Appendix G2

Paleontology Survey
and Assessment

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Paleontology Survey and Assessment for the Cadiz Valley Water Conservation, Recovery, and Storage Project

San Bernardino County, California

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TABLE OF CONTENTS

TABLE OF FIGURES

PALEONTOLOGICAL RESOURCES

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 The analysis includes a review of pertinent scientific literature and unpublished technical reports, published geologic maps, museum fossil locality records, and a field survey.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. This includes the 200-foot-wide Arizona and California Railroad Company (ARZC) right-of-way (ROW) from the Cadiz Inc. property in Section 36, Township T5N, Range R14E, and an approximately 200-foot-wide corridor northeast of the intersection of the ARZC ROW and the Colorado River Aqueduct (CRA), extending approximately 4,300 feet east from the ARZC ROW to the CRA canal, parallel to the CRA (referred to herein as the proposed pipeline alignment). Only one Project configuration was analyzed for impacts on paleontological resources (Figure 1), and field surveys of the project wellfield and conceptual spreading basin areas were not conducted because these facilities are still undergoing conceptual development. Paleontological surveys of these areas were completed as part of the previous EIS/EIR (2001), and numerous fossil localities were documented at that time. These areas will be evaluated herein at the programmatic level, because additional information regarding the specific location of the proposed wellfield expansion and spreading basin areas will be needed in order to fully evaluate potential impacts to paleontological resources. When the project design plans are finalized, and prior to implementing the Imported Water Storage Component, a further paleontological resources review consistent with CEQA shall be completed, including additional field surveys if appropriate. Based on the previous EIS/EIR (2001), a survey should be completed and could be done during the preconstruction phase of this project.

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.

1.0 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 requires 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.

1.1 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.

