Paleontological Technical Study

MURRIETA HOT SPRINGS ROAD IMPROVEMENTS PROJECT

City of Murrieta

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1.0 EXECUTIVE SUMMARY

This report presents the results of the paleontological technical study conducted by Paleo Solutions, Inc. (Paleo Solutions), under contract to HELIX Environmental Planning, Inc. (HELIX), in support of the Murrieta Hot Springs Road Improvements Project (Project) in the City of Murrieta, Riverside County, California. This work was required by the City of Murrieta to fulfill their responsibilities as the lead agency under the California Environmental Quality Act (CEQA).

The paleontological potential of the Project area was evaluated based on an analysis of existing paleontological data and a field survey. The three components of the analysis of existing data included a geologic map review, a literature search, and a museum records search at the Western Science Center (WSC) in Hemet, California. The analysis of existing data was supplemented with a pedestrian field survey. Geologic mapping by Kennedy and Morton (2003) indicates that the Project area is primarily underlain by Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit (QTsw); Pleistocene-age Pauba Formation, sandstone member (Qpfs); and Holocene- and latest Pleistocene-age young alluvial fan deposits (Qyfa). Within a half mile of the Project area, Cretaceous-age gabbro igneous rocks (Kgb), middle to early Pleistocene-age very old alluvial channel deposits (Qvoaa), and Holocene- to latest Pleistocene-age young alluvial channel deposits (Qyaa) are also present and may underlie the geologic units mapped at the surface within the Project area at shallow depth. While not mapped by Kennedy and Morton (2003) within the Project area or its half mile buffer, recent artificial fill (af) from previous development may be present within the bounds of the Project area. Thus, these units are also included in the analysis of existing data for this Project.

The field survey was unable to confirm the presence of the mapped geologic unit due to built environments, such as the paved road, sidewalk, powerlines, a shopping center, etc. However, the geologic units mapped by Kennedy and Morton (2003) are likely present at shallow depth within the bounds of the Project area. According to the records search, there are no previously recorded fossil localities within the Project area. However, the WSC reported several vertebrate localities in the Project vicinity from geologic units similar to those that underlie the Project area (Radford, 2018). Moreover, literature and database reviews identified numerous vertebrate fossils recovered from Pliocene- to Pleistocene-age deposits and the Pauba Formation, sandstone member elsewhere in Riverside County (Appendix A).

The Potential Fossil Yield Classification (PFYC) system was applied to the results of the analysis of existing data and field survey. Because gabbro is an intrusive igneous rock that forms deep below the surface under high heat and pressure, it has a very low potential to produce scientifically important paleontological resources (PFYC 1). Numerous vertebrate fossils have been recovered from sediments similar to the sandstone and conglomerate of the Wildomar area, sandstone unit; however, fossil occurrences are sporadic in these deposits. Thus, sandstone and conglomerate of the Wildomar area, sandstone unit have a moderate paleontological potential (PFYC 3). Because of its fine-grained lithology and potential to yield a scientifically significant and diverse fossil fauna, the Pauba Formation, sandstone member has a high paleontological potential (PFYC 4). Very old alluvial channel deposits are known to contain significant paleontological resources; however, channel deposits may be composed of coarse-grained sediments, which are not conducive to fossil preservation. Therefore, middle to early Pleistocene-age very old alluvial channel deposits are assigned a moderate paleontological potential (PFYC 3). Holocene-age deposits, such as the young alluvial fan deposits and young alluvial channel deposits, are considered to be too young to contain scientifically significant paleontological resources; thus, they have a low paleontological potential (PFYC 2). Lastly, unmapped recent artificial fill, which is likely present within the Project area, consists of previously disturbed sediments and any fossil found within these deposits will have lost their stratigraphic context; therefore, artificial fill also has a low paleontological potential (PFYC 2).

No fossil localities were recorded during the survey; however, sediments conducive to fossilization are likely present at shallow depth. Construction excavations that disturb Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit; Pleistocene-age Pauba Formation; and middle to early Pleistocene-age very old alluvial channel deposits should be monitored full-time by a professional paleontologist in order to reduce potential adverse impacts to scientifically important paleontological resources to a less than significant level. Additionally, artificial fill, young alluvial fan deposits, and young alluvial channel deposits should be initially spot-checked to determine if older, more paleontologically sensitive deposits are disturbed at depth; if older sedimentary geologic units are not disturbed by construction activities in these areas, then monitoring can be reduced or ceased at the discretion of a Qualified Paleontologist in consultation with the City of Murrieta. Lastly, gabbro deposits have very low potential for paleontological resources, and thus, do not require paleontological monitoring.

Prior to construction, a paleontological resource monitoring and mitigation plan (PRMMP) should be prepared. It should provide detailed recommended monitoring locations; a description of a worker training program; detailed procedures for monitoring, fossil recovery, laboratory analysis, and museum curation; and notification procedures in the event of a fossil discovery by a paleontological monitor or other project personnel. A curation agreement WSC, or another accredited repository, must also be obtained.

2.0 INTRODUCTION

This report presents the results of the paleontological technical study conducted by Paleo Solutions in support of the Murrieta Hot Springs Road Improvements Project (Project) in the City of Murrieta in Riverside County, California (Figure 1). All paleontological work was completed in compliance with CEQA, local regulations, and best practices in mitigation paleontology (Murphey et al., 2014).

2.1 PROJECT DESCRIPTION AND LOCATION

The Project area is situated along Murrieta Hot Springs Road in the City of Murrieta between its intersection with Margarita Road in the west and its intersection with Winchester Road (State Route [SR] 79) in the east, Riverside County, California. It encompasses approximately 60 acres of unsectioned land and is mapped on the United States Geologic Survey (USGS) Murrieta (1976) 7.5' Topographic Quadrangles (Figure 2, Table 1).

The Project consists of widening the existing four lane roadway to a full six lane arterial roadway with raised medians between Margarita Road to Winchester Road, as well as installing a new traffic signal at Calle Del Lago, traffic signal modifications at Margarita Road, and construction of retaining walls.

Geologic mapping by Kennedy and Morton (2003) indicates that the Project area is underlain by Pleistocene- and late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit (QTsw); Pleistocene-age Pauba Formation, sandstone member (Qpfs); and Holocene- and latest Pleistocene-age young alluvial fan deposits (Qyfa). Geologic units present within a half mile buffer of the Project area may also be impacted at depth by ground-disturbing activities. These units are therefore included in this analysis and consist of Cretaceous-age gabbro (Kgb), middle to early Pleistocene-age very old alluvial channel deposits (Qvoaa), and Holocene- to latest Pleistocene-age young alluvial channel deposits (Qyaa). Although not mapped by Kennedy and Morton (2003), recent artificial fill (af) may be present within the bounds of the Project area and is also included in this assessment.

Figure 1. Project overview map.

