

APPENDIX D – PALEONTOLOGICAL RESOURCES REPORT





**Peters Canyon Regional Park
Orange County, California**

Paleontological Resources Report

Prepared for:

Michael Baker International
14725 Alton Parkway
Irvine, CA 92618-2027

Prepared by:

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July 2016

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1.0 INTRODUCTION

Rincon Consultants, Inc. (Rincon) was retained by Michael Baker International to prepare a paleontological resources report for the Peters Canyon Regional Park Resource Management Plan (RMP) located in Orange County, California (Figure 1). This report will provide information to contribute to the park's Resources Management Plan and has been conducted in accordance with the California Environmental Quality Act (CEQA). The goals of the report were to identify the geologic units that may be impacted by future recreational development within the park, determine the paleontological sensitivity of geologic units within the park, assess potential for impacts to paleontological resources within the park, and recommend mitigation measures to avoid or mitigate impacts to scientifically significant paleontological resources should further recreational development occur within the park. As such, this paleontological resource report consists of a fossil locality record search, review of existing geologic maps, a review of primary literature regarding fossiliferous geologic units within the proposed project vicinity and region, and a museum paleontological records search.

This report provides information for documentation under CEQA and conforms to the accepted professional standards for the protection of paleontological resources as outlined by the Society of Vertebrate Paleontology (SVP 2010) for a paleontological resources report. Recommendations are also given to address or reduce adverse construction-related impacts to paleontological resources within the park.

1.1 PROJECT DESCRIPTION

Peters Canyon Regional Park is an approximately 342.48-acre¹ park located at 8548 E. Canyon View Avenue in Orange, California (T4S, R9W, S31; T5S, R9W, S36; T5S, R8W, S6; T5S, R9W, S1). This paleontological resources report has been completed in support of a Resources Management Plan for the park. The plan will examine the physical, natural and cultural conditions of the park and its surrounding areas and provide a master plan that addresses current and future park programming needs, including parking, trail access, regional connectivity, and long-term management plans for ecological and hydrological sustainability within the park. Currently no specific projects are proposed under the Resources Management Plan. In general, any new project development or operation and maintenance (O&M) activity that involves ground disturbance may result in direct impacts to paleontological resources. For the purposes of this analysis, Rincon has evaluated the paleontological sensitivity of the Peters Canyon Regional Park plan area, and provided an impacts assessment and recommended mitigation measures for any activity that may be conducted under the Resource Management Plan, and which could result in ground disturbing activity.

1.2 REGULATORY SETTING

¹ Note: The GIS boundary source originated from OC Parks and was adjusted to match County of Orange GIS Parcel Boundaries. Due to potential inaccuracies of the County GIS data, there is an acreage discrepancy of 1.39 acres more than shown on the figures.