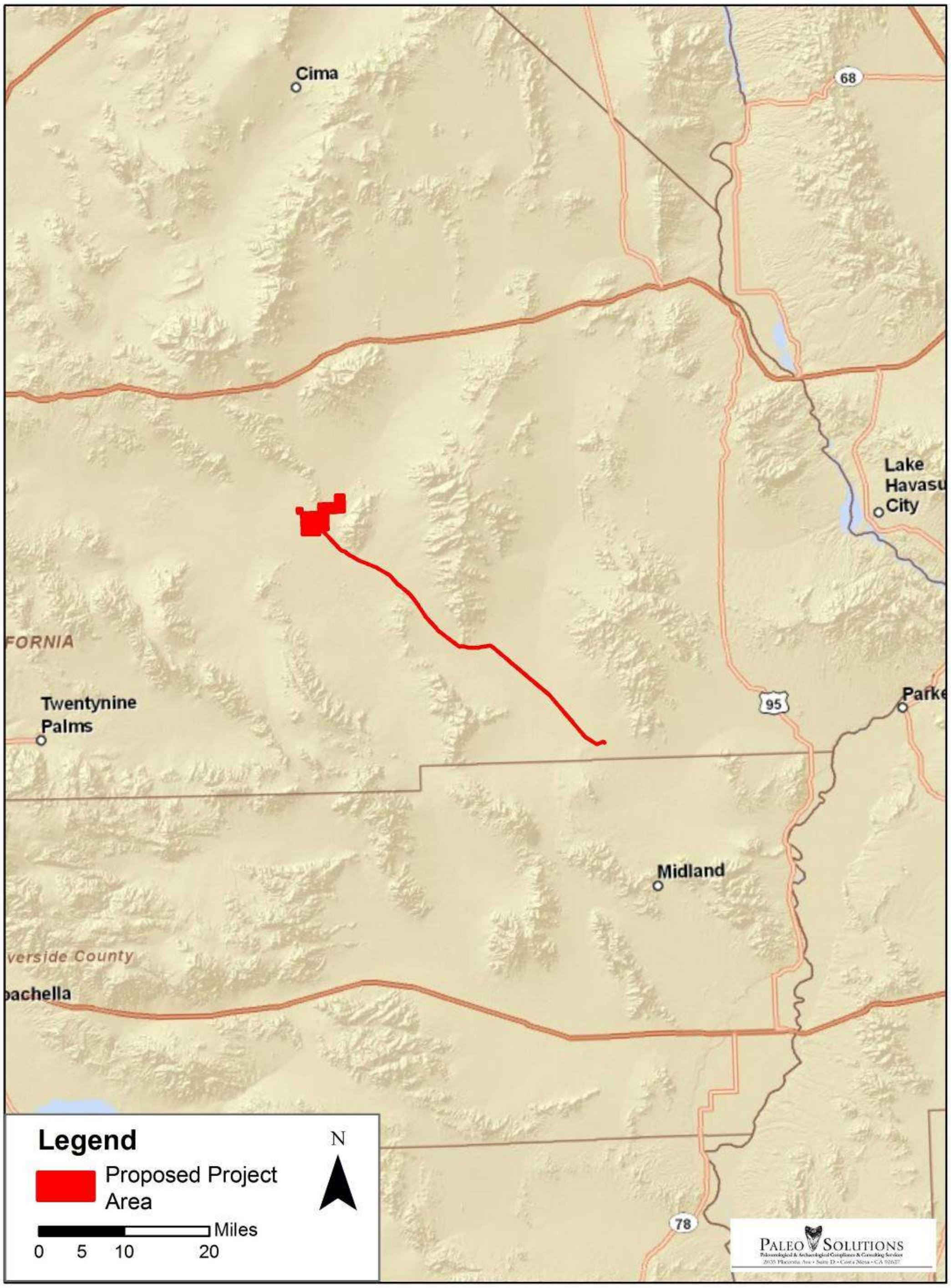

Figure 1. Location map of the proposed Project. The proposed pipeline alignment was surveyed for paleontological resources in 2010.

2.0 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 nonvertebrate 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.

3.0 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.

3.1 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 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.

3.2 GEOLOGY AND PALEONTOLOGY

This portion of the analysis applies to both the Phase I (Project Level) Facilities and 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 3.2.1).

The distribution of geologic units within the proposed Project area is shown in Figures 2-4. 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 5-7). Note that the sensitivity rankings on Figure 3 apply only to surface geologic units, and units with higher (or lower) sensitivity may be encountered at a shallow depth beneath the surface.

Table 1. Geologic units within the proposed Project area using the Potential Fossil Yield Classification System (see Section 2). 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	4* (high)
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			
Qy	Youngest alluvium	Holocene	2** (low)
Qya	Younger alluvium	Holocene	2** (low)
Qps	Playa deposit, silt and clay	Holocene	2** (low)
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	Recent/Holocene	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.