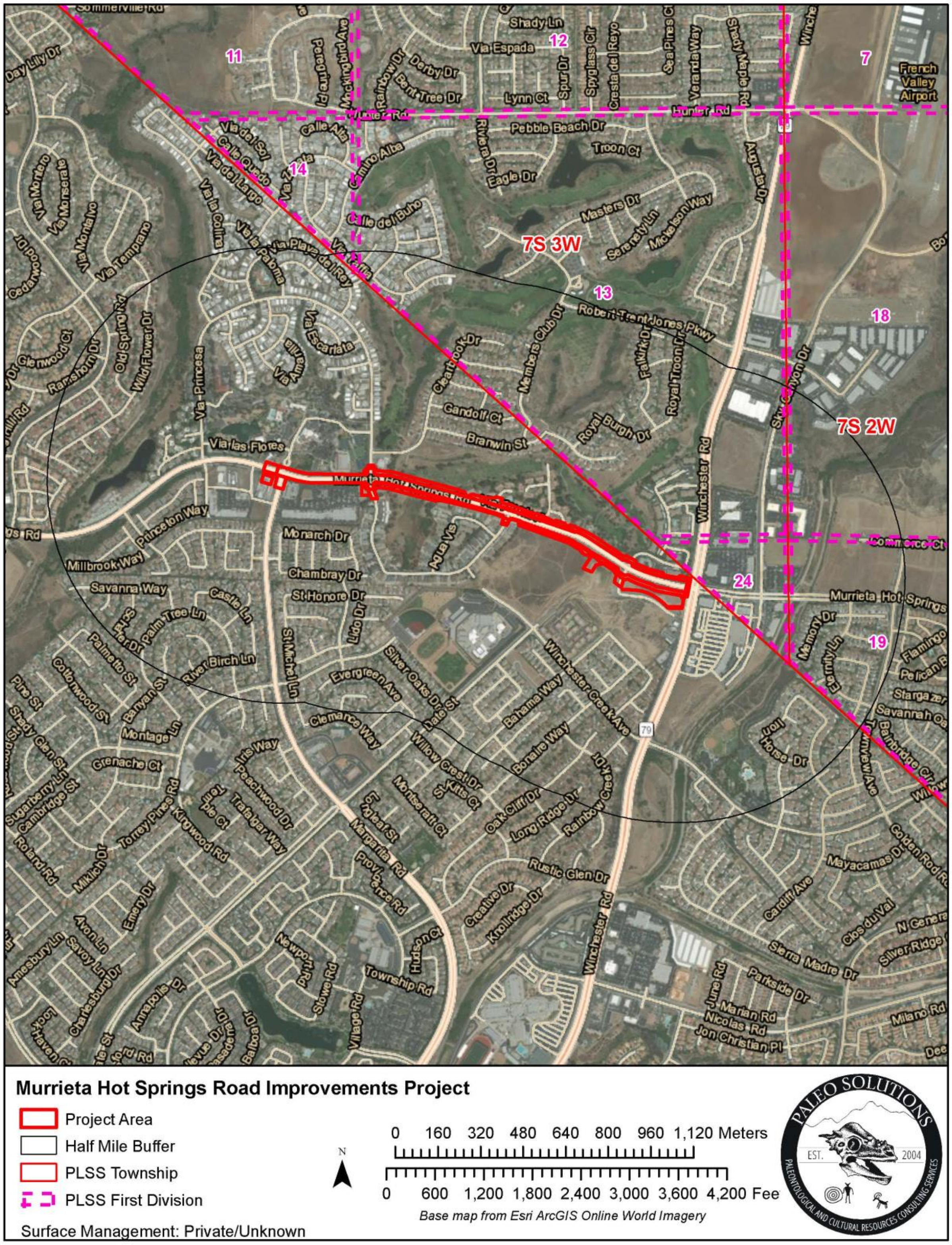

Figure 2. Project location map.

Table 1. Murrieta Hot Springs Road Improvements Project Summary

<table>
<tr><td>Project Name</td><td colspan="4">Murrieta Hot Springs Road Improvements Project</td></tr>
<tr><td>Project Description</td><td colspan="4">The Project consists of widening the existing four lane roadway to a full six lane arterial roadway with raised medians between Margarita Road to Winchester Road, as well as installing a new traffic signal at Calle Del Lago, traffic signal modifications at Margarita Road, and construction of retaining walls.</td></tr>
<tr><td>Project Area</td><td colspan="4">The Project area is situated along Murrieta Hot Springs Road in the City of Murrieta between its intersection with Margarita Road in the west and its intersection with Winchester Road (SR 79) in the east, Riverside County, California. It encompasses approximately 60 acres and is mapped on the USGS Murrieta (1976) 7.5’ Topographic Quadrangles.</td></tr>
<tr><td>Total Acres</td><td colspan="4">~60</td></tr>
<tr><td rowspan="2">Location (PLSS)</td><td>Quarter-Quarter</td><td>Section</td><td>Township</td><td>Range</td></tr>
<tr><td>N/A - Unsectioned</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="2">Land Owner</td><td>Surface Management Agency</td><td colspan="3">Miles</td></tr>
<tr><td>Undetermined</td><td colspan="3">~0.8</td></tr>
<tr><td>Topographic Map(s)</td><td colspan="4">Murrieta (1976) 7.5’ Topographic Quadrangles</td></tr>
<tr><td>Geologic Map(s)</td><td colspan="4">Kennedy, M.P., and Morton, D.M., 2003, Preliminary Geologic Map of the Murrieta 7.5’ Quadrangle, Riverside County, California: U.S. Geological Society, Open-File Report 03-189, scale 1:24,000.</td></tr>
<tr><td rowspan="8">Mapped Geologic Unit(s) and age(s)</td><td>Geologic Unit</td><td>Map Symbol</td><td>Age</td><td>Paleontological Potential (PFYC)</td></tr>
<tr><td>Unmapped artificial fill</td><td>af</td><td>Recent</td><td>2 (Low)</td></tr>
<tr><td>Young alluvial fan deposits</td><td>Qyfa</td><td>Holocene to latest Pleistocene</td><td>2 (Low)</td></tr>
<tr><td>Young alluvial channel deposits</td><td>Qyaa</td><td>Holocene to latest Pleistocene</td><td>2 (Low)</td></tr>
<tr><td>Very old alluvial channel deposits</td><td>Qvoaa</td><td>middle to early Pleistocene</td><td>3 (Moderate)</td></tr>
<tr><td>Pauba Formation, sandstone member</td><td>Qpfs</td><td>Pleistocene</td><td>4 (High)</td></tr>
<tr><td>Sandstone and conglomerate of the Wildomar area, sandstone unit</td><td>QTsw</td><td>Pleistocene and late Pliocene</td><td>3 (Moderate)</td></tr>
<tr><td>Gabbro</td><td>Kgb</td><td>Cretaceous</td><td>1 (Very Low)</td></tr>
<tr><td>Surveyor(s)</td><td colspan="4">Mathew Carson, M.S.</td></tr>
<tr><td>Date(s) Surveyed</td><td colspan="4">July 27, 2017</td></tr>
<tr><td>Formations Surveyed</td><td colspan="4">Pleistocene- and late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit (QTsw); Pleistocene-age Pauba Formation, sandstone member (Qpfs); and Holocene- and latest Pleistocene-age young alluvial fan deposits (Qyfa)</td></tr>
<tr><td>Previously Documented Fossil Localities within the Project area</td><td colspan="4">According to the WSC, there are no previously recorded fossil localities within the Project area. However, three fossil localities have been recorded from within one mile of the Project area. Two of these three localities are from a salvage collection, of which the scientific data and reports are missing. The third locality is associated with the Harveston II Collection, which yielded a single horse (Equus sp.) metacarpal (Radford, 2018).</td></tr>
<tr><td>Paleontological Results</td><td colspan="4">No paleontological resources were discovered during the survey. Therefore, no fossils were collected.</td></tr>
<tr><td>Disposition of Fossils</td><td colspan="4">Not applicable; no fossils observed or collected during survey.</td></tr>
</table>

