) because they consist of Pleistocene age sedimentary deposits including alluvial deposits that regularly produce scientifically significant fossil remains in the general vicinity of the Project area and elsewhere in southern California. The PFYC Class 3 and Class 4 geologic units have moderate to high potential to produce scientifically significant fossils respectively, and are discussed in greater detail below (see Section 4.2.1).

The distribution of geologic units within the proposed Wellfield and Staging areas are shown in Figures 4 through 7. The PFYC classes listed in Table 1 were assigned using the results of the paleontological literature and museum record searches. The results were used to prepare paleontological sensitivity maps (Figures 8 through 11). Note that the sensitivity rankings on Figures 8 through 11 apply only to surface geologic units, and units with higher (or lower) sensitivity may be encountered at a shallow depth beneath the surface.

Table 2. Geologic units within the proposed Project area using the Potential Fossil Yield Classification System (see Section 3). Geologic map abbreviations follow Bedford et al. (2010), Bishop (1963), and Howard (2002). Note that the sensitivity rankings apply only to surface geologic units, and units with higher (or lower) sensitivity may be encountered at a shallow depth beneath the surface.

Map Abbreviation	Geologic Unit	Age	PFYC Class (potential for fossils)
Bedford et al., 2010, Amboy 30' x 60' Quadrangle			
Qya	Young alluvial fan deposit	Holocene and latest Pleistocene	2** (low)
Qyaf	Young alluvial fan composed of fine-grained deposits	Holocene and latest Pleistocene	4* (high)
Qyv	Young valley-axis deposit	Holocene and latest Pleistocene	4* (high)
Qia	Intermediate alluvial fan deposit	Late to middle Pleistocene	4* (high)
Qha/ca	Abundant hillslope deposits and "carbonate rocks"	Holocene and Pleistocene	3* (moderate)
Qha/mi	Abundant hillslope deposits and "metamorphic rocks"	Holocene and Pleistocene	3* (moderate)
Howard, 2002, Sheep Hole Mountains 30' x 60' Quadrangle			
Qa	Youngest alluvium	Holocene	2** (low)
Qya	Younger alluvium	Holocene and latest Pleistocene	4* (high)
Qps	Playa deposit, silt and clay	Holocene	4* (high)
Qwo	Older windblown sand, stabilized (fossil) dunes	Holocene and Pleistocene	3* (moderate)
Jd	Diorite and Quartz diorite	Jurassic	1 (very low)
TrRb	Buckskin Formation, schist and gneiss	Triassic	1 (very low)
Xk	Kilbeck Gneiss	Early Proterozoic	1 (very low)
Bishop, 1963, Needles 1 x 2 Degree Quadrangle			
Qal	Quaternary alluvium	Holocene/Pleistocene	2** (low)
Ql	Quaternary lake deposits	Recent/Holocene	2 (low)
Qs	Dune sand	Recent/Holocene	2 (low)
pC	Undivided metamorphic rocks	Precambrian	1 (very low)
pC-gr	Undivided granitic rocks	Precambrian	1 (very low)
gr	Granitic rocks	Mesozoic	1 (very low)

*Holocene age deposits are too young to contain fossils, although Pleistocene deposits have high paleontological sensitivity. Highest PFYC ranking is applied to entire map unit for units mapped as containing both Holocene and Pleistocene age sediments.
 **Holocene age deposits are considered to have low paleontological sensitivity, but may be underlain at depth by Pleistocene age deposits with moderate or high paleontological sensitivity.

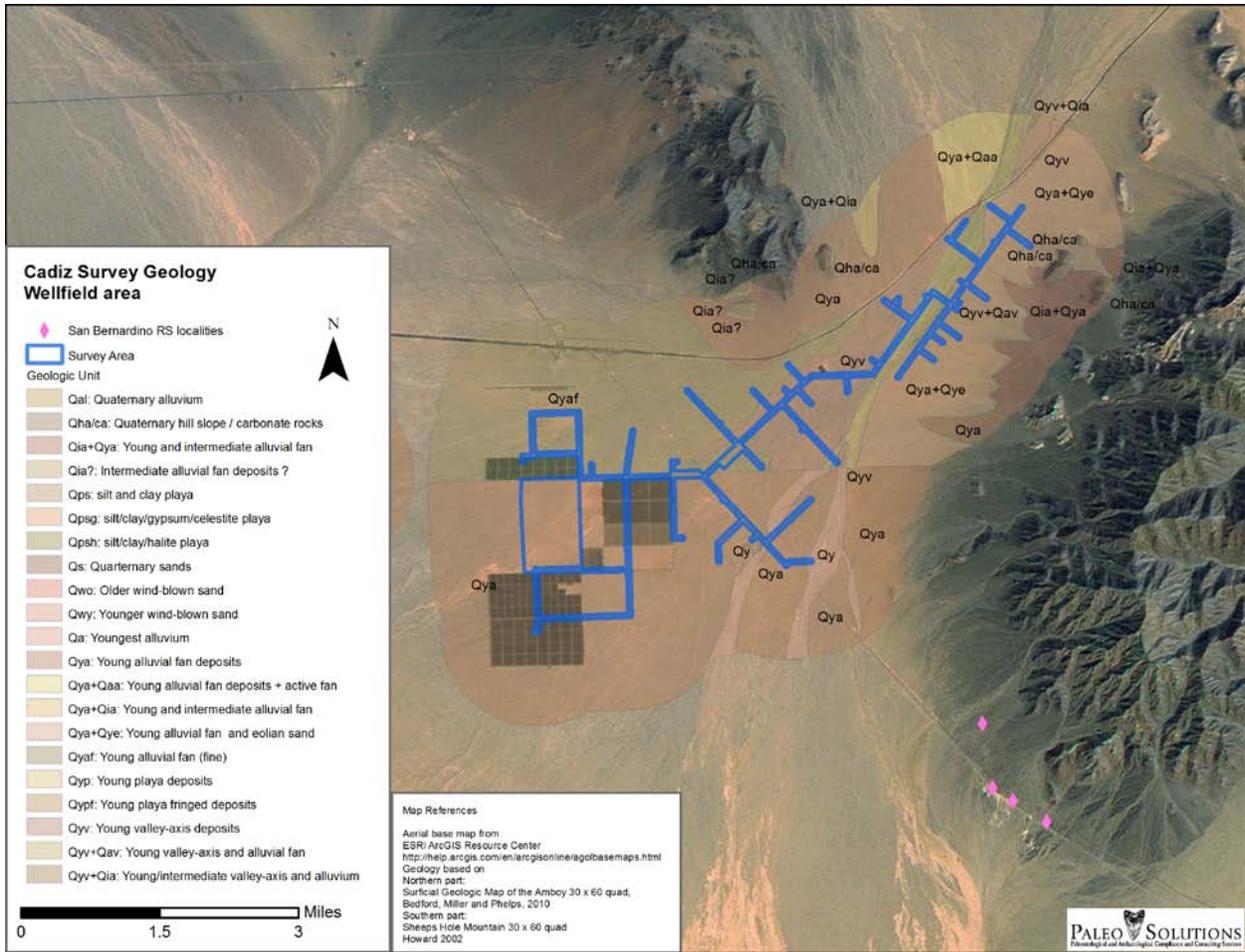


Figure 4. Geology map of the proposed Project (north end). The surveyed Wellfield area is shown in blue. See Table 1 for geologic unit abbreviations.

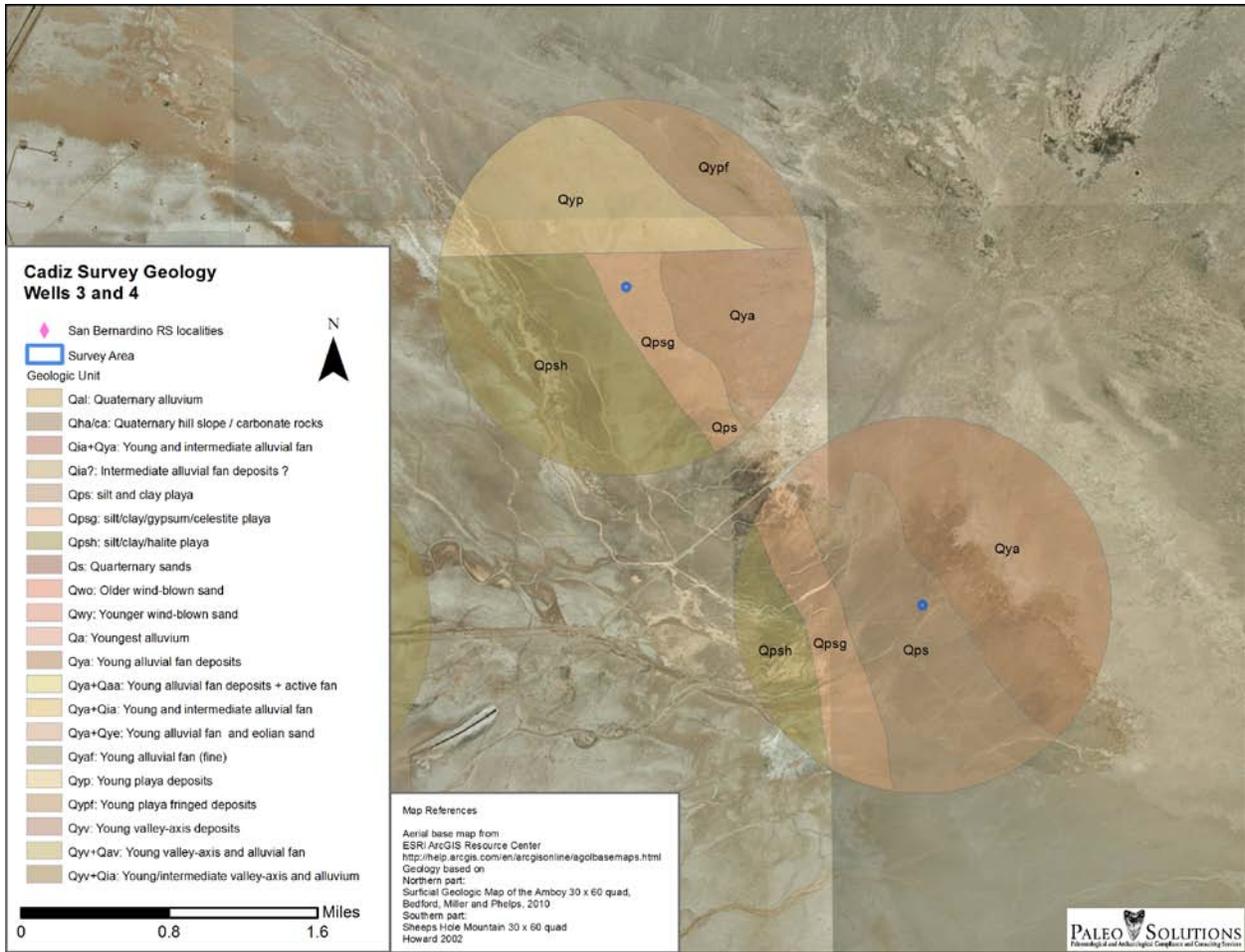


Figure 5. Geology map of the proposed Project. The surveyed Wellfield area is shown in blue. See Table 1 for geologic unit abbreviations.

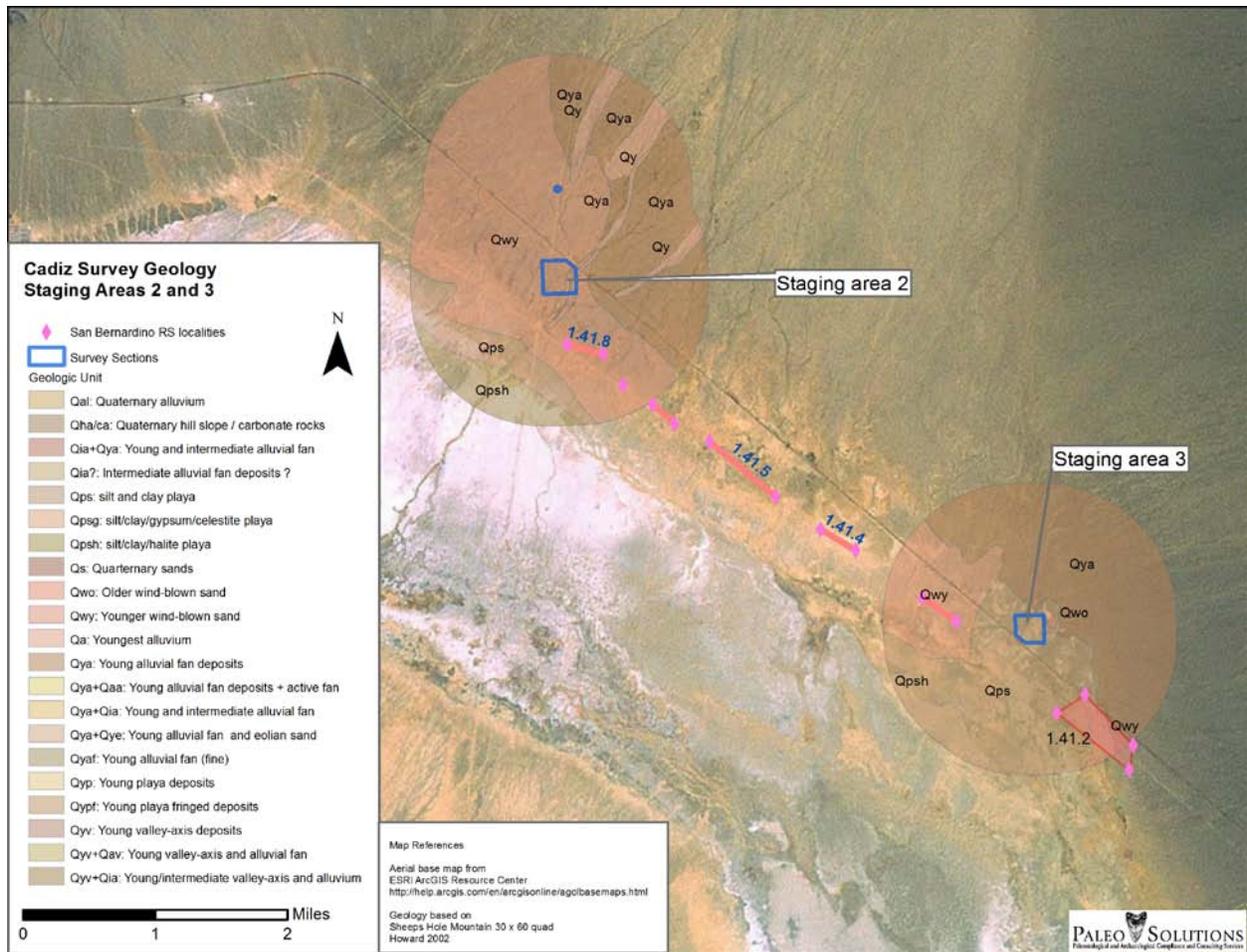


Figure 6. Geology map of the proposed Project. The surveyed Staging areas are shown in blue. See Table 1 for geologic unit abbreviations.