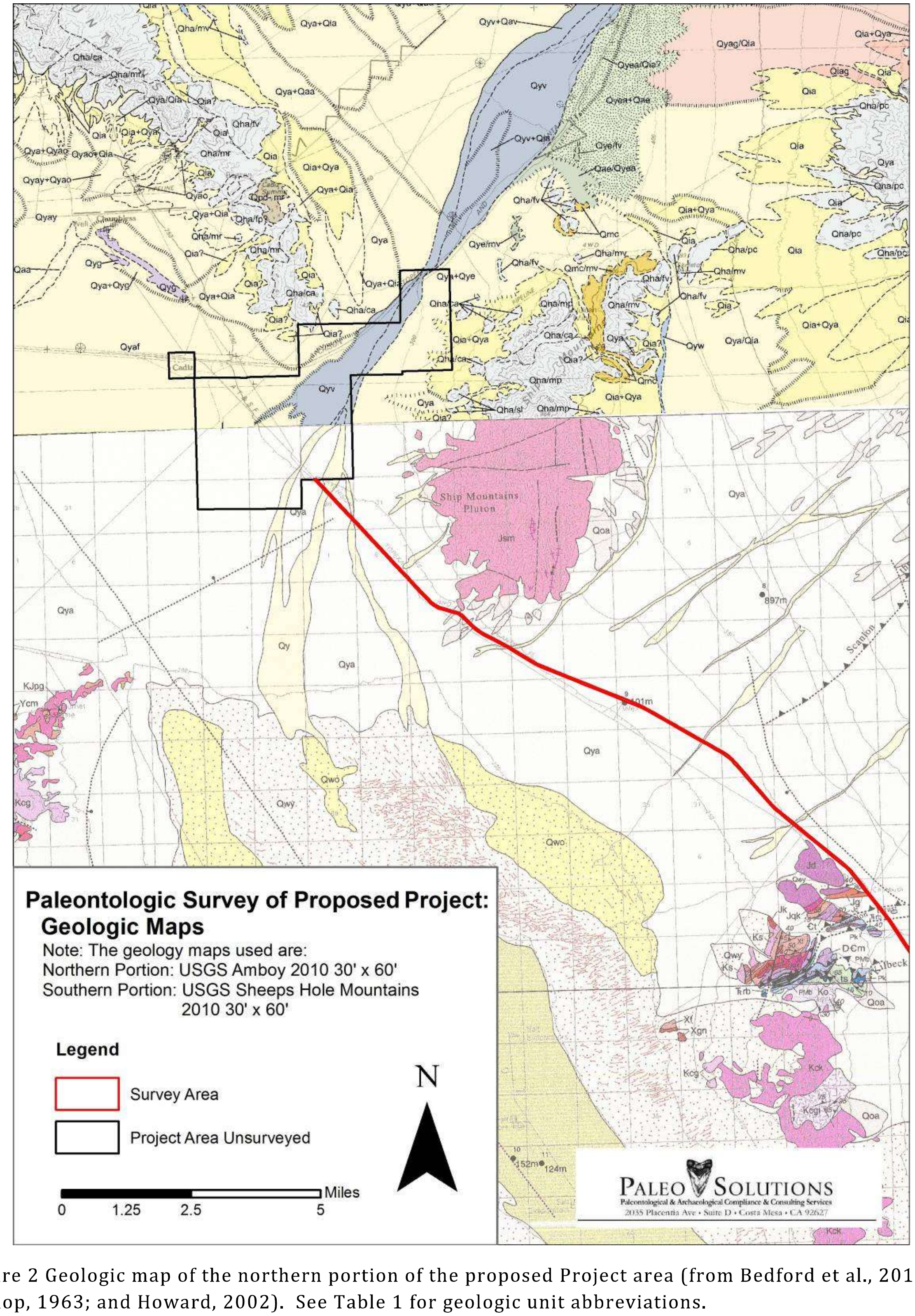

Figure 2 Geologic map of the northern portion of the proposed Project area (from Bedford et al., 2010; Bishop, 1963; and Howard, 2002). See Table 1 for geologic unit abbreviations.