Recommendation(s)	Construction excavations that disturb Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit; Pleistocene-age Pauba Formation; and middle to early Pleistocene-age very old alluvial channel deposits should be monitored full-time by a professional paleontologist in order to reduce potential adverse impacts to scientifically important paleontological resources to a less than significant level. Additionally, artificial fill, young alluvial fan deposits, and young alluvial channel deposits should be initially spot-checked to determine if older, more paleontologically sensitive deposits are disturbed at depth; if older sedimentary geologic units are not disturbed by construction activities in these areas, then monitoring can be reduced or ceased at the discretion of a Qualified Paleontologist in consultation with the City of Murrieta. Lastly, gabbro deposits have very low potential for paleontological resources, and thus, do not require paleontological monitoring. Prior to construction, a PRMMP should be prepared. It should provide detailed recommended monitoring locations; a description of a worker training program; detailed procedures for monitoring, fossil recovery, laboratory analysis, and museum curation; and notification procedures in the event of a fossil discovery by a paleontological monitor or other project personnel. A curation agreement WSC, or another accredited repository, must also be obtained.

3.0 DEFINITION AND SIGNIFICANCE OF PALEONTOLOGICAL RESOURCES

As defined by Murphey and Daitch (2007): "Paleontology is a multidisciplinary science that combines elements of geology, biology, chemistry, and physics in an effort to understand the history of life on earth. Paleontological resources, or fossils, are the remains, imprints, or traces of once-living organisms preserved in rocks and sediments. These include mineralized, partially mineralized, or unmineralized bones and teeth, soft tissues, shells, wood, leaf impressions, footprints, burrows, and microscopic remains. Paleontological resources include not only fossils themselves, but also the associated rocks or organic matter and the physical characteristics of the fossils' associated sedimentary matrix.

The fossil record is the only evidence that life on earth has existed for more than 3.6 billion years. Fossils are considered non-renewable resources because the organisms they represent no longer exist. Thus, once destroyed, a fossil can never be replaced. Fossils are important scientific and educational resources because they are used to:

- Study the phylogenetic relationships amongst extinct organisms, as well as their relationships to modern groups;
- Elucidate the taphonomic, behavioral, temporal, and diagenetic pathways responsible for fossil preservation, including the biases inherent in the fossil record;
- Reconstruct ancient environments, climate change, and paleoecological relationships;
- Provide a measure of relative geologic dating that forms the basis for biochronology and biostratigraphy, and which is an independent and corroborating line of evidence for isotopic dating;
- Study the geographic distribution of organisms and tectonic movements of land masses and ocean basins through time;
- Study patterns and processes of evolution, extinction, and speciation; and
- Identify past and potential future human-caused effects to global environments and climates."

Fossil resources vary widely in their relative abundance and distribution and not all are regarded as significant. According to Bureau of Land Management (BLM) Instructional Memorandum (IM) 2009-011, a "Significant Paleontological Resource" is defined as:

> "Any paleontological resource that is considered to be of scientific interest, including most vertebrate fossil remains and traces, and certain rare or unusual invertebrate and plant fossils. A significant paleontological resource is considered to be of scientific interest if it is a rare or previously unknown species, it is of high quality and well-preserved, it preserves a previously unknown anatomical or other characteristic, provides new information about the history of life on earth, or has an identified educational or recreational value. Paleontological resources that may be considered not to have scientific significance include those that lack provenience or context, lack physical integrity due to decay or natural erosion, or that are overly redundant or are otherwise not useful for research. Vertebrate fossil remains and traces include bone, scales, scutes, skin impressions, burrows, tracks, tail drag marks, vertebrate

coprolites (feces), gastroliths (stomach stones), or other physical evidence of past vertebrate life or activities" (BLM, 2008).

Vertebrate fossils, whether preserved remains or track ways, are classified as significant by most state and federal agencies and professional groups (and are specifically protected under the California Public Resources Code). In some cases, fossils of plants or invertebrate animals are also considered significant and can provide important information about ancient local environments.

The full significance of fossil specimens or fossil assemblages cannot be accurately predicted before they are collected, and in many cases, before they are prepared in the laboratory and compared with previously collected fossils. Pre-construction assessment of significance associated with an area or formation must be made based on previous finds, characteristics of the sediments, and other methods that can be used to determine paleoenvironmental and taphonomic conditions.

4.0 LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

This section of the report presents the regulatory requirements pertaining to paleontological resources that apply to this Project.

4.1 STATE REGULATORY SETTING

4.1.1 California Environmental Quality Act (CEQA)

The procedures, types of activities, persons, and public agencies required to comply with the CEQA are defined in the Guidelines for Implementation of CEQA (State CEQA Guidelines), as amended on March 18, 2010 (Title 14, Section 15000 et seq. of the California Code of Regulations) and further amended January 4th, 2013. One of the questions listed in the CEQA Environmental Checklist is: "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" (State CEQA Guidelines Section 15064.5 and Appendix G, Section V, Part C).

4.1.2 State of California Public Resources Code

The State of California Public Resources Code (Chapter 1.7), Sections 5097 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, and define the excavation, destruction, or removal of paleontological "sites" or "features" from public lands without the express permission of the jurisdictional agency as a misdemeanor. As used in Section 5097, "state lands" refers to lands owned by, or under the jurisdiction of, the state or any state agency. "Public lands" is defined as lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof.

4.2 LOCAL REGULATORY SETTING

4.2.1 Riverside County

The Riverside County General Plan requires consideration of paleontological resources under the Multipurpose Open Space Element of the general plan (County of Riverside, 2015). The Riverside County General Plan recommendations are based on the Society of Vertebrate Paleontology (SVP) Guidelines (SVP, 2010) for the mitigation of paleontological resources. The Multipurpose Open

Space Element of the general plan (County of Riverside, 2015) provides the following requirements for paleontological sensitive areas within the county:

- **OS 19.6** Whenever existing information indicates that a site proposed for development has high paleontological sensitivity as shown on Figure OS-8, a paleontological resource impact mitigation program (PRIMP) shall be filed with the County Geologist prior to site grading. The PRIMP shall specify the steps to be taken to mitigate impacts to paleontological resources.