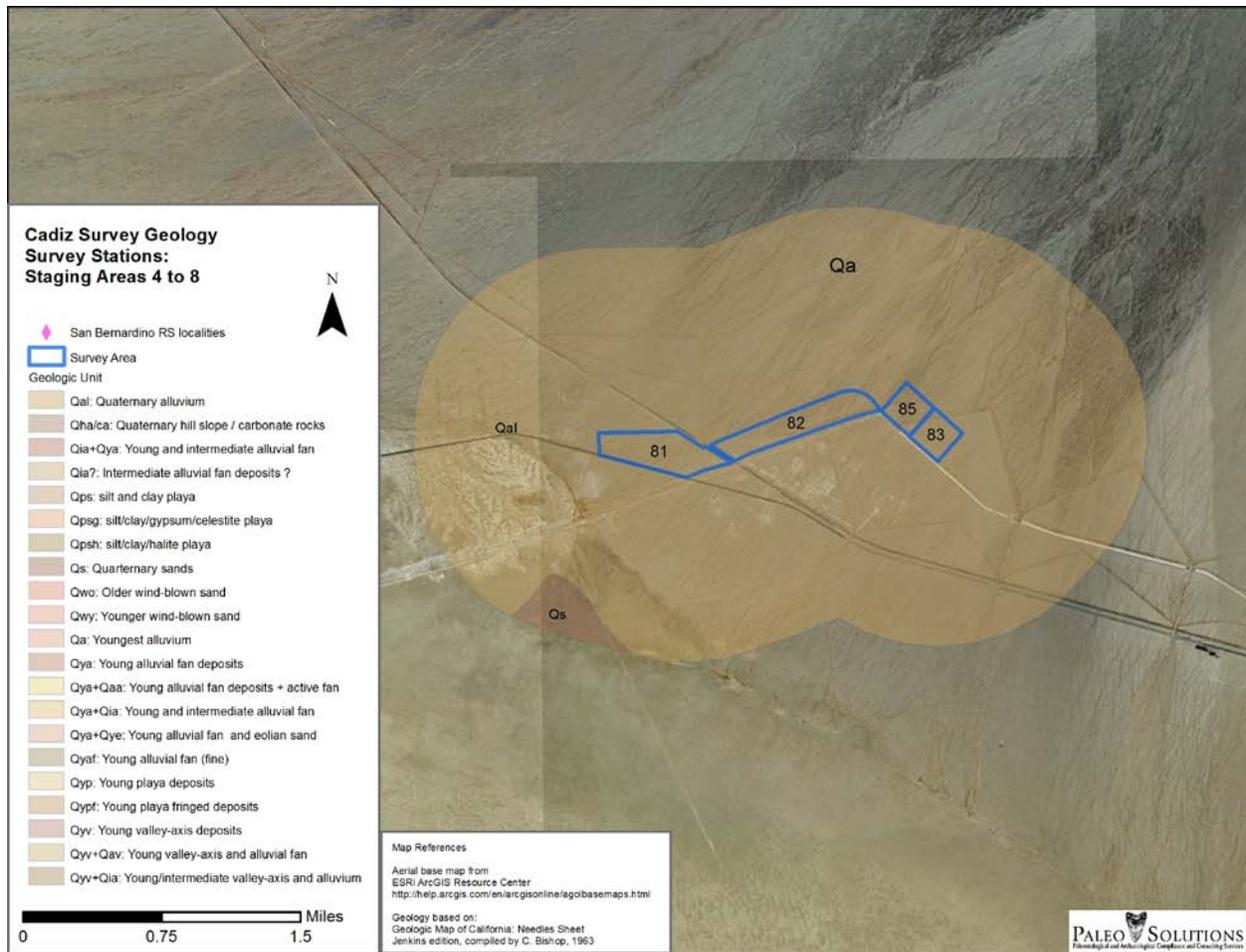


Figure 7. Geology map of the proposed Project. The surveyed Staging areas are shown in blue. See Table 1 for geologic unit abbreviations.

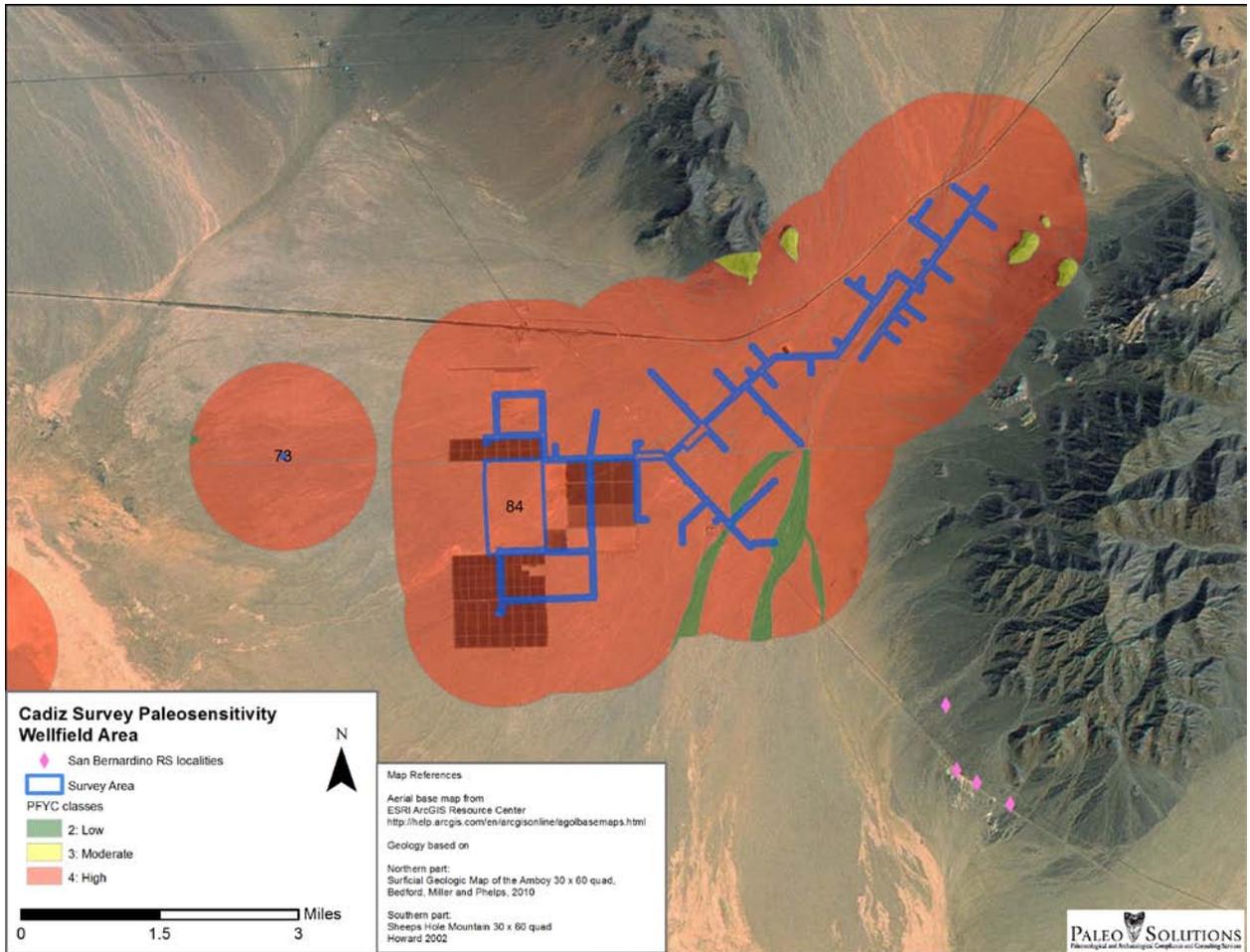


Figure 8. Paleontological sensitivity map of the Wellfield area for the proposed Project. Note that this sensitivity map does not strictly apply to the surface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

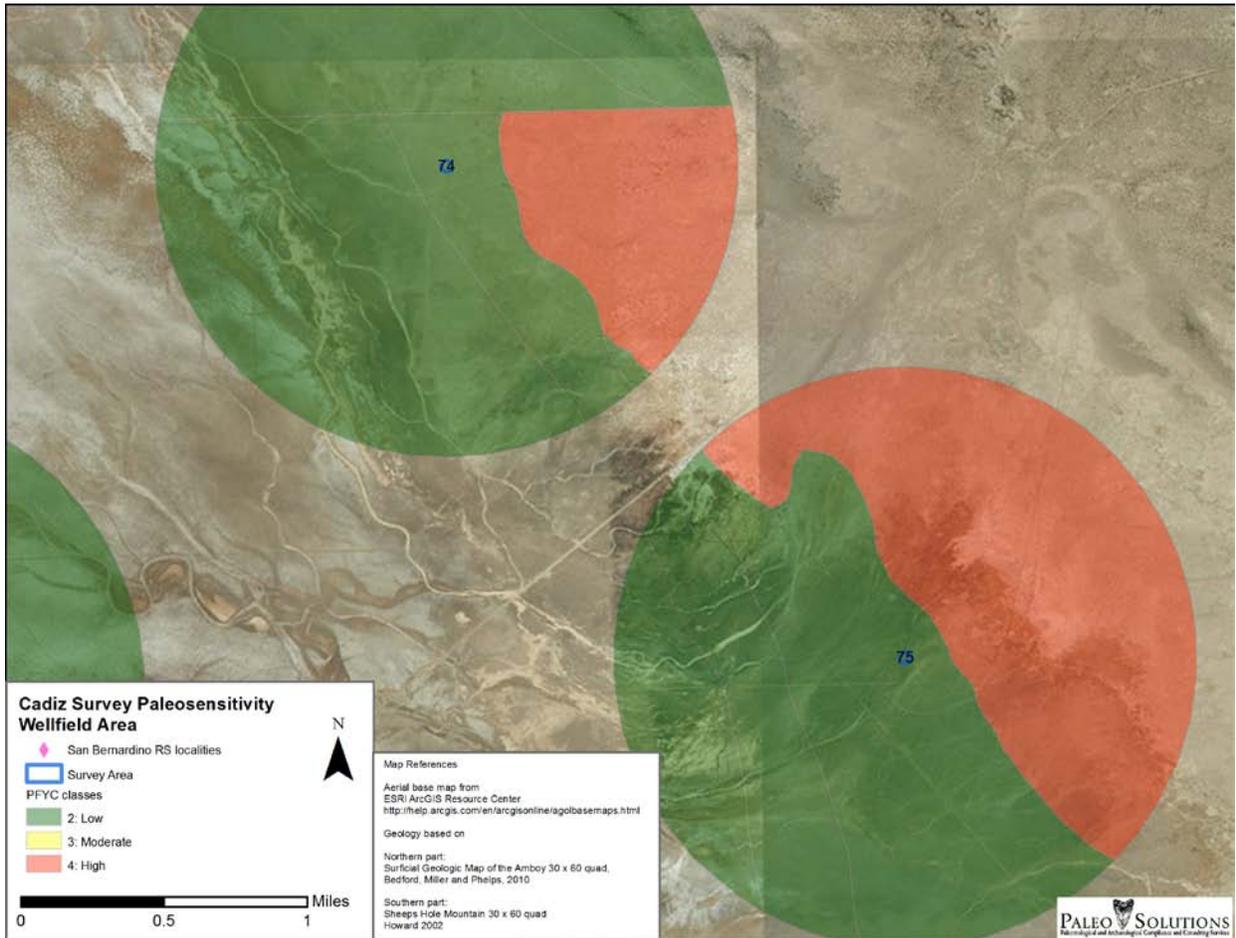


Figure 9. Paleontological sensitivity map of the Wellfield area for the proposed Project. Note that this sensitivity map does not strictly apply to the surface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