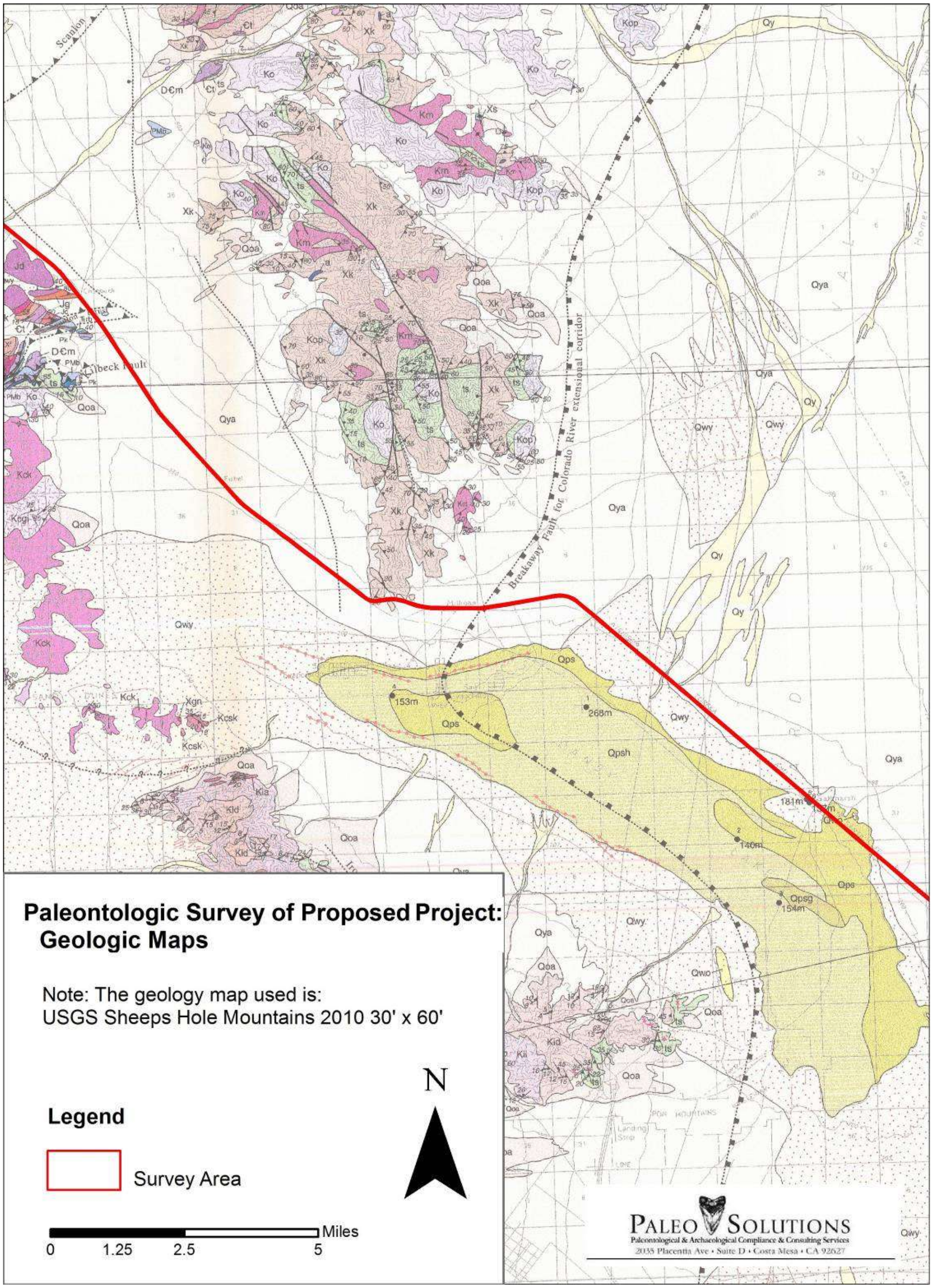

Figure 3. Geologic map of the middle portion of the proposed Project area (from Bedford et al., 2010; Bishop, 1963; and Howard, 2002). See Table 1 for geologic unit abbreviations.