- **OS 19.7** Whenever existing information indicates that a site proposed for development has low paleontological sensitivity as shown on Figure OS-8, no direct mitigation is required unless a fossil is encountered during site development. Should a fossil be encountered, the County Geologist shall be notified and a paleontologist shall be retained by the project proponent. The paleontologist shall document the extent and potential significance of the paleontological resources on the site and establish appropriate mitigation measures for further site development.

- **OS 19.8** Whenever existing information indicates that a site proposed for development has undetermined paleontological sensitivity as shown on Figure OS-8, a report shall be filed with the County Geologist documenting the extent and potential significance of the paleontological resources on site and identifying mitigation measures for the fossil and for impacts to significant paleontological resources prior to approval of that department.

- **OS 19.9** Whenever paleontological resources are found, the County Geologist shall direct them to a facility within Riverside County for their curation, including the Western Science Center in the City of Hemet.

4.2.2 City of Murrieta

The Conservation Element of the City of Murrieta General Plan 2035 (City of Murrieta, 2011) contains one goal and two policies regarding paleontological resources. Goal CSV-7 states that paleontological resources shall be conserved as a record of the region's natural history. Policies CSV 7.1 and 7.2 require that the City:

- Continue development review procedures that protect paleontological resources.

- Encourage local display and educational use of paleontological resources.

5.0 METHODS

This paleontological analysis of existing data included a geologic map review, a literature search, and museum records search. The analysis of existing data was supplemented with a pedestrian field survey. The goal of this report is to evaluate the paleontological potential of the Project area and make recommendations for the mitigation of adverse impacts on paleontological resources that may occur as a result of the proposed Project. Mathew Carson, M.S., performed the background research, created the GIS figures, conducted the field survey, and authored this report. Geraldine Aron, M.S., oversaw all aspects of the Project as the Paleontological Principal Investigator. Courtney Richards, M.S., performed the technical review of this report.

Paleo Solutions will retain an archival copy of all Project information including field notes, maps, and other data.

5.1 ANALYSIS OF EXISTING DATA

Paleo Solutions reviewed geologic mapping of the Project area Kennedy and Morton (2003). The literature reviewed included published and unpublished scientific papers. Paleontological museum records search results from the WSC were analyzed and incorporated into this paleontological investigation.

5.2 FIELD SURVEY

The field survey was conducted by Paleo Solutions' paleontologist Mathew Carson, M.S. The paleontological survey was conducted to check for any exposures of native, previously undisturbed rock or sediments of the underlying geologic units, and if present, assess the potential for fossils. The Project area and surrounding areas were documented and photographed, with photographed areas spatially referenced with a GPS unit.

5.3 CRITERIA FOR EVALUATING PALEONTOLOGICAL POTENTIAL

The PFYC system was developed by the BLM (BLM, 2016). Because of its demonstrated usefulness as a resource management tool, the PFYC has been utilized for many years for projects across the country, regardless of land ownership. It is a predictive resource management tool that classifies geologic units on their likelihood to contain paleontological resources on a scale of 1 (very low potential) to 5 (very high potential). This system is intended to aid in predicting, assessing, and mitigating paleontological resources. The PFYC ranking system is summarized in Table 2.

Table 2. Potential Fossil Yield Classification (BLM, 2016)

BLM PFYC Designation	Assignment Criteria Guidelines and Management Summary (PFYC System)
1 = Very Low Potential	Geologic units are not likely to contain recognizable paleontological resources.
	Units are igneous or metamorphic, excluding air-fall and reworked volcanic ash units.
	Units are Precambrian in age.
	Management concern is usually negligible, and impact mitigation is unnecessary except in rare or isolated circumstances.
2 = Low	Geologic units are not likely to contain paleontological resources.
	Field surveys have verified that significant paleontological resources are not present or are very rare.
	Units are generally younger than 10,000 years before present.
	Recent eolian deposits
	Sediments exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely
	Management concern is generally low, and impact mitigation is usually unnecessary except in occasional or isolated circumstances.
3 = Moderate Potential	Sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence.
	Marine in origin with sporadic known occurrences of paleontological resources.
	Paleontological resources may occur intermittently, but these occurrences are widely scattered
	The potential for authorized land use to impact a significant paleontological resource is known to be low-to-moderate.
	Management concerns are moderate. Management options could include record searches, pre-disturbance surveys, monitoring, mitigation, or avoidance. Opportunities may exist for hobby collecting. Surface-disturbing activities may require sufficient assessment to determine whether significant paleontological

BLM PFYC Designation	Assignment Criteria Guidelines and Management Summary (PFYC System)
	resources occur in the area of a proposed action and whether the action could affect the paleontological resources.
4 = High Potential	Geologic units that are known to contain a high occurrence of paleontological resources.
	Significant paleontological resources have been documented but may vary in occurrence and predictability.
	Surface-disturbing activities may adversely affect paleontological resources.
	Rare or uncommon fossils, including nonvertebrate (such as soft body preservation) or unusual plant fossils, may be present.
	Illegal collecting activities may impact some areas.
	Management concern is moderate to high depending on the proposed action. A field survey by a qualified paleontologist is often needed to assess local conditions. On-site monitoring or spot-checking may be necessary during land disturbing activities. Avoidance of known paleontological resources may be necessary.
5 = Very High Potential	Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources.
	Significant paleontological resources have been documented and occur consistently
	Paleontological resources are highly susceptible to adverse impacts from surface disturbing activities.
	Unit is frequently the focus of illegal collecting activities.
	Management concern is high to very high. A field survey by a qualified paleontologist is almost always needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designation of areas of avoidance, or special management designations should be considered.
U = Unknown	Geologic units that cannot receive an informed PFYC assignment
	Geological units may exhibit features or preservational conditions that suggest significant paleontological resources could be present, but little information about the actual paleontological resources of the unit or area is unknown.
	Geologic units represented on a map are based on lithologic character or basis of origin, but have not been studied in detail.
	Scientific literature does not exist or does not reveal the nature of paleontological resources.
	Reports of paleontological resources are anecdotal or have not been verified.
	Area or geologic unit is poorly or under-studied.
	BLM staff has not yet been able to assess the nature of the geologic unit.
	Until a provisional assignment is made, geologic units with unknown potential have medium to high management concerns. Field surveys are normally necessary, especially prior to authorizing a ground-disturbing activity.

6.0 ANALYSIS OF EXISTING DATA

The Project area is located within the northwestern portion of the Peninsular Ranges Geomorphic Province, a region characterized by northwest-trending fault-bounded mountain ranges, broad intervening valleys, and low-lying coastal plains (Yerkes et al., 1965). The Peninsular Ranges extend approximately 920 miles from the Los Angeles Basin to the southern tip of Baja California and vary in width from approximately 30 to 100 miles. Bedrock units within the Peninsular Ranges include pre-Cretaceous- and Cretaceous-age igneous rocks of the Southern California Batholith, Late Cretaceous-age sedimentary rocks, and post-Cretaceous-age sedimentary rocks or sediment (Yerkes et al., 1965; Norris and Webb, 1976). All post-Cretaceous-age rocks lie unconformably on either the Cretaceous-age sedimentary rocks or on basement (Norris and Webb, 1976). Pliocene-age nonmarine rocks and sediments and thick and widespread throughout the northern Peninsular

Ranges, and Quaternary deposits include fluvial and lacustrine sediments within the inland interior of the province (Norris and Webb, 1976).