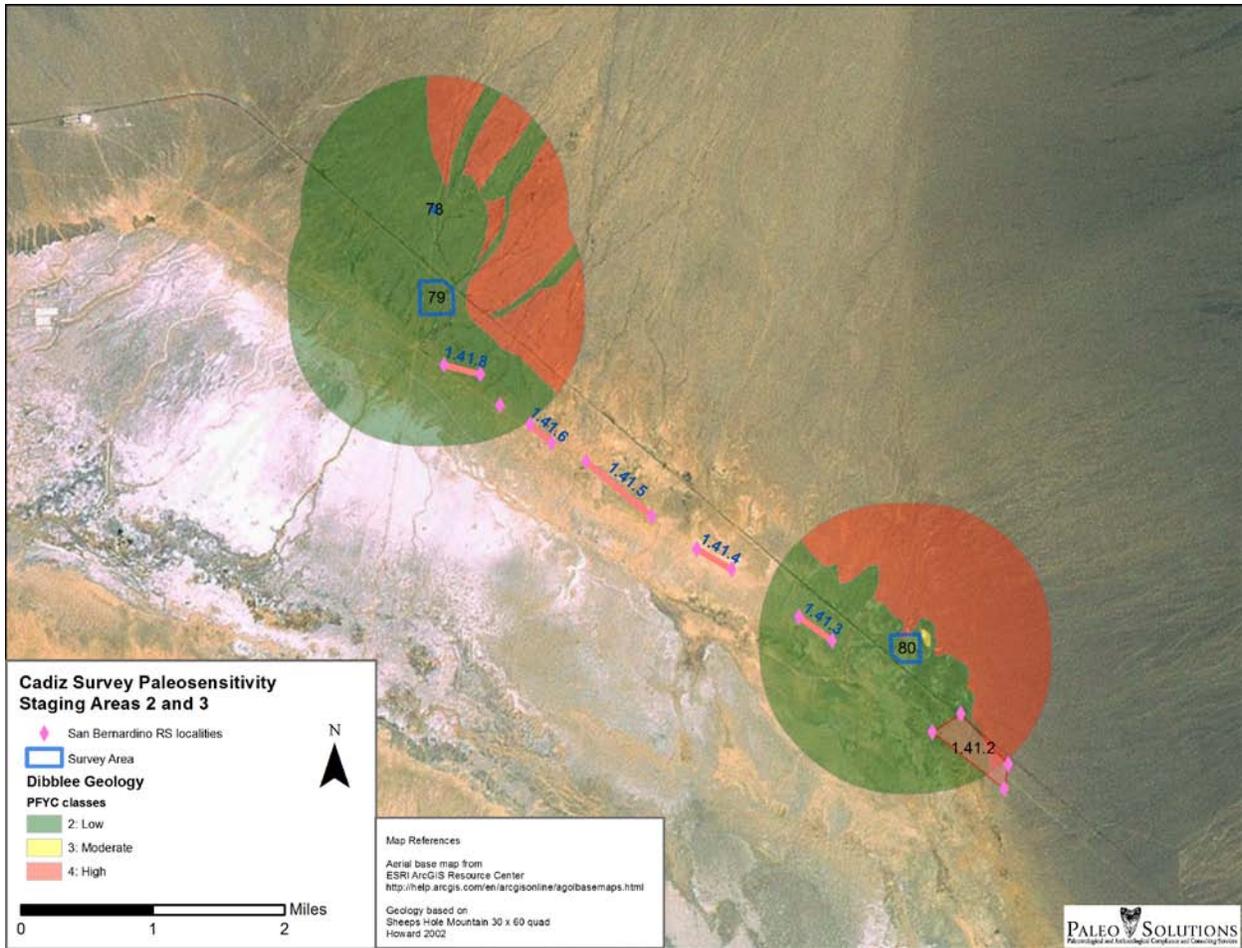


Figure 10. Paleontological sensitivity map of Staging areas 2 and 3 for the proposed Project. Note that this sensitivity map does not strictly apply to the surface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

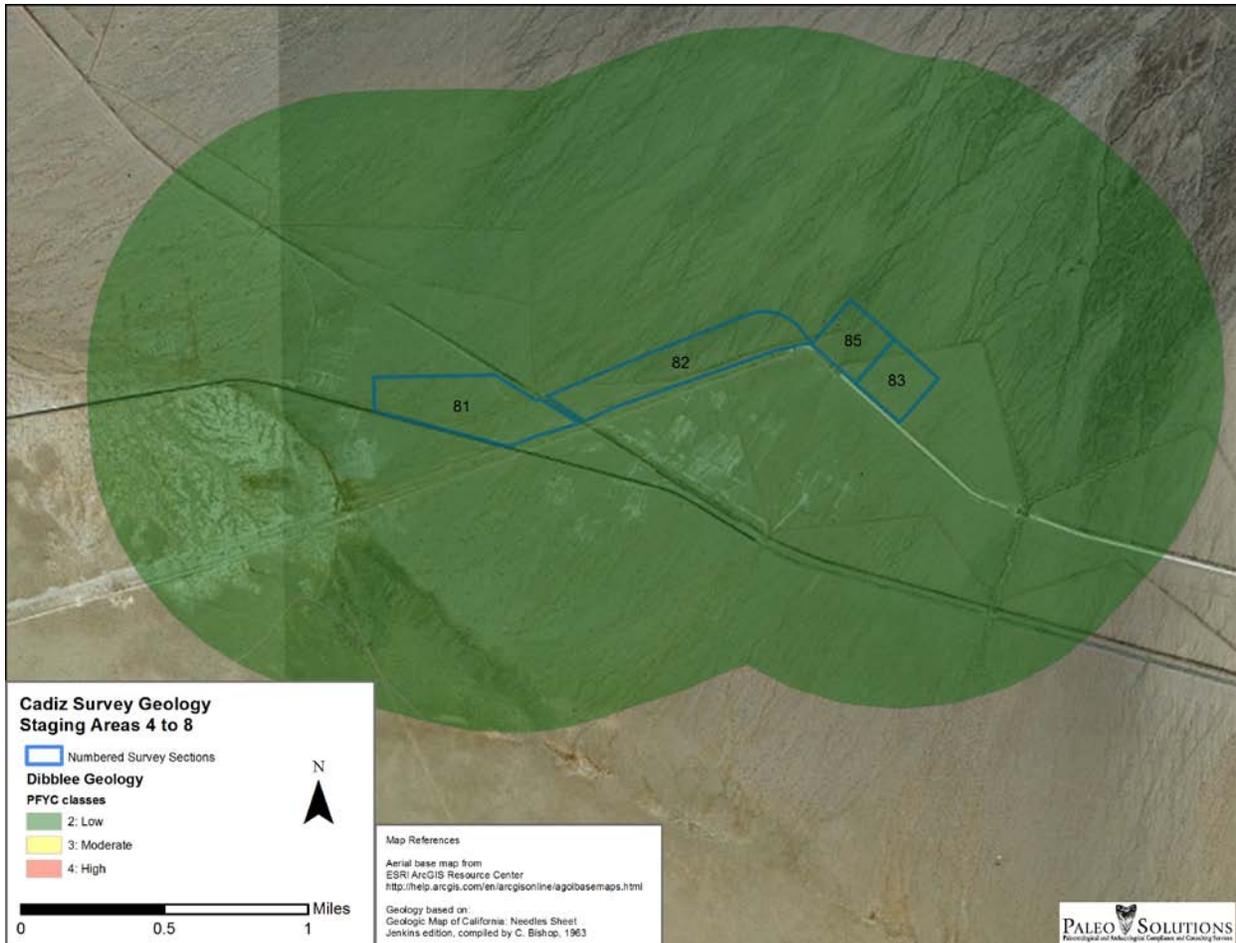


Figure 11. Paleontological sensitivity map of Staging areas 4 through 8 for the proposed Project. Note that this sensitivity map does not strictly apply to the surface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

4.2.1 SURFICIAL SEDIMENTARY DEPOSITS OF QUATERNARY AGE

Most of the substrate within the proposed Project area is composed of surficial sedimentary deposits of Pleistocene and Holocene age. As discussed previously, none of the igneous and metamorphic basement rocks (PFYC Class 1) located within the Project area are likely to contain scientifically significant fossil remains.

In terms of geographic extent, most of the Project area includes surficial sedimentary deposits that are of both Pleistocene and Holocene age (see Table 1). It is critical to note that although deposits of Holocene age that are too young to produce in-situ fossils, these deposits are known to be underlain at a shallow depth at many locations in the Mojave Desert by Pleistocene age deposits that do contain scientifically significant fossils and that document the paleoenvironments and paleoecology of this area during the Pleistocene “ice age.” Thus, in areas mapped as Holocene in age, Project excavations that are at or close to existing grade are unlikely to impact paleontological resources. However, deeper excavations may disturb older (Pleistocene), especially in alluvium and lake deposits, and less likely in hillslope, alluvial fan, and sand dune deposits. Specifically, older lake deposits underlie and encompass a larger geographic area than the current extent of Danby Dry Lake and Cadiz Dry Lake. Note that because of the natural variability of the thickness of younger surficial sediments and the resulting variability in the depth at which older Pleistocene surficial sediments occur, it is not possible to predict the depth at which Pleistocene deposits will be encountered without extensive geotechnical analysis.

Pleistocene alluvium contains locally abundant and well preserved fossil remains, and is regarded as having high paleontological sensitivity in southern California. Most of these fossils are housed at museums including the LACM, SBCM, Page Museum (La Brea Tar Pits), San Diego Natural History Museum, Ralph Clark Park, and other regional venues. Pleistocene taxa from older non-marine alluvium include a wide variety of amphibians including frog and salamander; reptiles including turtle, lizard, and snake; birds including raptor, duck, quail, secretary bird, and songbirds; and mammals. The most taxonomically diverse vertebrate group in terms of Pleistocene fossils, mammals include mammoth, mastodon, bison, deer, camel, horse, saber-tooth cat, coyote, weasel, dire wolf, ground sloth, tapir, antelope, camel, capybara, shrew, bat, ground sloth, jack rabbit, cottontail rabbit, ground squirrel, pocket gopher, pocket mouse, kangaroo rat, deer mouse, mouse, wood rat, vole, and muskrat (Graham and Lundelius, 1994; Jefferson, 1991; Lundelius et al., 1987). Fossil invertebrates and plants also occur locally in non-marine Pleistocene sedimentary deposits. The SBCM has documented numerous fossil remains of mammoth, mastodon, ground sloths, dire wolves, saber-toothed cats, large and small horses, camels, and bison throughout San Bernardino and Riverside counties and the Inland Empire.

A record search was conducted as part of the prior paleontological analysis for the Cadiz Groundwater Storage and Dry Year Supply Program EIR/EIS (MWD, 2001) that identified 179 previously recorded fossil localities in the project vicinity. Field surveys were conducted in March, April, and June 1999 of proposed Wellfield, reservoir, and spreading basin areas in the Cadiz-Fenner valleys; an approximately 35-mile-long pipeline alignment from the Cadiz-Fenner valleys to the Colorado River Aqueduct, including several alternative routes and a proposed pumping plant location near the existing Iron Mountain Pumping Plant; and a powerline alignment north of the Riverside/San Bernardino county line. Although the results of the prior paleontological analysis were based on a different project configuration, they indicate the potential for scientifically significant fossils to be present within the Quaternary deposits in the Project area.

For example, the former pipeline route ran parallel to the ARZC railroad for a short distance and then split into two sections at the eastern end of the Cadiz Dunes Wilderness Area: a western pipeline alignment that truncated at the West Portal Iron Mountain Tunnel and the CRA, and an eastern pipeline alignment that truncated at the Iron Mountain Pumping Area at the eastern end of the CRA. However, approximately 21 miles of the currently-proposed water conveyance pipeline (the northern portion) and portions of the currently-proposed Wellfield area overlap with the area that was surveyed in 1999.

The 1999 field surveys documented 24 newly recorded fossil localities along the former pipeline alignment and alternative routes. Fossils recovered along the former alignment alternatives consisted largely of fragments of mammalian longbones and one rabbit bone. The variety of fossils collected from the project Wellfield area included flamingo, Canada goose, mammoth, camel, two kinds of horse, coyote, dwarf pronghorn antelope, jackrabbit, ground squirrel, kangaroo rat and freshwater snail. The EIR/EIS reported that most of the former project area consisted of lake beds, paleosols and carbonate beds with a high potential for subsurface paleontological resources. The paleontological results from the 1999 surveys emphasize the high potential for scientifically significant paleontological resources in Pleistocene age lake beds within the currently-proposed footprint associated with the proposed Project.

In conjunction with this analysis conducted for the proposed Project, museum fossil locality record searches were completed by staff at the two major regional museums that are likely to have fossil collections from the vicinity of the proposed Project area. These include the Natural History Museum of Los Angeles County (LACM) and the San Bernardino County Museum (SBCM) (see Appendix B). The purpose of these record searches was to determine whether any previously recorded fossil localities occur within the proposed Project area analyzed herein, or are located elsewhere, but were found in the same geologic units that occur within the Project area.