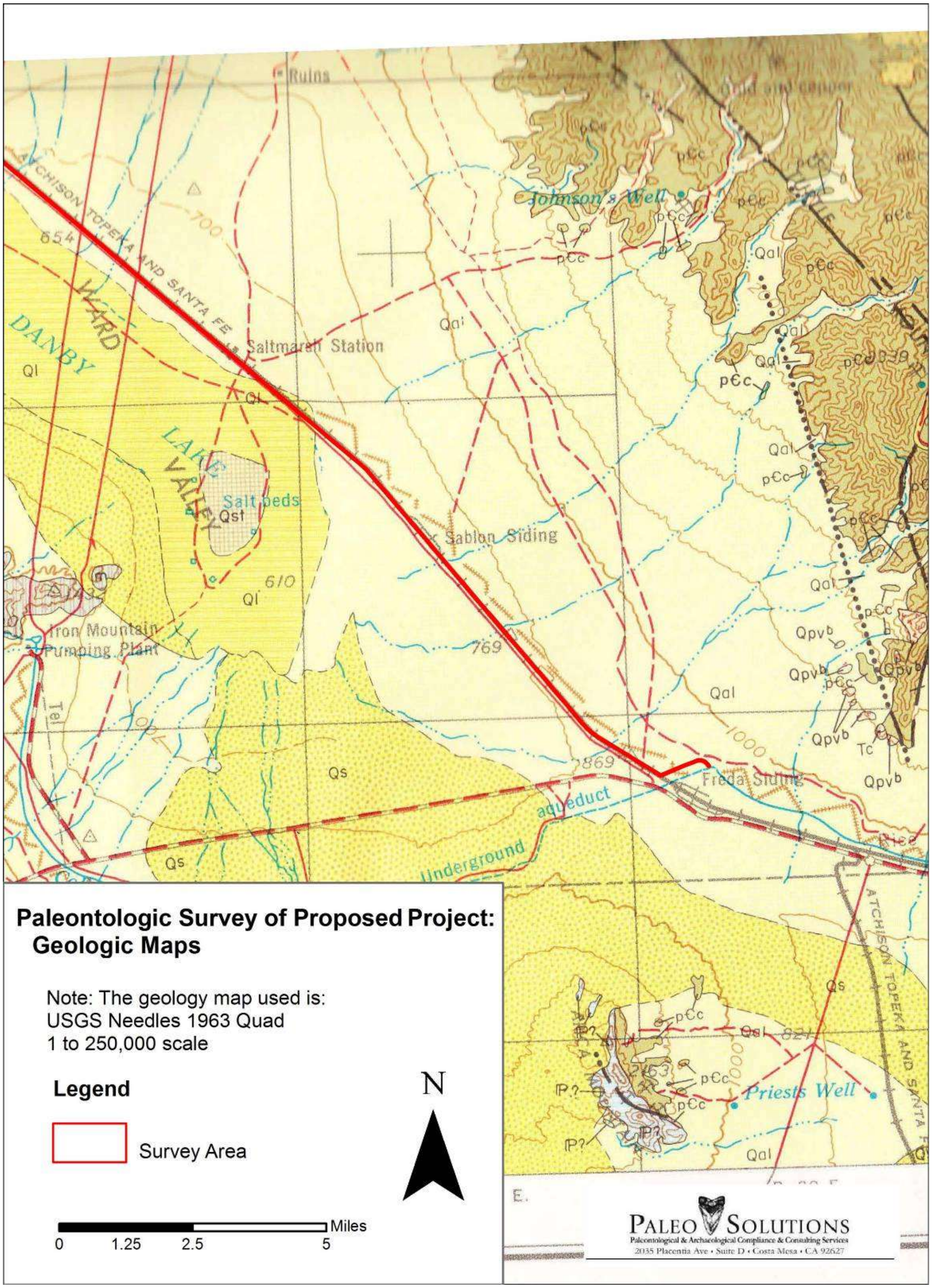

Figure 4. Geologic map of the southern portion of the proposed Project area (from Bedford et al., 2010; Bishop, 1963; and Howard, 2002). See Table 1 for geologic unit abbreviations.