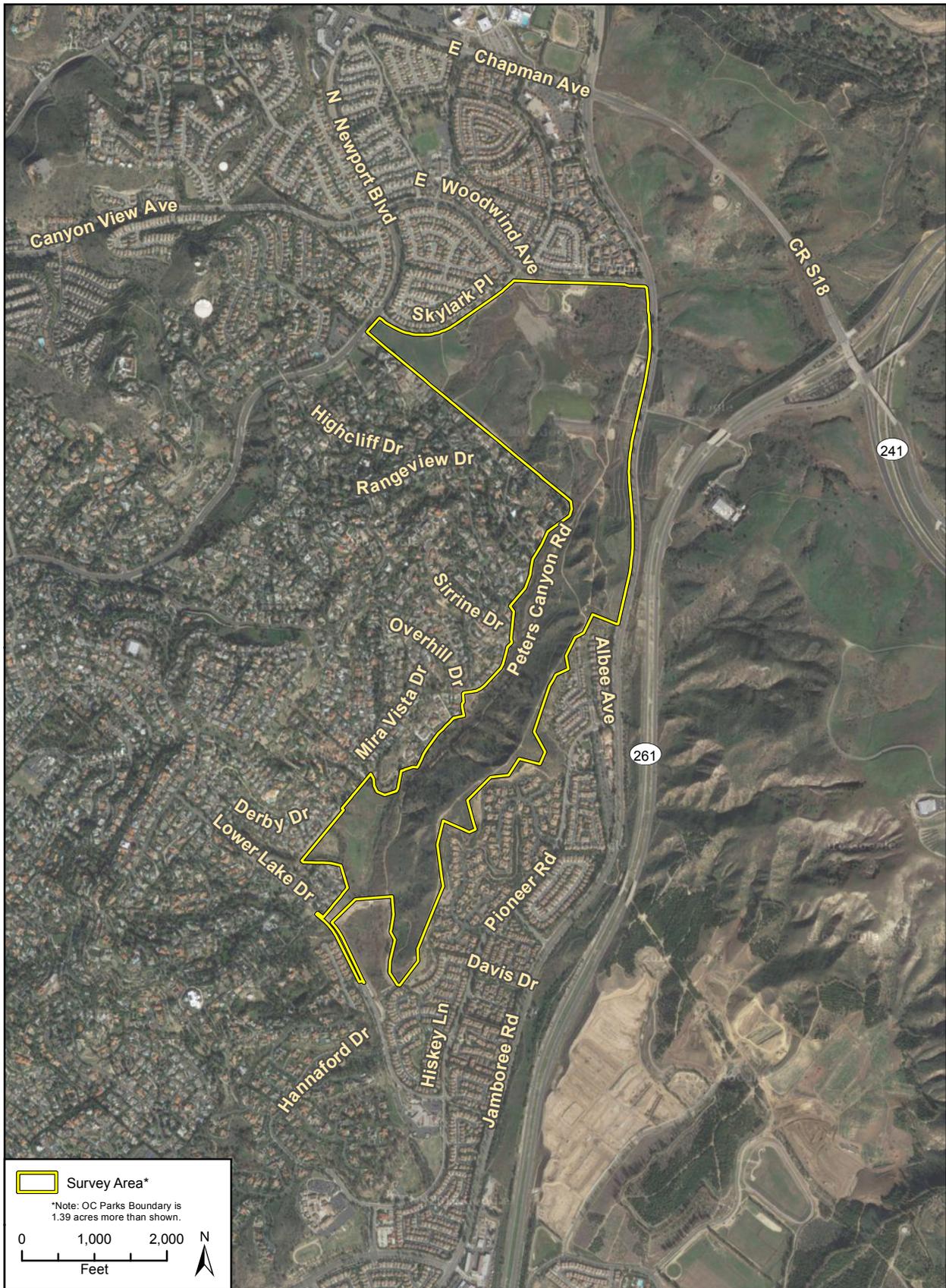


CEQA requires a lead agency determine whether a project may have a significant effect on paleontological resources. Chapter 1, Section 21002 states:

It is the policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects, and that the procedures required are intended to assist public agencies in systematically identifying both the significant effects of proposed projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects.

The CEQA Guidelines (Article 1, Section 15002(a)(3)) state that CEQA is intended to prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible. If paleontological resources are identified during the Preliminary Environmental Analysis Report, or other initial project scoping studies (e.g., Preliminary Environmental Study), as being within the proposed project area, the sponsoring agency must take those resources into consideration when evaluating project effects. The level of consideration may vary with the importance of the resource.





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Site Map

Figure 1

2.0 METHODS

2.1 LITERATURE REVIEW

Rincon conducted a review of geologic maps of the park and vicinity (Campbell et al. 2009; Lucas et al. 1997; Morton et al. 2004; Morton and Miller 2006; Prothero and Donohoo 2001; Schoellhamer et al. 1981) to identify and characterize the geology of the park and region. Rincon then conducted a literature search and review for the geology within the park, and the paleontology of the Santa Ana Mountains region to provide background data on the geologic and paleontological resources that may be present within the park.