The LACM has no previously recorded fossil localities within the Project area. However, in the general vicinity of the proposed Project area (Rhue, 2010) there are three LACM fossil localities. LACM 5977 produced a fossil specimen of the pocket mouse *Perognathus* found in Quaternary deposits located to the south-southwest of the proposed Project area along Interstate 10 on the southwest side of Ford Dry Lake. LACM (CIT) 208 and LACM 3414 yielded specimens of tortoise (*Gopherus*), horse (*Equus*), and camel (*Camelops* and *Tanupolama stevensi*) found in Quaternary deposits to the west-southwest of the Project area between the Eagle Mountains and the Coxcomb Mountains.

The SBCM has four previously recorded fossil localities along the proposed pipeline alignment and in other localities in the general vicinity (Scott, 2010). SBCM 141.2 was discovered at Danby Dry Lake, and produced fossil horse (*Equus* sp.), camel (*Camelops* sp.), jack rabbit (*Lepus* sp. Cf. *L. californicus*), kangaroo rat (*Dipodomys*), fox (*Vulpes*), and badger (*Taxidea taxus*). SBCM 141.8 also produced fossil remains of Rancholabrean North American Land Mammal “Age” from Danby Dry Lake, but the type of fossil(s) was not specified in the record search results. SBCM 142.2 produced plant remains (Tracheophtyta) and kangaroo rat (*Dipodomys*) from Cadiz Lake. SBCM 142.8 produced fossil remains of Rancholabrean North American Land Mammal “Age” from Cadiz Dry Lake, but the type of fossil(s) was not specified in the record search results. The SBCM also reports that the Danby and Cadiz areas have produced fossils of extinct horse (*Equus* sp.), large camel (cf. *Camelops* sp.), and pronghorn (*?Tetrameryx*), as well as mollusks, toads, tortoises (including the giant tortoise *Hesperotestudo*), lizards, snakes, birds, rabbits, and rodents (Reynolds and Reynolds, 1992; Scott, 2010; Scott and Cox, 2008).

5.0 FIELD SURVEY RESULTS

A paleontological field survey of the proposed Wellfield and conceptual spreading basin areas (Phase II, Programmatic Facilities) was performed on May 22 through May 25, 2012. Detailed field survey notes, including observed geology and photographs of the substrate along the water pipeline route, are available upon request (see also Appendix C). Surveys for the proposed pipeline alignment (Phase I, Project Level Facilities) were already conducted on October 18 through October 26 2010. No fossil localities were discovered during this survey.

6.0 RECOMMENDED MITIGATION MEASURES

Although most of the surface of the Project area is covered by a thin veneer of younger (Holocene) sediments (mostly alluvium, lake beds, sand dunes), older (Pleistocene) sediments and scientifically significant fossils are known to occur at certain locations on the surface as evidenced by surveys completed in 1999 for the previous EIR/EIS (MWD, 2001), LACM locality records (Rhue, 2010), SBCM locality records (Scott, 2010), and subsurface based on superpositional relationships of the Quaternary deposits in the general region of the Project.

Thus, there is a high likelihood that paleontological resources will be encountered in even shallow Project excavations. Prior to construction, and using available geotechnical information and project design plans in combination with geologic mapping, a detailed paleontological resources mitigation plan should be developed that reflects the final project footprint and identifies specific paleontological monitoring locations based as defined by areas where Pleistocene age sediments may be impacted during construction. Recommended paleontological mitigation measures are described below, and should be included in the detailed paleontological resources mitigation plan. The detailed paleontological mitigation plan should identify specific monitoring locations, procedures for fossil salvage, data collection, and procedures to follow if construction personnel find fossils in an area in which fossils were not anticipated, and no paleontological monitor is present.

Proposed Mitigation – Qualifications of Personnel

The detailed paleontological mitigation plan, and all subsequent paleontological resource work for the proposed Project, should be completed by a qualified vertebrate paleontologist. The County of San Bernardino (Development Code §82.20.040) defines a qualified vertebrate paleontologist as meeting the following criteria:

Education: An advanced degree (Masters or higher) in geology or paleontology, biology or related disciplines (exclusive of archaeology).

Professional Experience: At least five years professional experience with paleontologic (not including cultural) resources, including the collection, identification and curation of the resources.

Proposed Mitigation: Phase II (Programmatic) Facilities

The project Wellfield and spreading basin areas, which were previously surveyed in 1999, have been re-surveyed, because in the time elapsed since 1999, it is likely that additional scientifically significant fossils have eroded onto the surface. During the May 2012 survey, no new paleontological resources were discovered.

No additional field surveys for the programmatic level facilities evaluated herein are recommended, unless the facilities are relocated. The detailed construction mitigation plan should identify specific locations where project construction is anticipated to disturb sediments of Pleistocene age that occur on the surface, or where ground disturbance will penetrate overlying Holocene age sediments to a depth at which disturbance to Pleistocene sediments will occur. As stated previously, there is no way to accurately predict this depth, and in the absence of geotechnical data, a qualified paleontologist should be available to spot check shallow excavations (less than three feet deep) to examine the sediment profile bones and other remains

that may be unearthed in order to guide the monitoring level of effort in areas with Holocene age sediments mapped at the surface. All excavations greater than three feet deep should be continuously monitored unless it is determined by the on-site paleontologist that the depth of Pleistocene age sediments is deeper, at which point the monitoring level of effort should be adjusted accordingly.

Paleontological monitors must be experienced and be working under the direct supervision of a qualified paleontologist as defined above. Only fossils deemed to have scientific significance should be collected (see Section 2.1 for definition of scientific interest). Paleontological monitoring involves the systematic inspection of graded pad surfaces, cut slopes, excavation sidewalls, and spoils piles for unearthed fossils. When fossils are discovered, they and associated data must be collected quickly and professionally in order to prevent construction delays. Fossil salvage procedures should include the collection of bulk matrix samples if scientifically significant microfossils are believed to be present based on field evidence. Monitors should have the authority to temporarily divert construction crews in order to facilitate fossil salvage activities.

All fossils collected during monitoring should be transferred to a secure facility for laboratory preparation and identification. Laboratory preparation includes stabilization, matrix removal, and conservation of individual fossil specimens, and screenwashing and picking of bulk matrix samples. Fossils should be prepared to the point of curation (not display) and identified by technical specialists as needed to the lowest possible taxonomic level.

Following preparation, the fossils and associated data and a copy of the final paleontological mitigation report should be transferred to a public museum (paleontological repository) where they will be available for the benefit of current and future generations.

7.0 REFERENCES

- Anderson, J.L., Wooden, J.L., and Bender, E. E., 1993, Mojave Province of Southern California and vicinity: The Geology of North America, Precambrian: Conterminous U.S. Geological Society of America, p. 176-188.
- Bedford, D.R., Miller, D.M., and Phelps, G.A., 2010, Surficial geologic map data and physical properties for the Amboy 30 x 60 minute Quadrangle, California: U.S. Geological Survey Open-File Report 2006-1165, 33 p., scale 1:100,000, <http://pubs.usgs.gov/of/2006/1165>.
- Bishop, C.C., 1963, Geologic map of California: Needles Sheet: California Division of Mines and Geology, scale 1:250,000.

- Bureau of Land Management, 2007, Potential Fossil Yield Classification System: BLM Instruction Memorandum No. 2008-009 (PFYC revised from USFS, 1996).
- Burchfiel, B.C. and G.A. Davis, 1980, Mojave Desert and surrounding environs: In, Ernst, W.G. (editor): The Geotectonic Development of California, Englewood Cliffs, NJ: Prentice-Hall.
- Metropolitan Water District of Southern California (MWD) and US Bureau of Land Management (BLM), 2001, Cadiz Groundwater Storage and Dry Year Supply Program, Final EIR, 2001, <http://www.pacinst.org/reports/cadiz/feir/>.
- Metropolitan Water District of Southern California (MWD) Environmental Documentation for the Cadiz Water Storage and Dry-Year Supply Program, 1999, Paleontological Resource Draft Assessment Report.
- Glazner, A.F., Walker, J.D., Bartley, J.M., and Fletcher, J.M., 2002a, Late Paleozoic to Mesozoic evolution of the Mojave block in Southern California: In, Glazner, A.F., and Bartley, J.M. (editors), Geologic Evolution of the Mojave Desert and the Southwestern Basin and Range. Geological Society of America, Memoir 195, p. 1-18.
- Glazner, A.F., Walker, J.D., Bartley, J.M., and Fletcher, J.M., 2002b, Cenozoic evolution of the Mojave block in Southern California: In, Glazner, A.F., and Bartley, J.M. (editors), Geologic Evolution of the Mojave Desert and the Southwestern Basin and Range. Geological Society of America, Memoir 195, p. 9-41.
- Graham, R.W., and Lundelius, E.L., 1994, FAUNMAP: A database documenting the late Quaternary distributions of mammal species in the United States: Illinois State Museum Scientific Papers, vol XXV, no. 1, 287 p.
- Hazlett, R.W., 1992, Some thoughts on the development of Amboy Crater: In, Old Routes to the Colorado. San Bernardino County Museum Association Special Publication, 92-2.
- Howard, K.A., 2002, Geologic Map of the Sheep Hole Mountains 30'x 60' quadrangle, San Bernardino and Riverside Counties, California. U.S. Geological Survey Miscellaneous Field Investigations Map, MF-2344, scale 1:100,000.
- Jefferson, G.T., 1991, A catalog of late Quaternary vertebrates from California: Natural History Museum of Los Angeles County, Technical Reports 7:1-129.
- Karlstrom, K.E., C.F. Miller, J.A. Kingsbury and J.L. Wooden, 1993, Pluton emplacement along an active ductile thrust zone, Paiute Mountains, Southeastern California: Interaction Between Deformation and Solidification Processes. Geological Society of America Bulletin, v. 105, p. 213-230.

- Lundelius, E. L., Jr., C. S. Churcher, T. Downs, C. R. Harington, E. H. Lindsay, G. E. Schultz, H. A. Semken, S. D. Webb, and R. J. Zakrewski. 1987, The North American Quaternary sequence: In, M. O. Woodburne (ed.), *Cenozoic Mammals of North America Geochronology and Biostratigraphy*. University of California Press, Berkeley, Los Angeles, London, pp. 211-235.
- Miller, D.M., Howard, K.A., and John, B.E., 1982, Preliminary geology of the Bristol Lake region, Mojave Desert, California: In, Cooper, J.D. (compiler), *Geologic Excursions in the Mojave Desert, Volume and Guidebook*. Geological Society of America Cordilleran Section 78th Annual Meeting, Fullerton, California, California State University, pp. 91-100.
- Norris, R.M., and Webb, R.W., 1990, *Geology of California, Second Edition*. John Wiley and Sons, Inc., New York, p. 55-59, 183-191, 220-244, 453-454.
- Reynolds, R. E. and Reynolds, R.L., 1992, Pleistocene faunas in the Bristol-Danby Trough: In, San Bernardino County Museum Special Publication 92-2 (Old Routes to the Colorado). San Bernardino County Museum Association, Redlands, p. 83-86.
- Rosen, M.R., 1992, The Depositional Environment and Evolution of Bristol Lake Basin, Eastern Mojave Desert, California: In, Old Routes to the Colorado. Special Publication 92-2, San Bernardino County Museum Association, Redlands.
- Rhue, V.R., 2010, Paleontological resources for the proposed Cadiz Groundwater Storage Project, San Bernardino County, California, project area: Unpublished record search prepared by the Natural History Museum of Los Angeles County, 2 p.
- Scott, E., 2010, Paleontological literature and records review, Cadiz Groundwater Project, Cadiz Region, San Bernardino County, California: Unpublished record search prepared by San Bernardino Natural History Museum, 15 p.
- Scott, E., and Cox, S.M., 2008, Late Pleistocene distribution of *Bison* (Mammalia, Artiodactyla) in the Mojave Desert of southern California and Nevada: In, X. Wang and L.G. Barnes (editors), *Geology and Vertebrate Paleontology of western and southern North America in honor of David P. Whistler*. Natural History Museum of Los Angeles County Science Series no. 41, p. 359-382.
- Scott, E., and Springer, K., 2008, CEQA and fossil preservation in southern California: The Environmental Monitor, Fall 2003, p. 4-10, 17.
- Sharp, R.P., 1976, *Geology Field Guide to Southern California*: Kendall-Hunt Publishing Company, Dubuque, Iowa, p 28-24, 52-60.