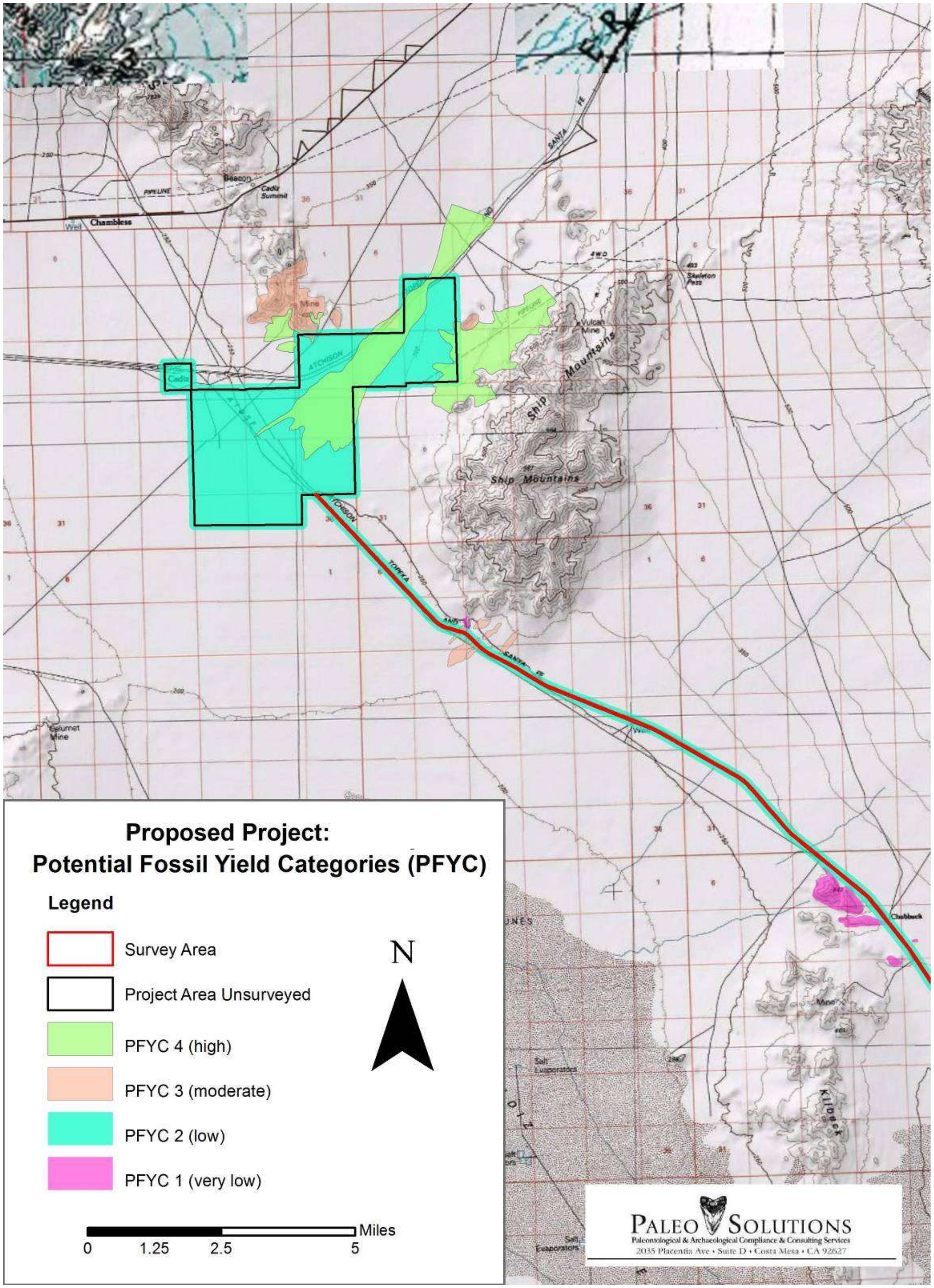

Figure 5. Paleontological sensitivity map of the northern portion of proposed Project area. Note that this sensitivity map and Table 1 applies only to surface geology, and not subsurface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1)