The Project area is located along a broad alluvial valley immediately adjacent to and east of the Elsinore fault zone complex, which is bound by the Willard Fault in the west and the Wildomar Fault in the east (Kennedy and Morton, 2003). The Murrieta Hot Springs Fault, which is a major splay of the Wildomar Fault, strikes east and is located immediately north of and subparallel to the Project area (Kennedy and Morton, 2003). Branching of this fault zone complex caused the development of valleys between the Willard Fault and Murrieta Hot Springs Fault, which have been filled dissected Pleistocene-age sedimentary units along their peripheries and Holocene- to latest Pleistocene-age sedimentary units within their axial regions (Kennedy and Morton, 2003).

6.1 LITERATURE SEARCH

Geologic mapping indicates that the Project is primarily underlain by the Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit (QTsw) and Pleistocene-age Pauba Formation, sandstone member (Qpfs); with minor amounts of Holocene- and latest Pleistocene-age young alluvial fan deposits (Qyfa) (Figure 3). Within a half mile of the Project area, Cretaceous-age gabbro igneous rocks (Kgb), middle to early Pleistocene-age very old alluvial channel deposits (Qvoaa), and Holocene- to latest Pleistocene-age young alluvial channel deposits (Qyaa) are also present and may underlie the geologic units mapped at the surface within the Project area at shallow depth (Figure 3). Thus, these units are also included in the analysis of existing data for this Project.

6.1.1 Gabbro – Cretaceous (Kgb)

On the north side of the Murrieta Hot Springs Fault (and, therefore, north of the Project area), Cretaceous-age gabbro of the Peninsular Ranges batholith is mapped by Kennedy and Morton (2003) (Figure 3). This unit consists of brown, medium to very coarse-grained hornblende gabbro, which is classified as an intrusive igneous rock. Igneous rocks are crystalline or non-crystalline rocks that form through the cooling and subsequent solidification of magma or lava. Intrusive (plutonic) igneous rocks form below the earth's surface. Magma and lava are formed by the melting of pre-existing plutonic rocks in the earth's crust or mantle due to increases in temperature, changes in pressure, or changes in geochemical composition. Extreme temperatures in the environments in which intrusive igneous rocks form prevent the preservation of fossils. Therefore, gabbro has a very low potential to produce scientifically important paleontological resources (PFYC 1).

6.1.2 Sandstone and conglomerate of the Wildomar area, sandstone unit – Pleistocene and late Pliocene (QTsw)

Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit was mapped by Kennedy and Morton (2003) as immediately underlying the Project area (Figure 3). This informal geologic unit consists of a sequence of Pleistocene-age to late Pliocene-age sandstone, pebbly sandstone, and conglomerate located within the Wildomar area (Morton and Miller, 2006) that is estimated to be up to 75 meters (246 feet) thick (Kennedy and Morton, 2003). Only the sandstone portion of the unit (QTsw) is mapped at the surface of the Project area or its half mile buffer; however, there is potential for the conglomerate to be encountered at depth. The sandstone is pale yellowish-green, medium grained, friable, and caliche-rich. The conglomerate is composed of locally derived cobble and boulder clasts.

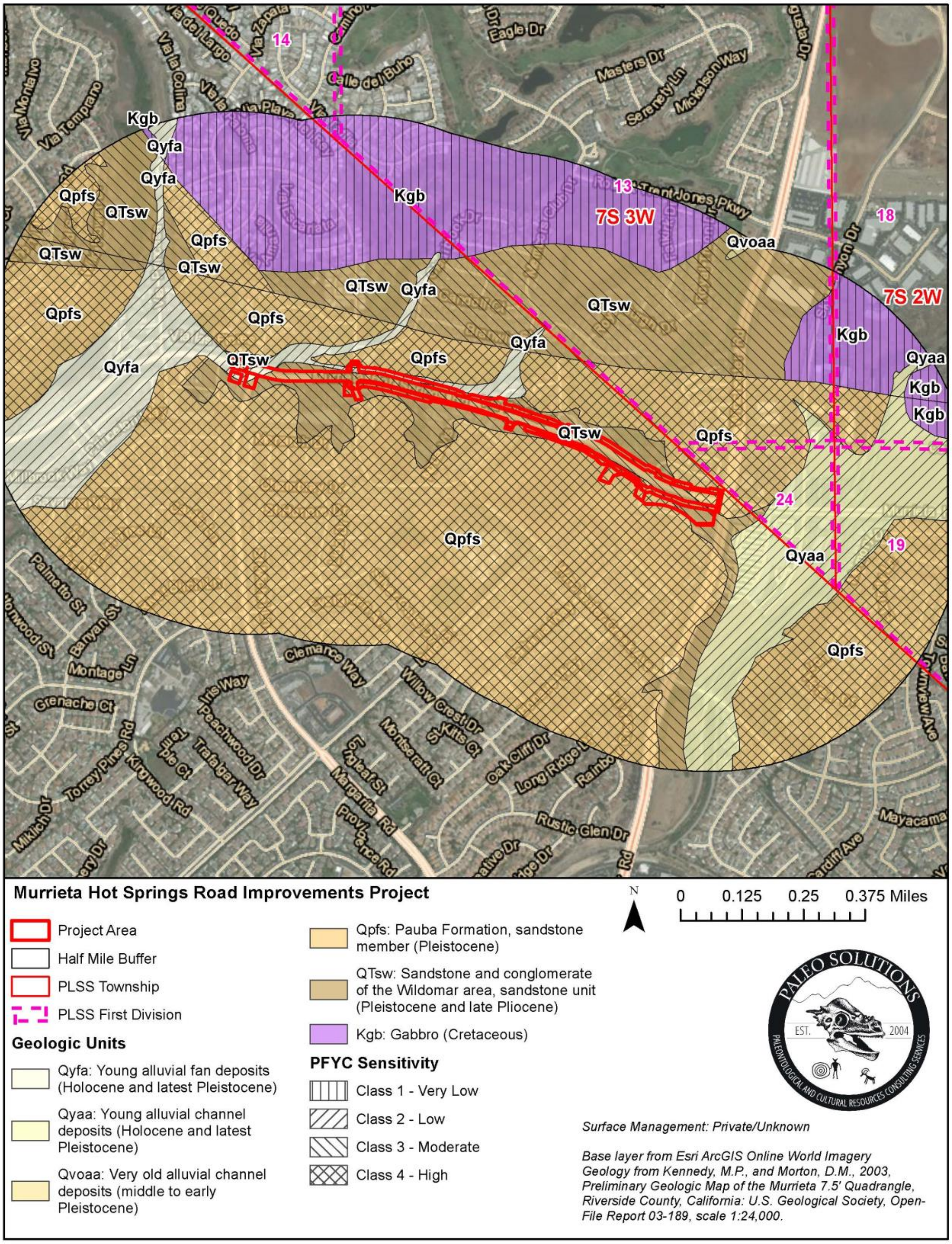

Figure 3. Project geology map.