Appendix A
2010 Survey Notes



Cadiz Paleontological Survey Results

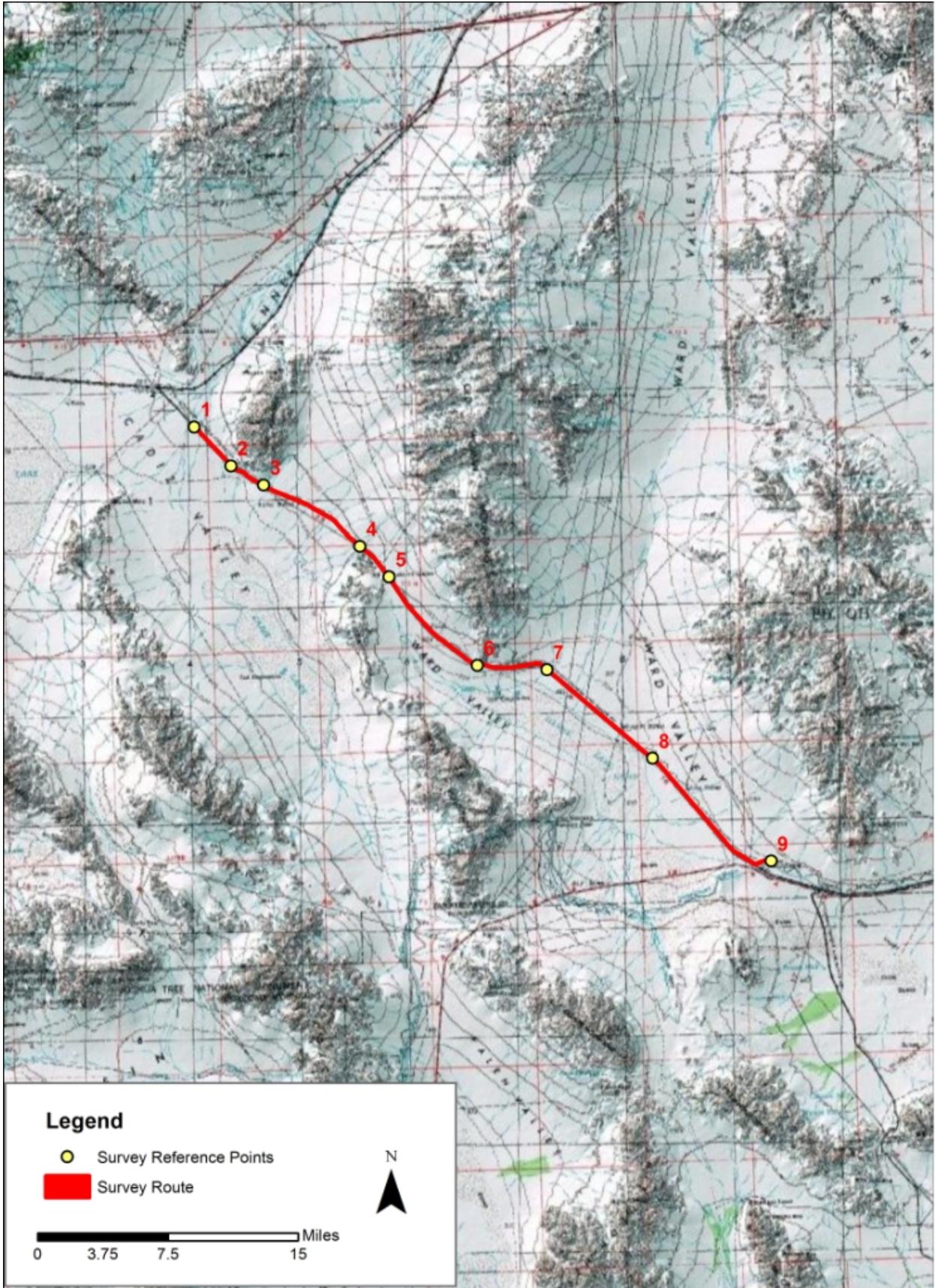


Figure 1. Project Location with Survey Reference Locations

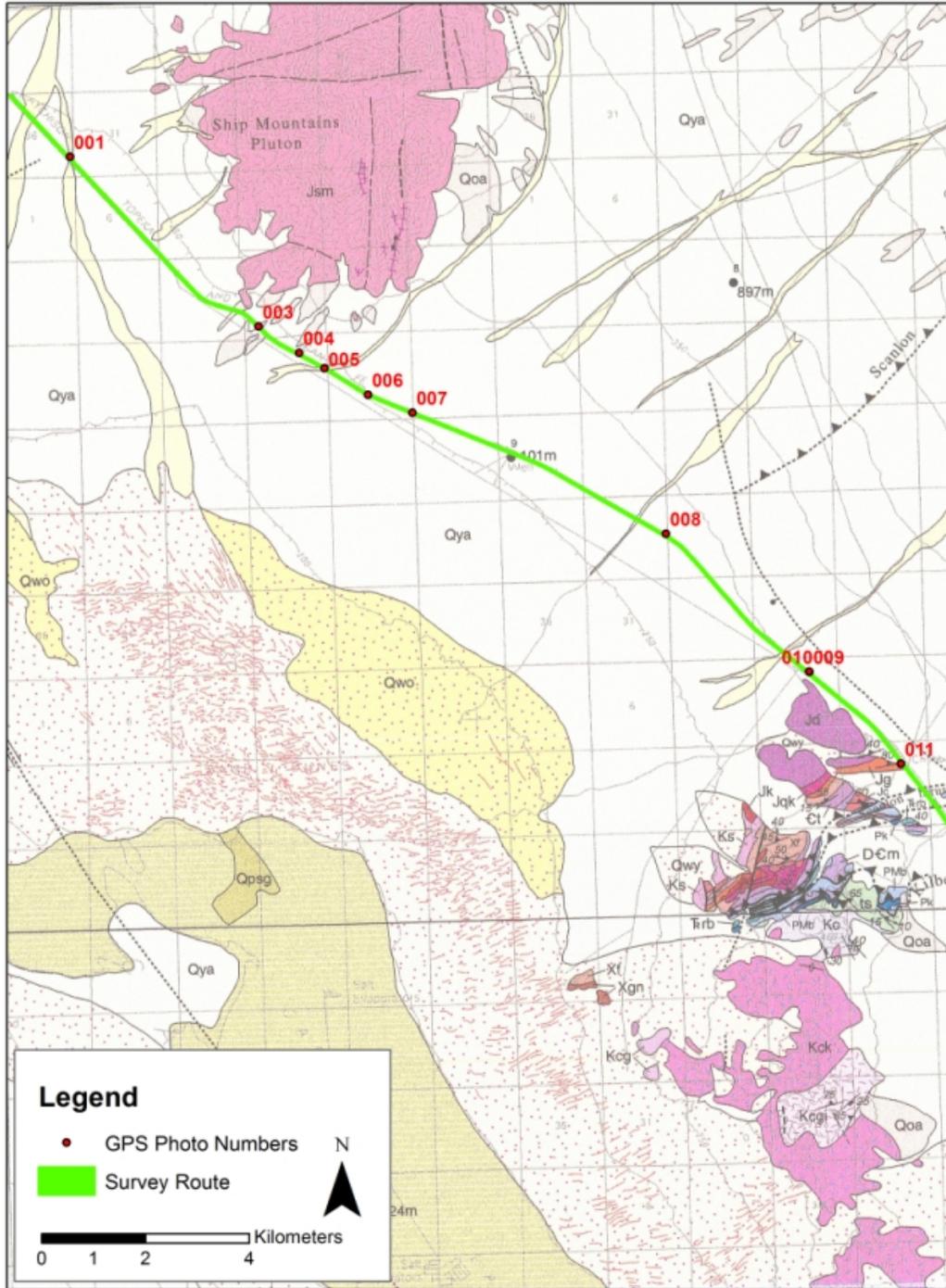


Figure 2. Geology map with survey route and photo numbers.

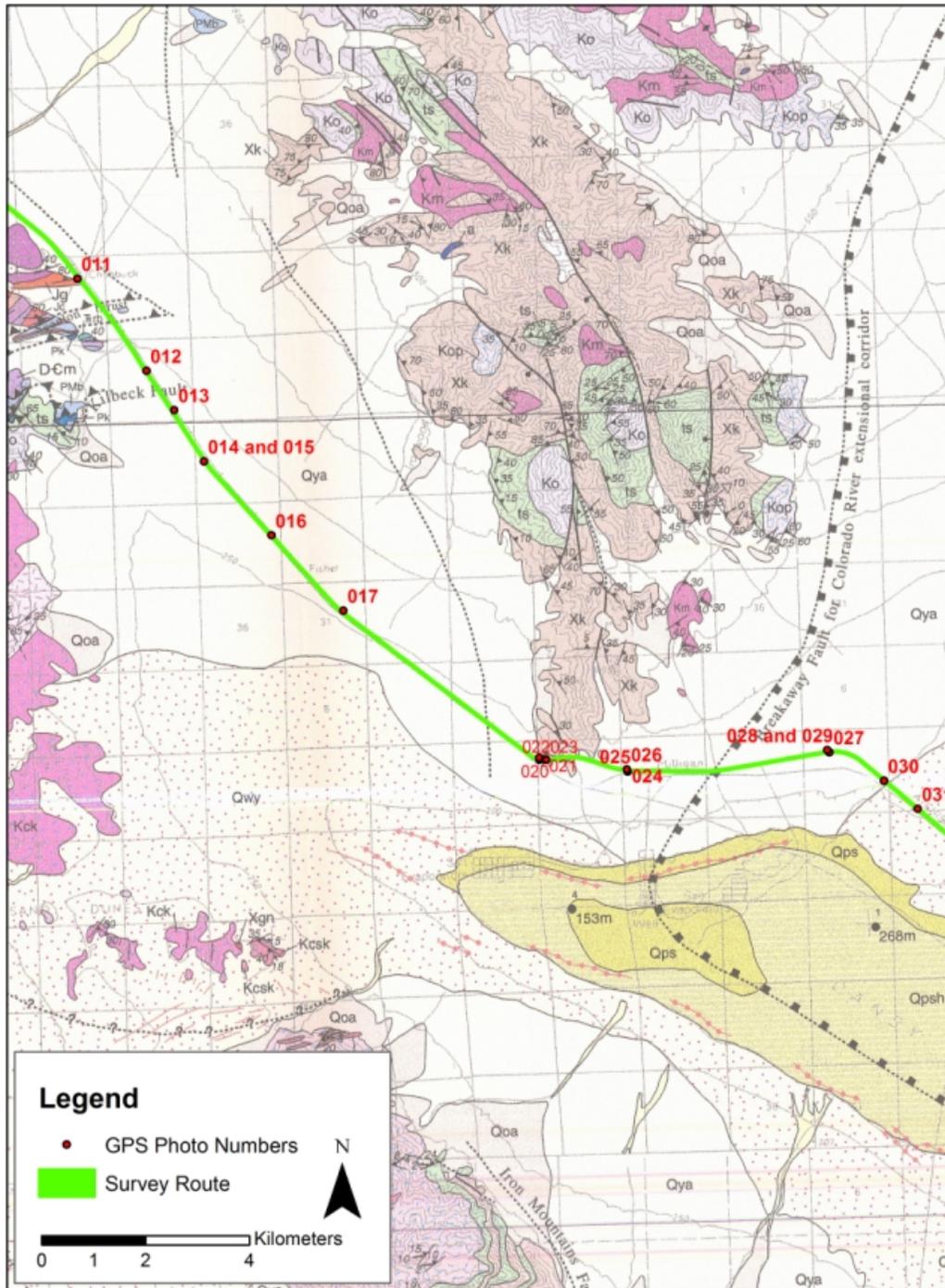


Figure 3. Geology map with survey route and photo numbers.

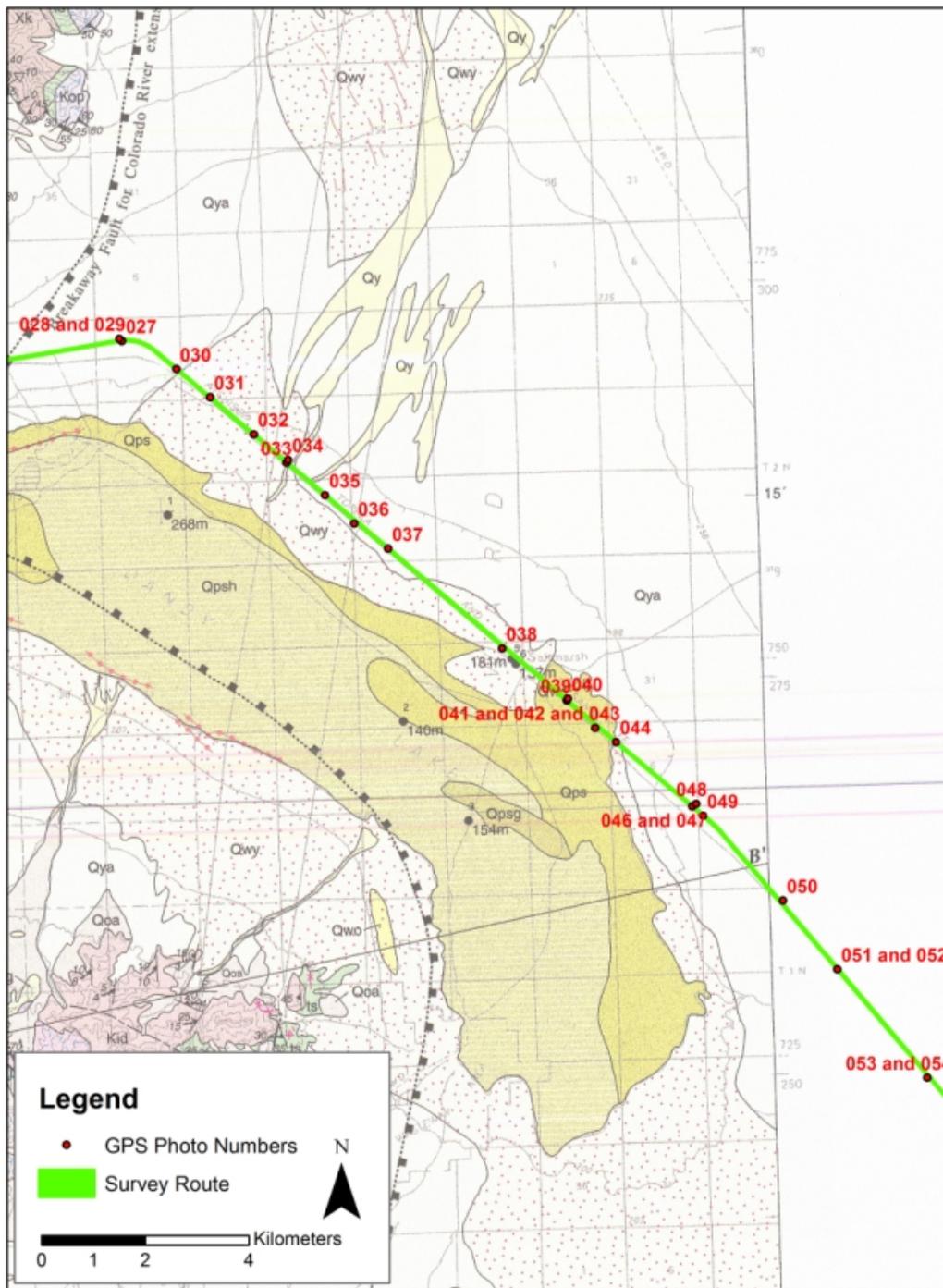


Figure 4. Geology map with survey route and photo numbers.