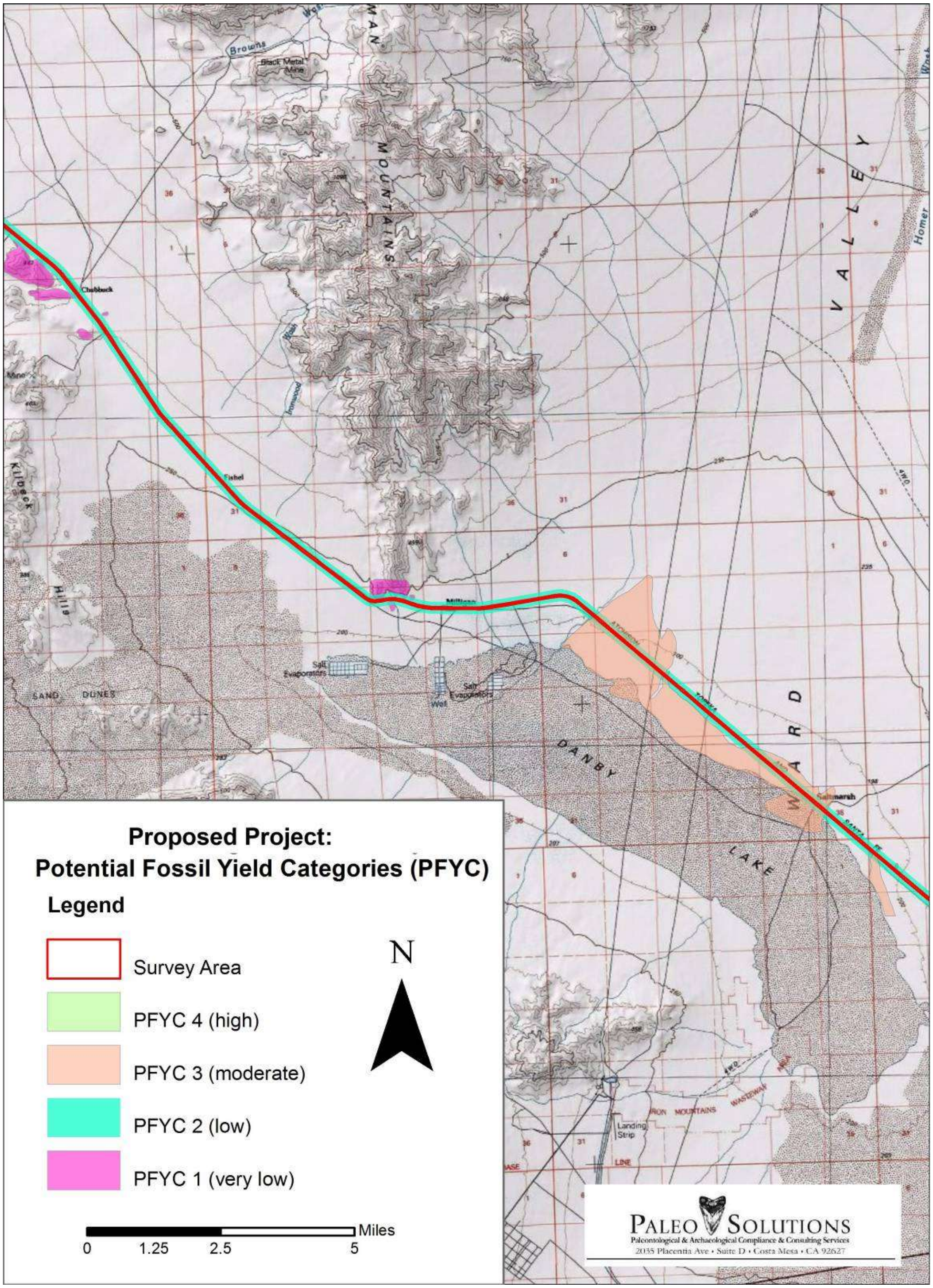

Figure 6. Paleontological sensitivity map of the middle portion of the proposed Project area. Note that this sensitivity map and Table 1 applies only to surface geology, and not subsurface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