A formal paleontological records search was conducted at the Natural History Museum of Los Angeles County (LACM). Additional records searches were conducted using the online collections databases maintained by the University of California Museum of Paleontology (UCMP), NEOMAP (UC Berkeley), and the Paleobiology Database. Records search details from the LACM are provided in Appendix A.

Rincon also conducted a literature search of peer-reviewed scientific journals and other publications. Initial searches of fossil collections and published scientific literature was restricted to Orange County and formations known to occur within the project site and vicinity. Collections and literature searches included all fossil types (vertebrate, invertebrate, plant, microfossils, and trace), but focused primarily on vertebrates. Literature and online collections search results are presented in Table 1 in Section 3.4 below.

2.2 PALEONTOLOGICAL SENSITIVITY

2.2.1 Fossil Resources and Professional Standards for Establishing Paleontological Sensitivity

Paleontological resources (fossils) are the remains or traces of once-living organisms. These include actual bones, shells or other organic remnants, impressions, casts, molds, mineral replacement of organisms, and indirect evidence such as tracks, trails and burrows. Fossils can range in size from microscopic (e.g., radiolarians and foraminiferans) to very large specimens (e.g., large mammal or reptile bones). Fossil remains are the only physical record of the presence of extinct organisms. As such, fossils are important evidence of the evolutionary history of both modern and extinct lineages. Fossils are also important for determining the relative ages of geologic strata and can provide unique, independent data for the correlation of sedimentary units on local and regional scales. In addition, fossils help us understand past climatic regimes and forecast potential future climate changes within human and geologic time scales.

The ability to establish provenience and depositional context for a fossil, including location and original stratigraphic placement, especially influence the significance of paleontological resources. A secondary factor necessary for fossil preservation is rock type. Sedimentary rocks have the greatest potential to preserve biological tissue. Extrusive igneous and metamorphic rocks can potentially contain paleontological resources, but processes common to the formation of those rock types (i.e., excessive heat and compression) usually obliterate any fossil resources



they may have once contained. Therefore, it is relatively uncommon to find fossils, especially vertebrate skeletal elements, in igneous and metamorphic rocks.

Only qualified, trained paleontologists with specific expertise in the type of fossils being evaluated can determine the exact scientific significance of paleontological resources. However, any qualified paleontologist can evaluate the potential significance of fossil specimens. The Society for Vertebrate Paleontology (SVP) broadly defines significant paleontological resources as follows (SVP 2010, page 11):

“Fossils and fossiliferous deposits consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years).”

Fossils represent direct evidence of life and environments from throughout earth’s history. As such fossils represent a source of data for scientists to conduct research on a wide variety of subjects that fall under the broad umbrella of “evolutionary pattern and process” including: biochronology, paleobiogeography, paleophylogeography, taphonomy, paleoecology, taxonomy, systematics, and cladistics. Studies in these various lines of research have the potential to inform inferences about evolutionary relationships, speciation and extinction, morphological change, adaptation, and species’ response to climate change. Because fossils represent the only direct evidence for life of the past, and because they can provide the foundational data for such a broad range of research, most identifiable fossils, and many unidentifiable fossils can, and should, be considered significant.

Significant paleontological resources are determined to be fossils or assemblages of fossils that are unique, unusual, rare, uncommon, diagnostically important, or are common but have the potential to provide valuable scientific information for evaluating evolutionary patterns and processes, or which could improve our understanding of paleochronology, paleoecology, paleophylogeography or depositional histories. New or unique specimens can provide new insights into evolutionary history; however, additional specimens of even well represented lineages can be equally important for studying evolutionary pattern and process, evolutionary rates and paleophylogeography. Even unidentifiable material can provide useful data for dating geologic units if radiocarbon dating is possible. As such, common fossils (especially vertebrates) may be scientifically important, and therefore considered highly significant. Therefore, fossils are considered to be significant if one or more of the following criteria apply:

1. The fossils have potential to provide information on the evolutionary relationships among organisms, living or extinct.
2. The fossils have potential to provide data useful in determining the age(s) of the rock unit or sedimentary stratum.
3. The fossils have potential to provide data useful in determining the depositional history of the region and the timing of geologic events therein.
4. The fossils have the potential to provide data regarding the paleoecology, paleobiogeography and/or paleophylogeography of a region.