Field Results

Section 1: From Proposed well filed area to Western Toe of Ship Mountains

From reference point 1 (see map) south the western toe of the Ship Mountains the ground surface with mostly pebble to gravel-sized felsic igneous and metamorphic clasts with a sandy matrix. Drainage cut-banks along this stretch show mostly poorly sorted gravelly alluvium (figure 5). The stratigraphy is not well-differentiated into layers. Older layers are not shallow enough to be visible in the channel bottoms. Clasts in the sediment show increasing gradually increasing size and density to the south. Drainage in the southern part of this section are rocky and grade into conglomerate near the channel bottoms. No fossil materials were observed on the surface in this section. Close examination of stream cut-banks also revealed no fossil specimens.



Figure 5. Stream cut-bank in northern section 1 showing mostly undifferentiated alluvium, facing west (photo number 001).

Section 2: Western Toe of Ship Mountains

From reference point 2 south to approximately one mile south of the Ship Mountains (reference point 3) the ground surface is paved with cobble to gravel-sized clasts of granodiorite and other granitic rocks along with metamorphics dominated by gneiss and gneiss variants. With depth the deposit is increasingly consolidated into conglomerate. The bottom depth of this deposit is unknown as stream cuts in this section are not deep enough to show underlying sediments. No fossil materials were observed on the surface in this section. Close examination of stream cut-banks also revealed no fossil specimens.



Figure 6. Southern tip of Ship Mountains seen from survey route, facing north (photo number 003).

Section 3: Sand plain south from Ship Mountains to eastern Kilbeck Hills

From reference point 3 south the surface deposits become increasingly sandy for a couple of miles until larger than gravel-sized clasts become uncommon on the surface. This sandy terrain remains dominant until the approach of the route to the Kilbeck Hills at reference point 4. Lithic materials are similar to those further north, including mixed granitics, gneiss, schist, quartzite and quartz. Examination of stream cut-banks show the sediments to be poorly sorted gravelly silty sand with some weakly

differentiated gravel strata (probably alluvium). No fossilized materials were discovered along this stretch either on the surface or in the cut-banks.

Section 4: Eastern toe of the Kilbeck Hills

From reference point 4 to reference point 5, the survey route passes close to the toe of the Kilbeck Hills. Here the sediments are rockier and dominated by intrusive igneous clasts. The materials along the survey route are often disturbed by grading. No fossil materials observe on surface or in cut-banks.



Figure 7. Desert terrain as seen from toe of eastern Kilbeck Hills, facing north (photo number 11).

Section 5: From the Kilbeck Hills south to the southern tip of the Old Woman Mountains

From the Kilbeck Hills at reference point 5 south to reference point 6, a hard gravelly clayey layer was observed in many of the stream cuts. Near the bottom of the stream cuts this strata of clayey sand mixed with gravel is revealed. It may represent an older deposit (figure 8). This strata occurs variably from around 0.75 to 1.25 meters below the prevailing surface where it was observed. The sediments overlying it are still mixed silty gravelly sand (alluvium).



Figure 8. Hardened sandy clay strata near base of stream cut-bank north of the railroad, facing NE (rock pick in center shows scale) (photo number 013).



Figure 7. Stratigraphy in stream cut to the north of the railroad (photo number , facing north (photo number 015).



Figure 8. Closeup of stratigraphy in stream cut to the north of the railroad at point X, facing north (photo number 014).

Section 6: From southern tip of the Old Woman Mountains to the northern edge of Danby Dry Lake

From the southern tip of the Old Woman Mountains (reference point 6) south to approximately the northernmost approach of the survey route to Danby Dry Lake (reference point 7), poorly sorted alluvium dominates most of the route. Most of the material exposed in stream cuts or visible on the surface is silty sand with a high gravel component, however often a harder clay layer is exposed that is similar to that mentioned in sections further to the north (see figure 9).



Figure 9. Clay layer exposed near surface in section 6, facing north toward Old Woman Mountains (photo number 025).

Section 7: Near northern shore of Danby Dry Lake

From reference point 7 to reference point 8 the survey route passes to the north of Danby Dry Lake at a distance of a mile or so. Along this stretch surface were dominated by sand scattered with volcanic tuff and some pumice. Stratigraphy revealed in the accessible cut-banks was mostly sand. The channels were seldom deep enough to find strata deeper than the dune layer (see figure 10).



Figure 10. Undifferentiated stratigraphy upstream from ROW in dune area (section 7), facing southeast. The groove shown is the result of testing. The large estwing pick shows scale (photo number 034).

Along this stretch are occasional area where dunes are less prominent and harder sediments are exposed in stream-cuts. These were generally gravelly and not very consolidated clayed sand (see figure 11).



Figure 11. Clay layer in bottom of drainage with softer sediments underneath that are being eroded, facing NW (photo number 038).



Figure 12. Stream cut-bank near southern part of vicinity to Danby Dry Lake, facing northwest. The material is silty sand with a strata of tufa deposits in the middle stratum (photo number 040).

Section 8: From eastern extent of Danby Dry Lake to end of survey route

From reference point 8 to the end of the survey route at reference point 9, the route crosses gravel-paved sand. Surface clasts are mostly felsic igneous and metamorphic, including granodiorite, diorite, gneiss, schist, quartzite, quartz and K-spar. Stream cut-banks reveal little stratigraphy and sediments are mostly poorly sorted sandy alluvium. Most stream cuts were too shallow to show deeper layers where older strata might occur. More southerly along the route clay nodules become common in the soil and concentrate somewhat with depth.



Figure 10. Stratigraphy of stream channel north of railroad bridge, facing northwest. The composition of the lower layer is exactly similar to that of the surface deposits. The middle strat is silty sand with an increasing amount of gravel with depth (photo number 048).

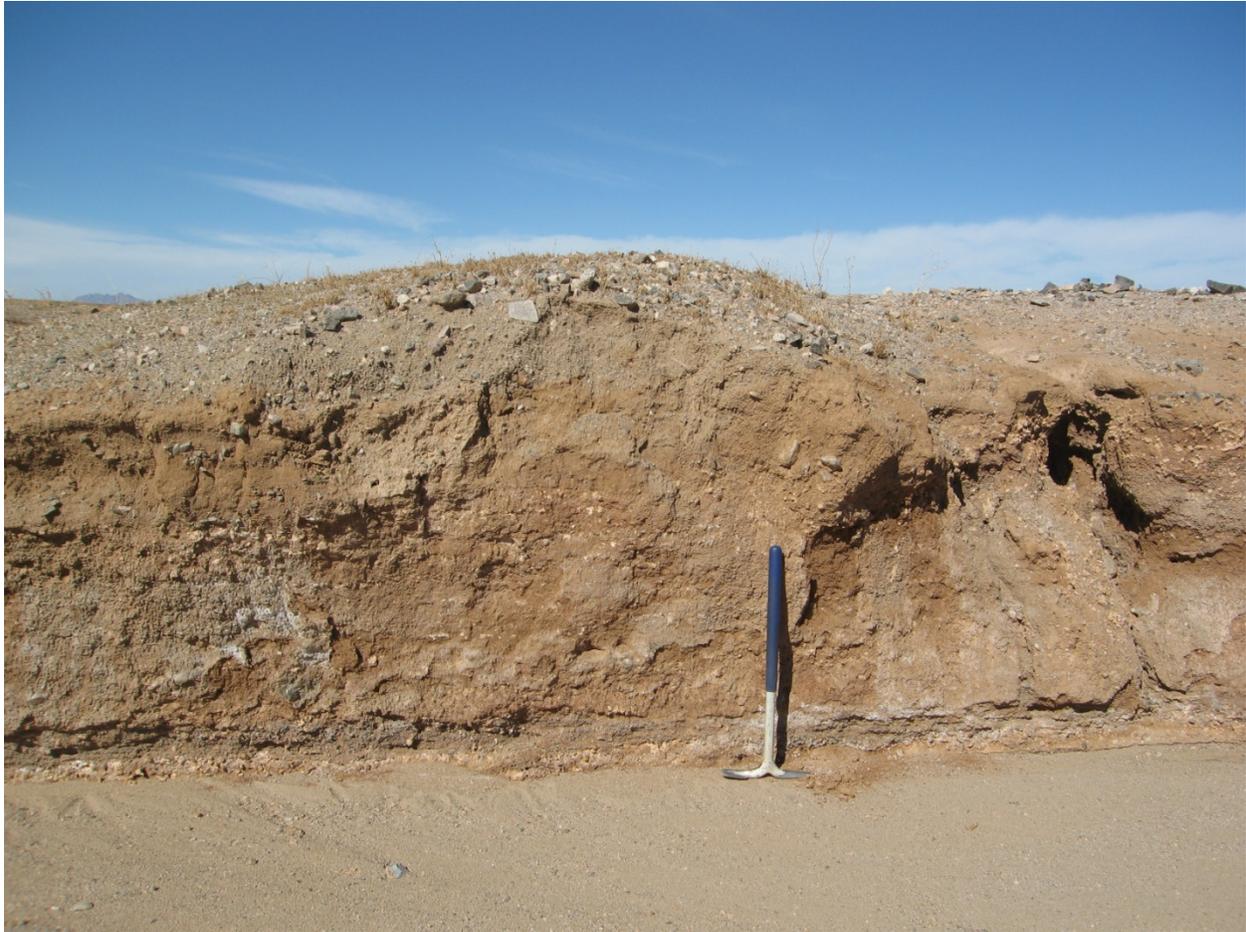


Figure 11. Gravelly clay layer exposed at very bottom of stream cut-bank, facing north northeast (photo number 039).



Figure 12. Stream-cut in section 8 showing gravel and clay nodules in surface layers, facing north (photo number 056).

Appendix B
Museum Locality Searches

Natural History Museum
of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007
tel 213.763.DINO
www.nhm.org



Vertebrate Paleontology Section
Telephone: (213) 763-3324
FAX: (213) 746-7431
e-mail: vrhue@nhm.org

20 October 2010

Paleo Solutions, Inc.
2035 Placentia Avenue, Suite D
Costa Mesa, CA 92627

Attn: Jen Kelly, Paleontologist/Specialist

re: Paleontological resources for the proposed Cadiz Groundwater Project, San Bernardino County,
project area

Dear Jen:

I have conducted a thorough search of our paleontology collection records for the locality and specimen data for the proposed Cadiz Groundwater Project, San Bernardino County, project area as outlined on the portions of the Arica Mountains, Sablon, Danby Lake, East of Milligan, Milligan, Chubbuck, Cadiz Lake NE, and Cadiz Lake NW USGS topographic quadrangle maps that you sent to Dr. Samuel A. McLeod on 11 October 2010. We do not have any vertebrate fossil localities that lie directly within the proposed project area, but we do have vertebrate fossil localities from the same or similar sedimentary deposits to those that occur in the proposed project area, albeit at some distance.

Almost the entire proposed project area has surficial deposits composed of Dune Sands and younger Quaternary Alluvium, primarily derived as coarse fan deposits from the surrounding Old Woman Mountains, Iron Mountains, and Turtle Mountains. These valley and stream fill, fan deposits typically do not contain significant vertebrate fossils, at least in the uppermost layers, but they may be underlain by older Quaternary deposits that may well contain significant vertebrate fossils. These older Quaternary deposits appear in close proximity to the proposed project area, near the base of the elevated terrain at the western slope of the Old Women Mountains.

Surficial Quaternary Lake deposits occur within the proposed project area along the eastern edge of the currently dry Danby Lake. These old lake bed deposits also appear near Cadiz Lake. It is important to note that these fine-grained sediments would be conducive to fossil burial and

preservation. In wetter past climates an expanded Danby Lake and Cadiz Lake would have extended to encompass a larger area and those lacustrine deposits could be expected at depth within your project area.

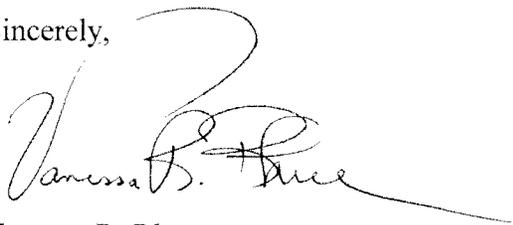
The project area intersects with a variety of igneous and metamorphic rocks in the elevated terrain along the southern tip of the Old Woman Mountains. Granitic rocks occur near the northern portion of Kilbeck Hill and the western slope of the Old Woman Mountains. Tertiary volcanic rocks outcrop at the southern tip of the Ship Mountains. These non-sedimentary deposits will, of course, be devoid of any recognizable vertebrate fossils.