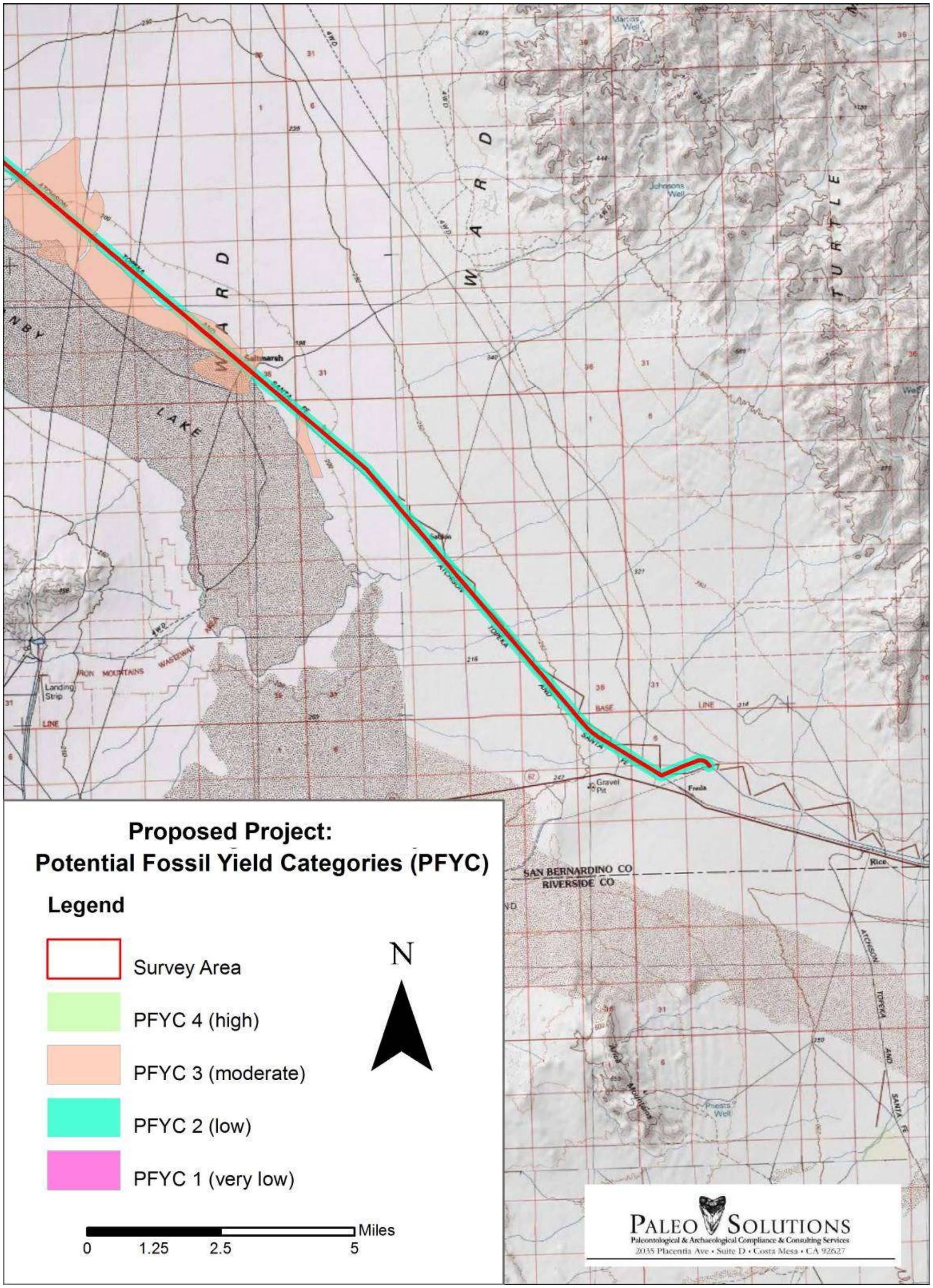

Figure 7. Paleontological sensitivity map of the southern portion of the proposed Project area. Note that this sensitivity map and Table 1 applies only to surface geology, and not subsurface geology. Subsurface deposits may have higher sensitivity in even shallow excavations (see Section 3.2.1).

3.2.1. 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 CRA, 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). 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).

4.0 FIELD SURVEY RESULTS

A paleontological field survey of the proposed pipeline alignment (Phase I, Project Level Facilities) was conducted on October 18 through October 26, 2010. No fossils were observed during the field survey. Detailed field survey notes, including observed geology and photographs of the substrate along the water pipeline route, are available upon request. Surveys were not conducted in the proposed wellfield or conceptual spreading basin areas (see Section 6.0) (Phase II, Programmatic Facilities).

5.0 RECOMMENDED MITIGATION MEASURES

Based on the field surveys of the proposed pipeline alignment and tie-in to the CRA, these Phase I (Project Level) Facilities are considered "cleared" for surface paleontological resources, and above ground staging and construction activities can proceed in these areas. However, ground-disturbing activities along the pipeline corridor that involve digging/disturbance of subsurface soils should be addressed as part of a paleontological mitigation plan, the basic parameters of which are outlined below.

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, should be re-surveyed prior to construction because in the time elapsed since 1999, it is likely that additional scientifically significant fossils have eroded onto the surface. However, surveys of the wellfield and spreading basin areas can be limited to individual disturbance areas, such as the area surrounding each well, pipeline corridors associated with the pipeline manifold system, associated access roads, and power distribution facilities, as determined in the final Project design plans. Previously surveyed areas that are not within the final Project footprint will not require additional survey, nor will areas within the final Project footprint in which no surface or subsurface disturbance will occur. A report should be prepared summarizing the results of the additional surveys, or the survey results can be integrated into the paleontological mitigation plan.

Proposed Mitigation – Phase I (Project Level) Facilities

No additional field surveys for the project level facilities evaluated herein are recommended. 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 1.1 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.

The results of the wellfield and spreading basin surveys, construction monitoring, and subsequent laboratory work, shall be compiled in a final paleontological mitigation report authored by the qualified paleontologist for the Project. The final report should include all Project data and a copy of the receipt of specimens from the paleontological repository.

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