5. The fossils represent unusual or unique circumstances in life history.
6. The fossils represent occurrences from a previously unknown strata or locality.

Thus, significant fossils can include remains of aquatic and terrestrial vertebrates, invertebrates and plants, or traces of plants and animals, whether common or uncommon. Assemblages of fossils that might otherwise be considered non-significant (e.g., very common invertebrates) but which could provide new evidence for stratigraphic correlation, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, and paleoclimatology are also scientifically important.

2.3 CATEGORIES OF PALEONTOLOGICAL SENSITIVITY

The SVP (2010) describes sedimentary rock units as having high, low, undetermined, or no potential for containing significant nonrenewable paleontological resources. This criterion is based on rock units within which vertebrate or significant invertebrate fossils have been determined by previous studies to be present or likely to be present. Significant paleontological resources are fossils or assemblages of fossils, which are unique, unusual, rare, uncommon, diagnostically or stratigraphically important, and those which add to an existing body of knowledge in specific areas, stratigraphically, taxonomically, or regionally (Reynolds 1990). While these standards were specifically written to protect vertebrate paleontological resources, all fields of paleontology have adopted these guidelines. Rincon has evaluated the paleontological sensitivity of the proposed project site according to the following SVP (2010) categories:

- I. **High Potential (sensitivity)** - Rock units from which significant vertebrate or significant invertebrate fossils or significant suites of plant fossils have been recovered are considered to have a high potential for containing significant non-renewable fossiliferous resources. These units include but are not limited to, sedimentary formations and some volcanic formations which contain significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Sensitivity comprises both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, or botanical and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, ecologic, or stratigraphic data. Areas which contain potentially datable organic remains older than Recent, including deposits associated with nests or middens, and areas which may contain new vertebrate deposits, traces, or trackways are also classified as significant.
- II. **Low Potential (sensitivity)** - Sedimentary rock units that are potentially fossiliferous, but have not yielded fossils in the past or contain common and/or widespread invertebrate fossils of well documented and understood taphonomic, phylogenetic species and habitat ecology. Reports in the paleontological literature or field surveys by a qualified vertebrate paleontologist may allow determination that some areas or units have low potentials for



yielding significant fossils prior to the start of construction. Generally, these units will be poorly represented by specimens in institutional collections and will not require protection or salvage operations. However, as excavation for construction gets underway it is possible that significant and unanticipated paleontological resources might be encountered and require a change of classification from Low to High Potential and, thus, require monitoring and mitigation if the resources are found to be significant.

- III. Undetermined Potential (sensitivity)** - Specific areas underlain by sedimentary rock units for which little information is available are considered to have undetermined fossiliferous potentials. Field surveys by a qualified vertebrate paleontologist to specifically determine the potentials of the rock units are required before programs of impact mitigation for such areas may be developed.
- IV. No Potential** - Rock units of metamorphic or igneous origin are commonly classified as having no potential for containing significant paleontological resources.



3.0 RESULTS

3.1 REGIONAL GEOLOGY

Peters Canyon Regional Park is located immediately southwest of, and at the foot of the Santa Ana Mountains, in the Peninsular Ranges geomorphic province (CGS 2002; Morton and Miller 2006). The Santa Ana Mountains block is one of several fault-bounded packages of rock defined by internally uniform characteristics (Morton and Miller 2006). The Santa Ana Mountains block is bounded by the Whittier and Elsinore fault zones to the east and the Pacific coast to the west. This broad area encompasses most of Orange County, but also includes parts of Los Angeles, Riverside, and San Diego counties.