Our closest vertebrate fossil locality from similar Quaternary deposits is LACM 5977, quite to the south-southwest of the proposed project area north of Interstate 10 and on the southwest side of Ford Dry Lake, that produced a fossil specimen of pocket mouse, *Perognathus*. From older Quaternary deposits, the Pinto Formation in this case, our next closest vertebrate fossil localities are LACM (CIT) 208 and LACM 3414, again at some distance west-southwest of the proposed project area between the Eagle Mountains and the Coxcomb Mountains, that produced fossil specimens of tortoise, *Gopherus*, horse, *Equus*, and camel, *Camelops* and *Tanupolama stevensi*.

Excavations in the igneous, metamorphic and volcanic rocks exposed in the more elevated terrain of the Old Woman Mountains, Kilbeck Hill, and Ship Mountains will not encounter any fossils. Surface grading or very shallow excavations in the sand dunes or the younger Quaternary fan deposits exposed in most of the proposed project area are unlikely to encounter significant vertebrate fossil remains. Deeper excavations in the proposed project area that extend down into older Quaternary deposits or the surficial Quaternary Lake deposits, however, may well uncover significant vertebrate fossils. Any substantial excavations in the proposed project area, therefore, should be monitored closely to quickly and professionally recover any fossil remains discovered while not impeding development. Any fossils recovered during mitigation should be deposited in an accredited and permanent scientific institution for the benefit of current and future generations.

This records search covers only the vertebrate paleontology records of the Natural History Museum of Los Angeles County. It is not intended to be a thorough paleontological survey of the proposed project area covering other institutional records, a literature survey, or any potential on-site survey.

Sincerely,

A handwritten signature in black ink, appearing to read "Vanessa R. Rhue". The signature is fluid and cursive, with a large, sweeping flourish at the end.

Vanessa R. Rhue

Vertebrate Paleontology

26 October 2010

Paleo Solutions, Incorporated
attn: Geraldine L. Aron, President
2035 Placentia Avenue, Suite "D"
Costa Mesa, CA 92627

re: **PALEONTOLOGY LITERATURE AND RECORDS REVIEW, CADIZ
GROUNDWATER PROJECT, CADIZ REGION, SAN BERNARDINO COUNTY,
CALIFORNIA**

Dear Ms. Aron,

The Division of Geological Sciences of the San Bernardino County Museum (SBCM) has completed a literature review and records search for the above-referenced project alignment in the Cadiz region of San Bernardino County, California. The property alignment traverses portions of the following United States Geological Survey 7.5' topographic quadrangle maps: Arica Mountains, California (1983 provisional edition); Cadiz Lake NE, California (1985 provisional edition); Cadiz Lake NW, California (1986 provisional edition); Chubbuck, California (1985 provisional edition); East of Milligan, California (1988 provisional edition); Milligan, California (1985 provisional edition); and Sablon, California (1983 provisional edition).

Previous geologic mapping (Bishop, 1963) indicates that the proposed project alignment primarily crosses surface exposures of undifferentiated Quaternary alluvium. This Holocene alluvium may comprise a thin sedimentary veneer over older Pleistocene alluvial sediments in the vicinity of Cadiz, and likely overlies Pleistocene lacustrine sediments in the vicinity of Danby Lake. These Pleistocene sediments have demonstrated high potential to contain significant nonrenewable paleontologic resources (Reynolds and Reynolds, 1992; Scott and Cox, 2008), and so are assigned high paleontologic sensitivity.

Pleistocene fossils from the Cadiz and Danby areas include remains of extinct horse (*Equus* sp.), large camel (cf. *Camelops* sp.), and pronghorn (*Tetrameryx*), as well as molluscs, toads, tortoises, lizards, snakes, birds, rabbits, and rodents (Reynolds and Reynolds, 1992; Scott and Cox, 2008). The Pleistocene age of the assemblage is confirmed by the presence of remains of extinct horse, pronghorn, and large camel, as well as the presence of fossils of extinct giant tortoise (*Hesperotestudo*). However, none of the fossils identified to date from either the Cadiz or the Danby Lake regions can be clearly determined to be early, middle, or late Pleistocene in age, due to the fragmentary nature of many of the finds. The recovery of additional, more complete, more diagnostic fossil remains from the region will undoubtedly clarify this issue.

For this review, I conducted a search of the Regional Paleontologic Locality Inventory (RPLI) at the SBCM. The results of this search indicate that several confirmed paleontologic resource localities (SBCM 1.41.2 - 1.41.8 and 1.42.2 - 1.42.5) are recorded by the SBCM along the corridor of the proposed project alignment. Locality data are appended. The abundance of paleontologic resource localities from this region, and the presence of these localities along the proposed project corridor, in combination demonstrate the high paleontologic sensitivity of Pleistocene alluvial sediments present within the area of effect of the project alignment.

Recommendations

The results of the literature review and the check of the RPLI at the SBCM demonstrate that excavation into undisturbed surficial and subsurface Pleistocene sediments along portions of the corridor of the proposed project alignment has high potential to impact paleontologic resources. A qualified vertebrate paleontologist must develop a program to mitigate impacts to significant nonrenewable paleontologic resources. This program must include curation of recovered resources (Scott and others, 2004) and be consistent with the provisions of the California Environmental Quality Act (Scott and Springer, 2003), as well as with regulations currently implemented by the Counties of Kern and San Bernardino and the proposed guidelines of the Society of Vertebrate Paleontology.

The County of San Bernardino (Development Code §82.20.040) defines a qualified vertebrate paleontologist as meeting the following criteria:

Education: An advanced degree (Masters or higher) in geology, paleontology, biology or related disciplines (exclusive of archaeology).

Professional experience: At least five years professional experience with paleontologic (not including cultural) resources, including the collection, identification and curation of the resources.

The County of San Bernardino (Development Code §82.20.030) requires that paleontologic mitigation programs include, but not be limited to:

(a) Field survey before grading. In areas of potential but unknown sensitivity, field surveys before grading shall be required to establish the need for paleontologic monitoring.

(b) Monitoring during grading. A project that requires grading plans and is located in an area of known fossil occurrence, or that has been demonstrated to have fossils present in a field survey, shall have all grading monitored by trained paleontologic crews working under the direction of a qualified professional, so that fossils exposed during grading can be recovered and preserved. Paleontologic monitors shall be equipped to salvage fossils as they are unearthed, to avoid construction delays, and to remove samples of sediments that are likely to contain the remains of small fossil invertebrates and vertebrates. Monitors shall be empowered to temporarily halt or divert equipment to allow

removal of abundant or large specimens. Monitoring is not necessary if the potentially-fossiliferous units described for the property in question are not present, or if present are determined upon exposure and examination by qualified paleontologic personnel to have low potential to contain fossil resources.

(c) Recovered specimens. Qualified paleontologic personnel shall prepare recovered specimens to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates. Preparation and stabilization of all recovered fossils is essential in order to fully mitigate adverse impacts to the resources.

(d) Identification and curation of specimens. Qualified paleontologic personnel shall identify and curate specimens into the collections of the Division of Geological Sciences, San Bernardino County Museum, an established, accredited museum repository with permanent retrievable paleontologic storage. These procedures are also essential steps in effective paleontologic mitigation and CEQA compliance. The paleontologist must have a written repository agreement in hand prior to the initiation of mitigation activities. Mitigation of adverse impacts to significant paleontologic resources is not considered complete until curation into an established museum repository has been fully completed and documented.

(e) Report of findings. Qualified paleontologic personnel shall prepare a report of findings with an appended itemized list of specimens. A preliminary report shall be submitted and approved before granting of building permits, and a final report shall be submitted and approved before granting of occupancy permits. The report and inventory, when submitted to the appropriate Lead Agency along with confirmation of the curation of recovered specimens into the collections of the San Bernardino County Museum, will signify completion of the program to mitigate impacts to paleontologic resources.

References

- Bishop, C.C., 1963. Geologic map of California, Needles sheet, scale 1:250,000. California Division of Mines and Geology Regional Geologic Map Series.
- Reynolds, S.F.B. and R.L. Reynolds, 1992. Pleistocene faunas in the Bristol-Danby trough. *In* S.F.B. and J. Reynolds (eds.), *Old Routes to the Colorado*. SBCM Association Special Publication 92-2: 83-86.
- Scott, E. and S.M. Cox, 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) in the Mojave Desert of southern California and Nevada. *In* X. Wang and L.G. Barnes (eds.), *Geology and vertebrate paleontology of western and southern North America: Contributions in honor of David P. Whistler*. Natural History Museum of Los Angeles County Science Series No. 41, p. 359 - 382.
- Scott, E. and K. Springer, 2003. CEQA and fossil preservation in southern California. *The Environmental Monitor*, Fall 2003, p. 4-10, 17.

Scott, E., K. Springer and J.C. Sagebiel, 2004. Vertebrate paleontology in the Mojave Desert: the continuing importance of "follow-through" in preserving paleontologic resources. *In* M.W. Allen and J. Reed (eds.) *The human journey and ancient life in California's deserts: Proceedings from the 2001 Millennium Conference*. Ridgecrest: Maturango Museum Publication No. 15, p. 65-70.

Please do not hesitate to contact us if you have any further questions.

Sincerely,

Eric Scott, Curator of Paleontology
Division of Geological Sciences
San Bernardino County Museum

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.2 PROJECT:

Name: Saltmarsh A Area: Danby Dry Lake

County: San Bernardino County State: California District:

USGS Map: Danby Lake, CA; 7.5'

Utm Zone: 11 Utm Datum: NAD1927 Meters East: 681200 Meters North: 3786875

Elevation Feet: 630. Elevation Meters: 192.02

Utm Zone: 11 Utm Datum: NAD1927 Meters East: 681775 Meters North: 3786250

Elevation Feet: 630. Elevation Meters: 192.02

Utm Zone: 11 Utm Datum: NAD1927 Meters East: 681725 Meters North: 3785950

Elevation Feet: 630. Elevation Meters: 192.02

Utm Zone: 11 Utm Datum: NAD1927 Meters East: 680850 Meters North: 3786650

Elevation Feet: 630. Elevation Meters: 192.02

PM: San Bernardino Meridian T 1N R 18E Sections: 1 E NE

PM: San Bernardino Meridian T 1N R 18E Sections: 6 W

Field Number:

Other Number:

Repository: SBCM

Collector:

Description: Brown playa clays grade upward into green efflorescent lacustrine siltstone capped by tan tufa kernels. Exposed section is covered by "fossil" dune sand.

1.6 mi SE of Saltmarsh Siding, on west side of AT&SF railroad and east of present surface of Danby Lake.

Formation:

Unit/Member:

Geologic Age: Pleistocene

Data Entry: GB 10/05/2009

Taxa/Object Found: Equus sp. (small), Camelops sp., Lepus sp. cf. L. californicus, Dipodomys sp., Vulpes sp., Taxidea taxus

Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.3 **PROJECT:** All-American Pipeline
Name: Salt Marsh B **Area:** Danby Dry Lake
County: San Bernardino County **State:** California **District:** Needles
USGS Map: Iron Mountains, CA; 7.5' Prov. Ed. 1983
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 679640 **Meters North:** . 3787780
 Elevation Feet: 680. **Elevation Meters:** 207.26
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 679237 **Meters North:** 3788075
 Elevation Feet: **Elevation Meters:** .
PM: San Bernardino Meridian **T** 2N **R** 18E **Sections:** 35 E 1/4
Field Number: Salt Marsh 1
Other Number:
Repository: SBCM **Collector:** Quintin Lake
Description:
Formation: **Unit/Member:**
Geologic Age:
Data Entry: JCS 06/09/2008
Taxa/Object Found:
Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.4 **PROJECT:** All-American Pipeline
Name: Salt Marsh C **Area:** Danby Dry Lake
County: San Bernardino County **State:** California **District:** Needles
USGS Map: Iron Mountains, CA; 7.5' Prov. Ed. 1983
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 678425 **Meters North:** 3788660
 Elevation Feet: 640. **Elevation Meters:** 195.07
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 678000 **Meters North:** 3788920
 Elevation Feet: . **Elevation Meters:** .
PM: San Bernardino Meridian **T** 2N **R** 18E **Sections:** 26 SW SW
Field Number:
Other Number:
Repository: SBCM **Collector:** Quintin Lake
Description:
Formation: **Unit/Member:**
Geologic Age:
Data Entry: JCS 06/09/2008
Taxa/Object Found: ?Camelops sp., Lagomorpha
Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.6 **PROJECT:** All American Pipeline
Name: Salt Marsh E **Area:** Danby Dry Lake
County: San Bernardino County **State:** California **District:**
USGS Map: Danby Lake, CA; 7.5'
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 676240 **Meters North:** 3790225
 Elevation Feet: 650. **Elevation Meters:** 198.12
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 675980 **Meters North:** 3790460
 Elevation Feet: 650. **Elevation Meters:** 198.12
PM: San Bernardino Meridian **T** 2N **R** 18E **Sections:** 21 sw, se, se
Field Number: SaltMars5
Other Number:
Repository: SBCM **Collector:**
Description: Pleistocene
Formation: **Unit/Member:**
Geologic Age: Rancholabrean