A Blancan to Irvingtonian age fossil vertebrate fauna has been reported from the lower portion of this unnamed sequence (Kennedy and Morton, 2003; Morton and Miller, 2006). Numerous vertebrate and invertebrate fossils have been recovered from Pliocene- to Pleistocene-age geologic units of equivalent lithology and age throughout Riverside County. Although the University of California Museum of Paleontology (UCMP) does not contain records for unnamed geologic units, the online Paleobiology Database (PBDB) contains several records of fossil localities from unnamed sandstone units within Riverside County. According to the PBDB, these fossil localities have yielded pronghorn (Antilocapridae, *Antilocapra* sp., *Tetrameryx* sp.), deer (Cervidae, *Odocoileus* sp.), tapir (*Tapirus californicus*), peccary (*Platygonus bicalcaratus*), camel (Camelidae, *Hemiauchenia* sp.), horse (*Equus* sp., *Equus scotti*), mammoth (*Mammuthus* sp.), mastodon (*Mammut* sp.), ground sloth (*Megalonyx* sp., *Paramylodon* sp., *Paramylodon harlani*), wolf (Canidae, *Canis* sp.), coyote (*Canis latrans*), fox (*Vulpes* sp., *Vulpes velox*), cat (Felidae), short-faced bear (*Arctodus simus*), rabbit (Archaeolaginae, Leporidae, *Hypolagus* sp., *Lepus* sp., *Sylvilagus* sp.), mustelids (*Mustela* sp., *Mephitis* sp., *Taxidea* sp.), bat (Microchoptera), shrew (Soricidae, *Sorex* sp.), rodent (Arvicolinae, Cricetidae, Perognathinae, Sciuridae, *Dipodomys* sp., *Erethizon* sp., *Geomys* sp., *Microtus* sp., *Microtus californicus*, *Microtus meadensis*, *Myodes* sp., *Neotamias* sp., *Neotoma* sp., *Ondatra* sp., *Onychomys torridus*, *Ophiomys parvus*, *Peromyscus* sp., *Prodipodomys* sp., *Reithrodontomys* sp., *Sigmodon* sp., *Sigmodon minor*, *Spermophilus* sp., *Spermophilus beecheyi*, *Thomomys* sp., *Thomomys bottae*, *Thomomys gidleyi*), mole (*Scapanus* sp.), bird (Aves), snake (Colubridae, Natricinae, *Crotalus* sp.), lizard (Anguidae, Iguanidae, Lacertilia, *Anniella* sp., *Eumeces* sp., *Gerrhonotus* sp., *Phrynosoma* sp., *Sceloporus* sp., *Uta stansburiana*), tortoise (*Geochelone* sp.), turtle (Emydinae, Testudines), salamander (Plethodontinae), frog (*Anura* sp., *Hyla* sp.), toad (*Bufo* sp.), and fish (*Gasterosteus aculeatus*), as well as invertebrates, such as gastropods (*Succinea* sp.) (PBDB, 2018). Pliocene- to Pleistocene-age fossils have the potential to yield significant vertebrate fossils from fine-grained sediments; however, these fossils are sporadic throughout this geologic unit. Therefore, the sandstone and conglomerate of the Wildomar area, sandstone unit is considered to have moderate paleontological potential (PFYC 3).

6.1.3 Pauba Formation, Sandstone Member - Pleistocene (Qpfs)

The Pauba Formation, sandstone member (Figure 3) was named in 1955 for exposures in the Rancho Pauba area approximately two miles southeast of Temecula (Kennedy and Morton, 2003; Morton and Miller, 2006). The Pauba Formation, sandstone member is mapped along the northern and southern boundary and is likely present at unknown depth below younger Holocene-age deposits (e.g., young alluvial fan deposits; see next section) (Figure 3). It is composed of brown to grayish-brown, moderate to well indurated siltstones, sandstones, and conglomerates. It has been divided into two informal members: a sandstone member and a fanglomerate member; however, only the sandstone member is mapped underlying the Project area and its half-mile buffer.

The Pauba Formation, sandstone member contains an extensive variety of late Irvingtonian and early Rancholabrean fossils that are primarily mammals (Kennedy and Morton, 2003; Morton and Miller, 2006; Pajak, et al., 1996). The UCMP (2018) online database does not contain records for the Pauba Formation; however, the PBDB (2018) does contain numerous records of fossil localities from the Pauba Formation of Riverside County. These fossil localities have yielded pronghorn (Antilocapridae, *Capromeryx* sp.), deer (*Odocoileus* sp.), sheep (*Ovis canadensis*), camel (*Camelops* sp., *Camelops hesternus*, *Hemiauchenia* sp., *Hemiauchenia macrocephala*), tapir (*Tapirus californicus*), horse (*Equus* sp., *Equus scotti*), mammoth (*Mammuthus* sp., *Mammuthus columbi*), mastodon (*Mammut americanum*), ground sloth (*Paramylodon* sp., *Paramylodon harlani*), saber-toothed cat (*Smilodon fatalis*), coyote (*Canis latrans*), bat (Chiroptera), rabbit (Leporidae, *Lepus* sp., *Sylvilagus* sp.), mustelid (*Mustela* sp.), shrew (*Sorex* sp.), rodent (Cricetidae, *Dipodomys* sp., *Microtus* sp., *Microtus californicus*, *Neotoma* sp., Perognathinae, *Peromyscus* sp., Sciuridae, *Thomomys* sp., *Thomomys bottae*), and mole (*Scapanus* sp.) (PBDB, 2018). Because of its fine-grained lithology and potential to yield a scientifically significant and diverse fossil fauna, the Pauba Formation, sandstone member has a high paleontological potential (PFYC 4).

6.1.4 Very Old Alluvial Channel Deposits – middle to early Pleistocene (Qvoaa)

Middle to early Pleistocene-age unnamed very old alluvial channel deposits are mapped within a half mile buffer of the Project area to the north-northwest (Kennedy and Morton, 2003) (Figure 3). These deposits consist of moderately to well-indurated, reddish-brown, mostly dissected gravel, sand, silt, and clay-bearing alluvium derived from fluvial sedimentation on canyon floors (Kennedy and Morton, 2003). Within the vicinity of the Project area, these sediments are arenaceous, consisting of very coarse-grained sand through very fine-grained sand. According to Kennedy and Morton (2003), these deposits can consist of thin, discontinuous alluvial deposits of Holocene-age in some areas.