Peters Canyon Regional Park lies in the transition area between the western flank of the Santa Ana Mountains (a relatively young range that only emerged within the last 4 million years) and the more quiescent flat-lying area of the Los Angeles Basin (Grant 2007). Local tectonism is currently uplifting the entire park and thrusting it southwestward, accommodated by the El Modena thrust fault located at the southern end of the park (Grant 2007). However, most sedimentary rocks within the park were deposited prior to the uplift of the Santa Ana Mountains that was initiated in the Pliocene (Morton and Miller 2006).

During the Eocene, the project area and broader region (i.e. the area that would eventually become the Los Angeles Basin) was at the interface of the ocean and the continent, resulting in sedimentary sequences of interbedded marine and terrestrial units. From the Eocene to the Miocene, alternating deposition of marine and terrestrial sediments occurred as the oceanic shoreline went through natural cycles of retreat and advance over a broad area (Morton and Miller 2006). The regionally important Vaqueros and Sespe formations accumulated during this time. During the middle Miocene, tectonic dynamics initiated the Los Angeles Basin proper and sediments began filling this topographic low, still connected to the ocean as a regional embayment, from terrestrial rivers (e.g., the Topanga Group, Morton and Miller 2006). Terrestrial rivers are still actively depositing sediments in the greater Los Angeles Basin today as uplift of the Santa Ana Mountains continues at a rate of approximately 1.5 feet every 1,000 years (Grant 2007).

3.2 PROJECT SITE GEOLOGY

The park contains five mapped geologic units including Quaternary landslides (Qls), Quaternary young fanglomerate (Qy_{f_{sa}}), Quaternary very old fanglomerate (Qvof_a), undivided Topanga Group (Tt), and undifferentiated Vaqueros and Sespe formations (Tvs) (Morton and Miller 2006). These units are each described in more detail below.

Quaternary landslide (Qls)

Relatively recent landslide features (Holocene and Pleistocene-age movement) in the Santa Ana Mountains are common, particularly in the Sespe and Vaqueros formations. These units consist mainly of unconsolidated silt, sandstone, and conglomerate at dip angles exceeding 20 degrees (Morton and Miller 2006). Only a few small landslide deposits are mapped within the park boundaries.



Quaternary young fanglomerate (Qyf_{sa})

Holocene and late Pleistocene-age fanglomerates (subscript 'sa' stands for 'surficial alluvium') occur within the topographically lowest parts of the park, especially along East Ridge View Trail, which traverses from the south end of the reservoir to the south end of the park (Figure 2). These sediments comprise unconsolidated to moderately consolidated silt, sand, pebbly cobbly sand, and boulder alluvial-fan deposits. Young fanglomerates are light tan to brown in color and are slightly to moderately dissected (Morton and Miller 2006). Within the park, these sediments have primarily accumulated within Peters Canyon proper and the flat-lying southern end (Figure 2).

Quaternary very old fanglomerate (Qvof_a)

Early to middle Pleistocene-age fanglomerates (subscript 'a' stands for 'alluvium') underlie the park north of the reservoir (Figure 2). These deposits comprise moderately to well consolidated silt, sand, gravel, and conglomerate. These deposits range in color from orangish brown to reddish in color and tend to be moderately to well dissected (Morton and Miller 2006). Pleistocene fanglomerates within the park accumulated in fault-controlled basins and outwash plains on the western flanks of the uplifting Santa Ana Mountains (Morton and Miller 2006).