Data Entry: GB 10/05/2009
Taxa/Object Found: cf. Camelops sp.
Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.7 **PROJECT:** All American Pipeline
Name: Sal Marsh F **Area:** Danby Dry Lake
County: San Bernardino County **State:** California **District:** Needles
USGS Map: Danby, CA; 15'
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 675620 **Meters North:** 3790700
 Elevation Feet: . **Elevation Meters:** .
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 675620 **Meters North:** 3790700
 Elevation Feet: . **Elevation Meters:** .
PM: San Bernardino Meridian T 2N R 18E **Sections:** 21 center W
Field Number: Q 1-16.1
Other Number:
Repository: **Collector:**
Description: Pleistocene
Formation: **Unit/Member:**
Geologic Age: Rancholabrean

Data Entry: GB 10/05/2009
Taxa/Object Found: Camelops sp.
Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.41.8 **PROJECT:** All-American Pipeline
Name: Salt Marsh G **Area:** Danby Dry Lake
County: San Bernardino County **State:** California **District:** Needles
USGS Map: Danby Lake, CA; 7.5'
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 675380 **Meters North:** 3791080
 Elevation Feet: 650. **Elevation Meters:** 198.12
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 674940 **Meters North:** 3791200
 Elevation Feet: 650. **Elevation Meters:** 198.12
PM: San Bernardino Meridian **T** 2N **R** 18E **Sections:** 21 SE, SW, NW
Field Number: SaltMarsh6
Other Number:
Repository: SBCM **Collector:**
Description:
Formation: **Unit/Member:**
Geologic Age: Rancholabrean

Data Entry: GB 10/05/2009
Taxa/Object Found:
Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.42.3 **PROJECT:** All-American Pipeline

Name: AAPL Archer #2 **Area:** Cadiz Lake

County: San Bernardino County **State:** California **District:** Needles

USGS Map: United States Geological Survey. . Cadiz Lake, CA; 15'

Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 644325 **Meters North:** 3812675

Elevation Feet: 740. **Elevation Meters:** 225.55

PM: San Bernardino Meridian **T** 4N **R** 15E **Sections:** 8 SE, NW, NW, SE

Field Number: Q 1-28.2

Other Number: Q 1-28.22

Repository: SBCM **Collector:**

Description:

Formation: **Unit/Member:**

Geologic Age:

Data Entry: GB 10/05/2009

Taxa/Object Found: Tracheophyta, Gastropoda, Phrynosoma, Colubridae, Ophidia, Rodentia

Notes:

SAN BERNARDINO COUNTY MUSEUM REGIONAL PALEONTOLOGIC LOCALITY INVENTORY

SBCM: 1.42.5 **PROJECT:** All-American Pipeline
Name: AAPL Archer #4 **Area:** Cadiz Lake
County: San Bernardino County **State:** California **District:** Needles
USGS Map: United States Geological Survey. . Cadiz Lake, CA; 15'
Utm Zone: 11 **Utm Datum:** NAD1927 **Meters East:** 643800 **Meters North:** 3814025
 Elevation Feet: 740. **Elevation Meters:** 225.55
PM: San Bernardino Meridian **T** 4N **R** 15E **Sections:** 8 NW, NW, SW, SE, NW
Field Number: W 1-18.1
Other Number:
Repository: SBCM **Collector:**
Description:
Formation: **Unit/Member:**
Geologic Age: Rancholabrean

Data Entry: GB 10/05/2009
Taxa/Object Found:
Notes:

Appendix C
2012 Survey Notes



FIELD SURVEY RESULTS

INTRODUCTION

This report presents the observations and findings for the May 2012 paleontological resources field survey conducted for the Cadiz Water Project. The survey was conducted for the Phase II (Programmatic) Facilities section of the project and took place in the well-field and spreading basin areas. The survey took place on May 22 through May 25 2012 and was performed by Mark Deering and Paul Nisbit of Paleo Solutions Inc.

METHODOLOGY

For record-keeping in the field, the survey route was divided into sections. For instance, in the well-field area these sections correspond to the legs of the well-field 'tree'. In the other locations, they were defined so as to provide complete coverage of the staging areas and monitoring wells. Survey stations were defined at junctions and other key points of the survey sections. At these survey stations photos and GPS points were routinely shot. The survey stations were numbered in roughly the order in which the survey was to be under-taken.

GPS points were shot with a Trimble GeoXT GPS unit and photos with an Apple iPad equipped with a Theodolite Pro app for geo-tagging photos. Records were kept in a File Maker Pro database installed on an Apple iPad with a File Maker Go mobile app.

NORTHEAST WELL-FIELD

The survey started near the northeast part of the well-field area. In general the northeast well-field area lies on open mostly flat terrain carved by shallow drainage channels. The surface is usually paved with sub-rounded and sub-angular metamorphic and volcanic gravels and small pebbles with occasional larger clasts being common. No sedimentary gravels were observed. The surface indicates a deflated alluvium in which the smaller particles have been removed by eolian processes. Most of the channels are too shallow to display stratigraphy in their cut-banks, and those that were defined were generally less than 3 ft high. The sediments are generally not indurated, and no outcrops or exposures of older sediment were present in the area of the well-field.



Figure 1. Typical terrain in the northeast part of the well-field area. Note shallow channeling typical of the northeast well-field area. Photo to the southeast from survey station 8.



Figure 2. Typical terrain in the southwest part of the northeast well-field area. Photo to the northwest from survey station 31.



Figure 3. Cut-bank near contact of Qyv (Quaternary young valley-axis deposits) and Qya (Quaternary young alluvial deposits). Photo to the southeast at survey station 34.

SOUTHWEST WELL-FIELD

Orchards and vineyards dominate much of the western well-field area. Areas of the well-field near the orchards are generally similar but even more devoid of surface vegetation. Channeling in this area is slight. Much of this area has been disturbed by grading associated with the orchards and vineyards. As to the northeast the surface is deflated by eolian processes. Rock clasts visible on the surface are volcanic and metamorphic. These gravels and pebbles are generally sub-rounded in configuration. No indurated sedimentary rock was observed in the area. Most of the sediments visible at the surface are Quaternary young alluvium.



Figure 4. Typical terrain in southwest well-field area. Photo to the southwest from survey station 46.



Figure 5. Typical terrain near the orchards in the southwest well-field area. Photo to the southeast from survey station 58.

STAGING AREAS

Staging area 1: The largest staging area occurs in the western-most part of the well-field and the orchards. This area is largely disturbed on the surface by agricultural grading. As to the northeast the surface is dominated by volcanic and metamorphic gravels and pebbles though with some silt and sand near the surface as a result of the grading. Quaternary young alluvium is the dominant sediment in the area.

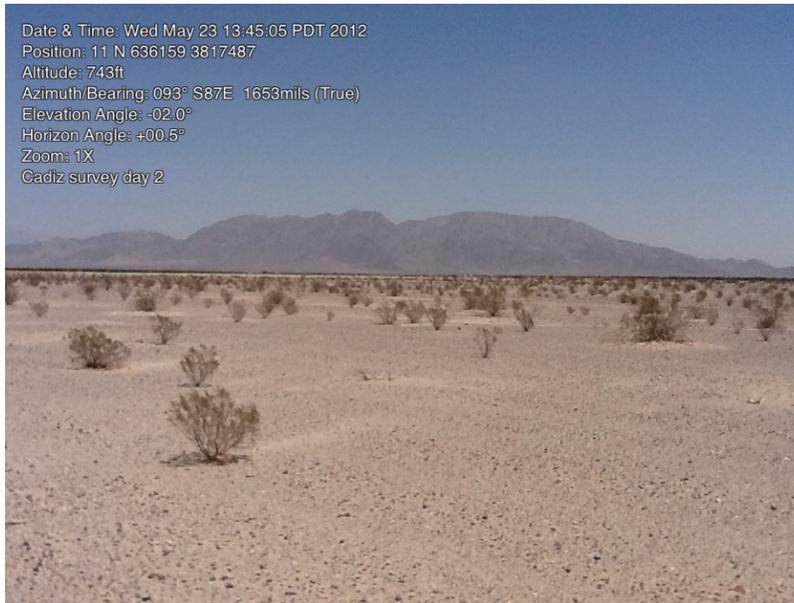


Figure 6. Terrain in staging area 1. Photo to the southeast from survey station 56.

Staging area 2: This area lies about 600 yards to the north of previously recorded San Bernardino locality 1.41.8. The area is mostly flat and without noticeable channels except in the east where a shallow drainage runs parallel to the eastern boundary. Cut-banks in this channel are shallow at less than 2 feet in height and show no distinct stratigraphy. The surface is much deflated but is paved mostly with metamorphic gravels and pebbles rather than the volcanic materials that are more prominent both to the north and to the south. Rodent burrowing is common in this area but burrow tailings were devoid of fossil materials. The surface in this area is generally sandier than elsewhere on the survey.



Figure 7. Terrain in the drainage in the western part of staging area 2. Photo to the southwest at survey station 66.

Staging area 3: This area also occurs near previously recorded localities, specifically about 800 yards from San Bernardino locality 1.41.3. It lies to the north of the railroad bed in a barren area of engineered dikes. In the southern part of the area drainage channels display some stratigraphy and clay hardpan sediments can be seen to occur about 3 to 4 feet below the natural surface in some areas. The surface is mostly hard-packed silty sand devoid of stones.



Figure 8. Natural stratigraphy below disturbed dike fill in the south part of staging area 3. Photo to the southwest from survey station 69.



Figure 9. Channeled terrain in the southwest part of staging area 3. Photo to the northeast from survey station 67.



Figure 10. Typical terrain in staging area 3. Photo to the southwest from survey station 68.

Staging areas 4 through 8: These areas occur in the southern most part of the project near the California Aqueduct. These areas are generally flat and uncut by drainages except for area 4, where a channel cuts fairly deeply, showing older hardpan at about 4 ft below natural surface along the north side of the channel bottom.



Figure 11. Natural stratigraphy visible below disturbed dike fill in staging area 4. Photo to the southeast from survey station 81.

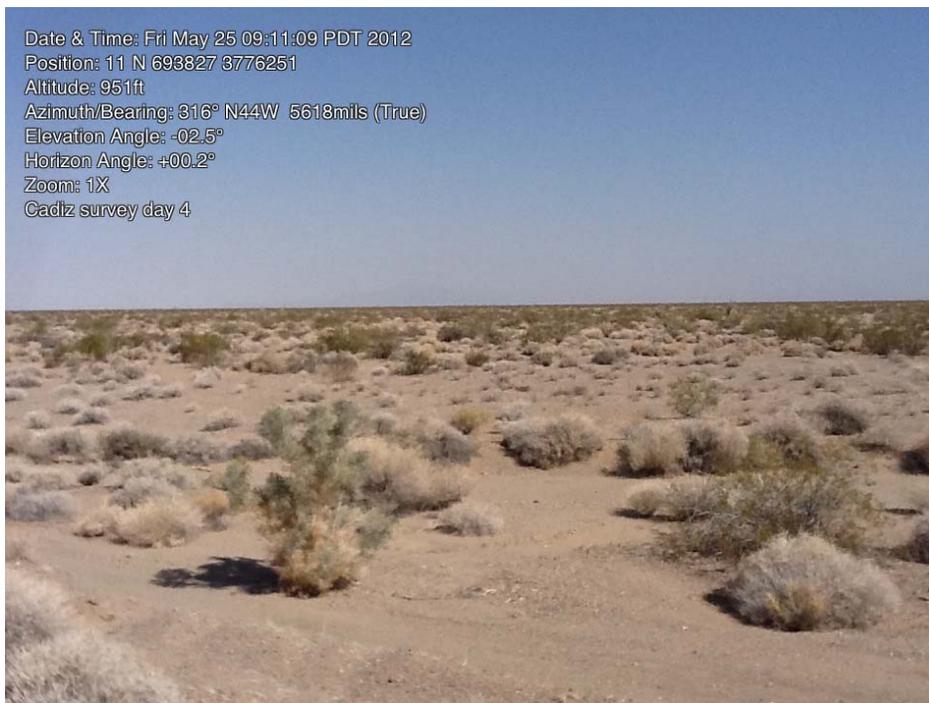


Figure 12. Typical terrain in staging area 7. Photo to the northwest from survey station 77.

MONITORING WELLS

Monitoring well 1: The terrain at the location of monitoring well 1 is open flat desert pavement consisting of volcanic and metamorphic gravels and pebbles. No drainages run through the area, so no cut-banks were available for examination.



Figure 13. Terrain in the area of monitoring well 1. Photo to the northeast from survey station 70.

Monitoring wells 2 and 3: Monitoring wells 2 and 3 lie in the dry lake bed of Bristol Lake. The surface consists of loose silty sand. At no more than a foot below surface the sediment is hardened and appears mostly impermeable. No vegetation occurs in these areas. Below the hard-pan layer fossil potential may be high.

Date & Time: Thu May 24 14:23:10 PDT 2012
Position: 11 N 624190 3818158
Altitude: 599ft
Azimuth/Bearing: 359° N01W 6382mils (True)
Elevation Angle: +00.4°
Horizon Angle: +00.6°
Zoom: 1X
Cadiz survey day 3



Figure 14. Terrain in the area of monitoring well 3. Photo to the northwest from survey station 74.