The UCMP (2018) online database does not contain records for the older alluvial channel deposits; however, it does have several fossil records from Pleistocene-age (Irvingtonian to Rancholabrean) sediments and geologic units of comparable lithology and age. The UCMP contains records of horse (*Equus bautistensis*, *Hipparionini* sp.), deer (*Odocoileus* sp.), tapir (*Tapirus merriami*), pronghorn (*Capromeryx* sp., *Antilocapra* sp.), mammoth (*Mammuthus* sp.), ground sloth (*Megalonyx* sp.), rabbit (*Lepus* sp.), rodent (*Microtus* sp., *M. californicus*, *Neotoma* sp., *Thomomys gidleyi*, *Perognathus* sp., *Peromyscus hagermanensis*, *P. complexus*, *Mimomys* sp., *Sigmodon minor*), and tortoise (*Gopherus* sp., *G. agassizii*), as well as fossil invertebrates and plants (UCMP, 2018). The PBDB contains fossil records comparable to those listed for the sandstone and conglomerate of the Wildomar area, sandstone unit and Pauba Formation (PBDB, 2018). Some Pleistocene-age alluvial deposits are composed of coarse-grained material, which is not typically conducive to the preservation of fossils. For example, coarse-grained surficial Quaternary deposits derived from the local plutonic igneous rocks have a low probability to contain fossils; however, older, finer grained alluvial sediments may contain significant paleontological resources. Therefore, middle to early Pleistocene-age very old alluvial channel deposits are assigned a moderate paleontological potential (PFYC 3).

6.1.5 Young Alluvial Channel and Fan Deposits – Holocene and latest Pleistocene (Qyaa and Qyfa)

Holocene to latest Pleistocene deposits typically consist of variable compositions of unconsolidated clay, silt, sand, gravel, and larger clasts. Within the bounds of the Project area, Holocene-age young alluvial fan deposits are mapped within the bounds of the Project area, predominantly to the west and immediately adjacent to the Project area along its northern boundary (Figure 3). Young alluvial fan deposits consist of unconsolidated deposits composed of gravel, sand, and silt of alluvial fans and headward drainages of fans (Kennedy and Morton, 2003). On the eastern side of Winchester Road immediately outside the Project area, Holocene- to latest Pleistocene-age young alluvial channel deposits are mapped by Kennedy and Morton (2003), and consist of unconsolidated sand, silt, and clay-bearing alluvium, derived from fluvial sediment deposition along canyon floors.

Holocene-age (less than 11,000 years old) sediments are typically too young to contain fossilized material (SVP, 2010), but they may overlie sensitive older (e.g., Pleistocene- and Pliocene-age) deposits at variable depth. These deposits (Qyaa and Qyfa) are assigned low paleontological potential (PFYC 2) at the surface using BLM (2016) guidelines. However, they have an unknown paleontological potential in the subsurface since there is potential for these deposits to be conformably underlain by older, paleontologically sensitive geologic units.

6.1.6 Unmapped Artificial Fill – Recent (af)

Although Kennedy and Morton (2003), do not map fill within the bounds of the Project area or its immediately vicinity, recent artificial fill (af) may be present within the bounds of the Project area, particularly underlying built structures or areas, such as underlying the asphalt in the right of way (ROW). These sediments consist of previously disturbed, reworked sediments and any fossils recovered from artificial fill have lost their stratigraphic or scientific significance. Therefore, artificial fill has a low paleontological potential (PFYC 2).

6.2 PALEONTOLOGICAL RECORD SEARCH RESULTS

According to the WSC, there are no previously recorded fossil localities within the Project area. However, three fossil localities have been recorded from within one mile of the Project area. Two of these three localities are from a salvage collection, of which the scientific data and reports are missing. The third locality is associated with the Harveston II Collection, which yielded a single horse (*Equus* sp.) metacarpal (Radford, 2018).

7.0 FIELD SURVEY

Paleo Solutions' paleontologist, Mathew Carson, M.S., surveyed the Project area on Friday, July 27, 2018. The survey consisted of a pedestrian reconnaissance of the Project area, safely inspecting the road side and overall ROW for exposures of the geologic units mapped by Kennedy and Morton (2003). The Project area is located within the ROW of Murrieta Hot Springs Road and its road intersections between Margarita Road to the west and Winchester Road to the east. The Project area consists of a paved road and curb, which have low topographic relief to flat (Figure 4). However, immediately north and south of the Project area, moderately steep hills and slopes comprise the local topography (Figure 5). The Project area has been previously disturbed by built environments, including the four-lane, paved asphalt ROW making up Murrieta Hot Springs Road (Figure 4), cement curbs and sidewalks (Figure 4), earthen and concrete drainage channels along either side of the road (Figure 6), powerline poles, artificial slopes along the northern and southern boundary along residential areas, the Margarita Shopping complex and associated parking lot near Margarita Road, the Calvary Bible College campus (Figure 7), a golf course, and other shopping areas near Winchester Road. Non-built areas consist of lightly vegetated hills with well-developed soil (Figures 5 and 6).

No discernible native sediment or rock exposures were present within the Project area to investigate the potential for paleontological resources. Surficial sediments exposed along the southern curbside of Murrieta Hot Springs Road (an area mapped as Pauba Formation, sandstone member) consisted of buff- to tan-colored, winnowed fine-grained sand and silt, with buff-colored very coarse-grained sand and pebbles of igneous origin, possibly from the neighboring plutonic rocks, such as the Cretaceous-age gabbro (Kgb) (Figure 8).

No paleontological resources were observed or collected during the paleontological survey.

Figure 4. View of the Project area along Murrieta Hot Springs Road, showing pavement, sidewalks, powerline poles, and other built structures. View northeast.

Figure 5. Moderately steep rolling hills immediately adjacent to the Project area on the southern side of Murrieta Hot Springs Road. View south.