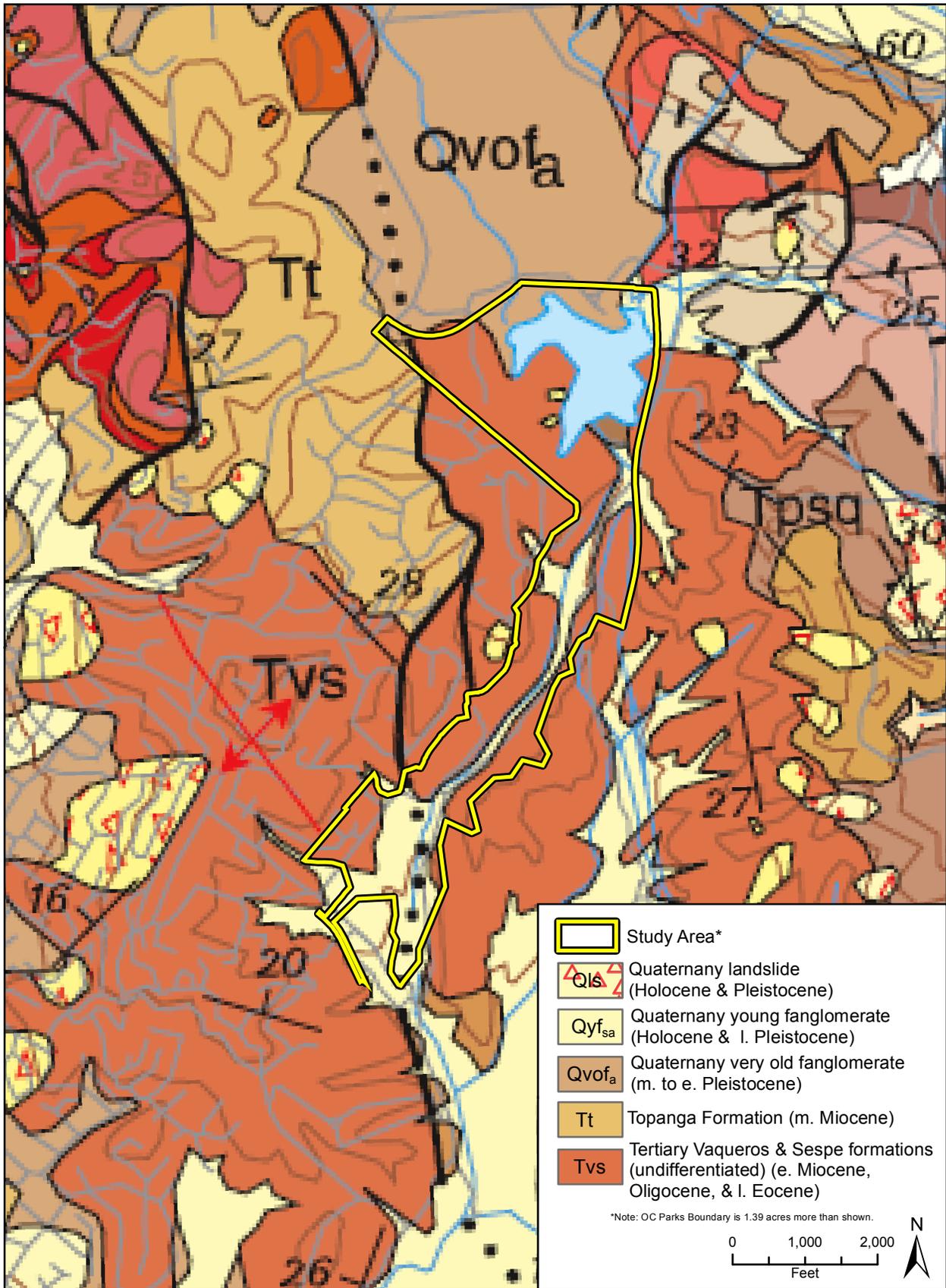
Topanga Group, undivided (Tt)

The undivided Topanga Group crops out on the north and west flanks of the Santa Ana Mountains, where it consists of a cemented fluvial conglomerate at its base and medium- to coarse-grained tan to gray fluvial and marine sandstone higher up (Morton and Miller 2006). In the vicinity of Peters Canyon, the basal conglomerate is approximately 30 feet thick and the upper sandstones interbed with fine-grained silty sandstones and vitric tuff layers such that the whole unit (including the basal conglomerate) is approximately 40 feet thick (Whistler and Lander 2003). Only a small portion of the Topanga Group is mapped within the northwest corner of the park.