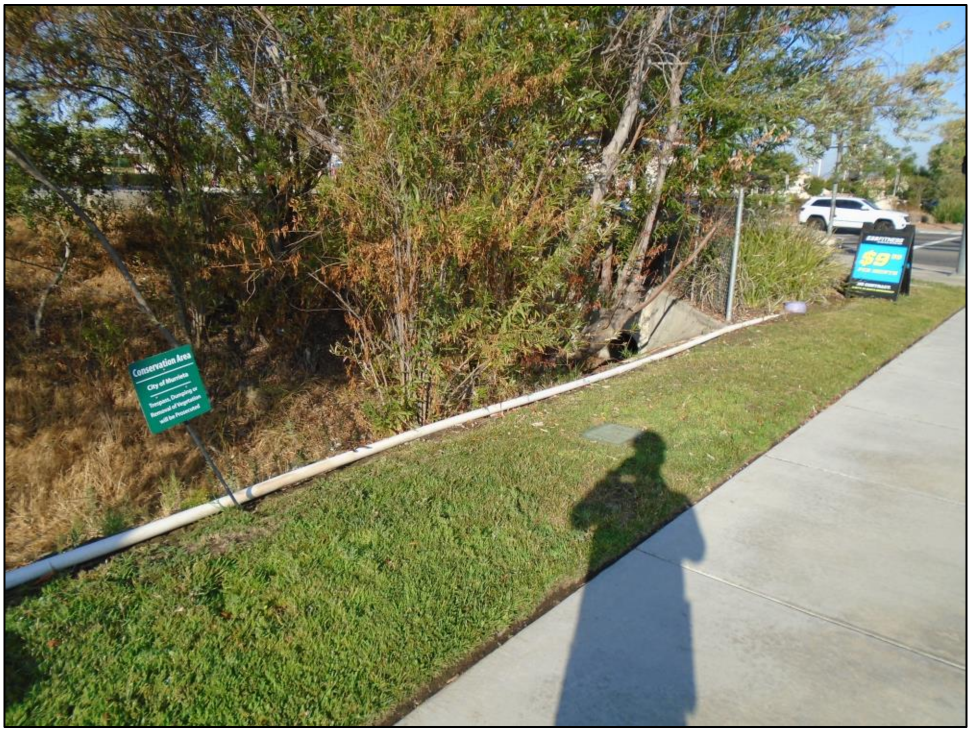

Figure 6. Earthen ditch, covered by vegetation and terminating under Margarita Road in a cement culvert. View southwest.

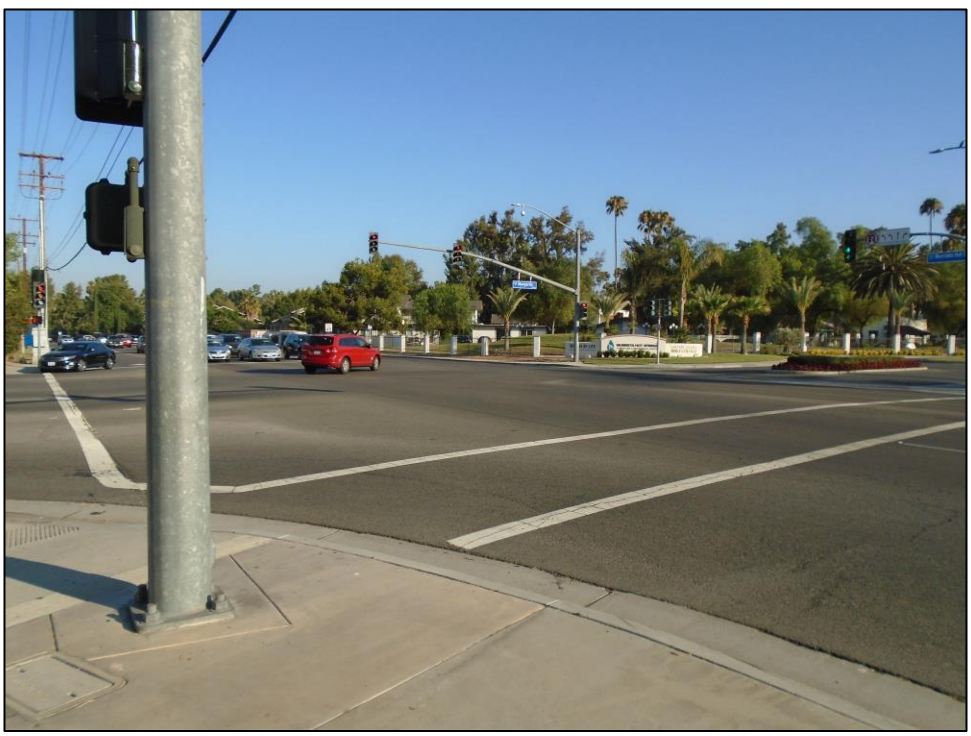

Figure 7. View of the Project area, showing the adjacent Calvary Bible College campus, located at the intersection of Margarita Road and Murrieta Hot Springs Road. View southeast.

Figure 8. Southern curbside along Murrieta Hot Springs Road ROW showing surficial sediments, possibly belonging to the Pauba Formation, sandstone member, consisting of buff- to tan-colored, winnowed fine-grained sand and silt, with buff-colored very coarse-grained sand and pebbles of igneous origin. View northeast.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Construction excavations that disturb Pleistocene- to late Pliocene-age sandstone and conglomerate of the Wildomar area, sandstone unit; Pleistocene-age Pauba Formation; and middle to early Pleistocene-age very old alluvial channel deposits should be monitored full-time by a professional paleontologist in order to reduce potential adverse impacts to scientifically important paleontological resources to a less than significant level. Additionally, artificial fill, young alluvial fan deposits, and young alluvial channel deposits should be initially spot-checked to determine if older, more paleontologically sensitive deposits are disturbed at depth; if older sedimentary geologic units are not disturbed by construction activities in these areas, then monitoring can be reduced or ceased at the discretion of a Qualified Paleontologist in consultation with the City of Murrieta. Lastly, gabbro deposits have very low potential for paleontological resources, and thus, do not require paleontological monitoring.

Prior to construction, a PRMMP should be prepared. It should provide detailed recommended monitoring locations; a description of a worker training program; detailed procedures for monitoring, fossil recovery, laboratory analysis, and museum curation; and notification procedures in the event of a fossil discovery by a paleontological monitor or other project personnel. A curation agreement WSC, or another accredited repository, must also be obtained.

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APPENDIX A. MUSEUM RECORDS SEARCH RESULTS

WESTERN SCIENCE CENTER

PaleoSolutions
Barbara Webster, MS
911 S. Primrose Ave., Unit N
Monrovia, CA 91016

July 5, 201

Dear Ms. Webster,

This letter presents the results of a record search conducted for the Murrieta Hot Springs Roac Improvement Project in the city of Murrieta, Riverside County, California. The project site is located along Murrieta Hot Springs Road between Margarita Road and Winchester Road/ California State Route 79.

The geologic units underlying this project are mapped primarily as sandstone deposits dating from the Pleistocene period, with some small areas of young alluvial channel deposits from th late Pleistocene to Holocene period (Kennedy & Morton, 1993). Pleistocene sandstone and alluvial units are considered to be of high paleontological sensitivity. The Western Science Center does not have localities within the project area, but has three fossil localities within a o mile radius that resulted in large Pleistocene mammal fossil specimens. Two of the three localities within the one mile radius are from a salvage collection that is missing the associate scientific data and reports. The third locality with the one mile radius of the project area is associated with the Harveston II Collection.

The Harveston II Collection was excavated in 2003 and produced over twenty localities and fi Pleistocene fossil specimens, including mammoth, bison, horse and rodent material, in simila mapped units to the Murrieta Hot Springs Road Improvement Project area. The Harveston II locality that falls within the one mile radius of the project area consisted of single Equus sp. metacarpal.

Any fossils recovered from the Murrieta Hot Springs Road Improvement Project area would b scientifically significant. Excavation activity associated with development of the project area would impact the paleontologically sensitive Pleistocene units and it is the recommendation o the Western Science Center that a paleontological resource mitigation program be put in place monitor, salvage, and curate any recovered fossils associated with the current study area.

If you have any questions, or would like further information about the Harveston II Project, please feel free to contact me at dradford@westerncentermuseum.org

Sincerely,

Darla Radford
Collections Manager

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