Vaqueros and Sespe formations (undifferentiated) (Tvs)

Across much of southern California, the Vaqueros and Sespe formations are easily differentiated by lithology and depositional setting; the Vaqueros Formation comprises predominantly gray-green marine sandstones and the Sespe is a widespread red to varicolored continental pebble and cobble conglomerate (Hamlin 1904; Morton and Miller 2006; Prothero and Donohoo 1997; Schoellhamer et al. 1981; Watts 1897; Whistler and Lander 2003). However, within the Santa Ana Mountains and the nearby Puente and San Joaquin Hills, these two units interdigitate on a nearly bed-by-bed (i.e., the smallest lithostratigraphic unit) basis to such a degree that they cannot be separately mapped even at a scale of 1:24,000 (a scale typically used in local geologic mapping) and so are usually referred to as 'undifferentiated' (Morton and Miller 2006; Whistler and Lander 2003). This interdigitation is the result of deposition in an environment in which the shoreline was continually shifting (Campbell et al. 2009). The undifferentiated Vaqueros and Sespe is nearly 4,000 feet thick locally and overlies the lower to middle Eocene Santiago Formation. The Vaqueros-Sespe contacts the overlying lower to middle Miocene Topanga Group (undivided) at an erosional surface (Whistler and Lander 2003). The Vaqueros-Sespe is found in most of the northern and central portions of the park.





Source: Morton and Miller (2006).

Geologic Map

Figure 2

3.4 PALEONTOLOGICAL RESOURCES

Based on the characteristics of the formations just described and previously reported fossil occurrences within them, each formation can be assigned a paleontological sensitivity rating using the SVP (2010) system described above (Section 2.3). Three of the five units that exist within the park have a high sensitivity for paleontological resources (Table 1 and Figure 3).

Quaternary landslide (Qls) and Quaternary young fanglomerate (Qyf_{sa})

Holocene sediments include units deposited during the past 11,700 years. However, Holocene alluvium has not produced significant fossil discoveries and is generally considered to have low paleontological sensitivity where it occurs. The young fanglomerate and landslide deposits are considered to have a low sensitivity for paleontological resources at the surface as they are primarily too young (the young conglomerate is mainly middle to late Holocene-age), lack the stratigraphic provenience necessary to adequately contextualize scientifically significant fossils (landslide deposits), and are not known to have yielded paleontological resources (McLeod 2016, Appendix A). However, at shallow depth (i.e., greater than five feet), both the young fanglomerate and landslide units could be underlain by the older, high sensitivity Pleistocene and Vaqueros-Sespe deposits (Table 1).

Quaternary very old fanglomerate (Qvof_a)

A formal records search of the Natural History Museum of Los Angeles County (LACM) collections recorded two localities in Pleistocene sediments (LACM 4943 and 7897) in the vicinity of Peters Canyon Regional Park (McCleod 2016, Appendix A). Each of these localities contained fossil horse teeth. A search of the online collections database of the UCMP of Pleistocene-age deposits in Orange County yielded 101 localities, 98 of which contain only marine invertebrates and just three contain vertebrates. Of the three vertebrate localities, 36 of the 38 specimens collected were from the strictly marine Palos Verdes Sand in Newport Beach and only two specimens (individual horse teeth) are from non-marine sediments. Pleistocene marine deposits do not occur within the Peters Canyon Regional Park. A search of the online Paleobiology Database recorded 14 localities within Pleistocene formations in Orange County, none of which occur within Peters Canyon Regional Park. However, Pleistocene-age terrestrial sediments are known throughout California to produce fossils and so are considered highly sensitive wherever they occur (see e.g., Agenbroad 2003; Bell et al. 2004; Jefferson 1985, 1991; Merriam 1911; Reynolds et al. 1991; Savage et al. 1954; Scott and Cox 2008; Springer et al. 2009; Wilkerson et al. 2011; Winters 1954). Therefore, Quaternary very old fanglomerates within the park are considered highly sensitive for paleontological resources.

Topanga Group, undivided (Tt)

A search of the online collections database of the UCMP of the Topanga Group in Orange County yielded two localities containing only microfossils and invertebrates. Additional paleontological literature review revealed four additional localities in the undivided Topanga Group from the Upper Oso Dam area, approximately 10 miles to the southeast of Peters Canyon Regional Park (Howard and Barnes 1987). These localities contained a mixed marine and terrestrial bird fauna including albatross, shearwaters, boobies and gannets, ducks, and auk. A bird sample of this age (middle Miocene) is rare for Orange County and is the only marine avifauna in California of this age south of the Sharktooth Hill Bonebeds in Kern County



(Howard and Barnes 1987). The Upper Oso Dam bird fossils are repositated at the LACM and the locality numbers are listed in Table A1, in the Appendix.

Vaqueros and Sespe formations (undifferentiated) (Tvs)

A formal records search of the Natural History Museum of Los Angeles County (LACM) collections recorded five localities in V/S deposits (LACM 3983-3985, 6624, and 6666; Table A1; McLeod 2016, Appendix A). These localities yielded an assortment of terrestrial and marine vertebrates including horses, rodents, whales, sharks, and desmostylians (amphibious horse-like animals that resembled hippos). All of these localities were found within just a few miles of the park.

A search of the online collections database of the University of California Museum of Paleontology (UCMP) recorded no fossil localities within the Sespe Formation and 83 localities within the Vaqueros Formation in Orange County. Of the Vaqueros Formation localities, 82 contained only marine invertebrates and one contained only plants; no vertebrates are known. The NEOMAP online database (UC Berkeley) search recorded 33 localities from the Sespe Formation and 13 from the Vaqueros Formation in Orange County. From these localities, a total of 237 individually numbered mammalian fossils were recovered, including rodents, rabbits, camels, carnivores, horses, and insectivores. The NEOMAP search largely duplicates the locality list provided in Whistler and Lander (2003). A search of the online Paleobiology Database recorded 34 localities within the Sespe Formation and 30 within the Vaqueros Formation. Of these 64 localities, 14 from the Sespe and 23 from the Vaqueros (37 total) contained only marine invertebrates (Cushman and Leroy 1938; Loel and Corey 1932; Schoellhamer et al. 1981; Van Ee et al. 2012; Zullo 1992).

Additional review of published maps showing fossil localities in this part of Orange County and the LACM records search reveals marine invertebrates from at least three unnumbered localities in Vaqueros-Sespe deposits have been recovered from within the boundaries of the park and at least 13 localities from Vaqueros-Sespe deposits have been found nearby (McLeod 2016, Appendix A; Prothero and Donohoo 1997; Schoellhamer et al. 1981; Whistler and Lander 2003; Table A1, Appendix A). Although no vertebrate fossils (marine or terrestrial) have been recovered within the park, at least 8 of the aforementioned Vaqueros-Sespe localities are within 5 miles of the park. The majority of the Vaqueros-Sespe localities were discovered during construction on the Eastern Transportation Corridor project in the mid- to late-1990s (Whistler and Lander 2003). One locality, ETC Jamboree Road, occurs approximately 100 feet outside the eastern boundary of the park and revealed the first record of Eocene land mammals in the Vaqueros-Sespe (McLeod 2016; Prothero and Donohoo 1997; Schoellhamer et al. 1981; Whistler and Lander 2003). This locality, along with the ETC Windy Ridge locality, located approximately three miles north of the park, contained the oldest land mammals from the Vaqueros-Sespe anywhere in Orange County (Whistler and Lander 2003). All Vaqueros-Sespe deposits are considered highly sensitive for paleontological resources within the park based on past known resources in these deposits.



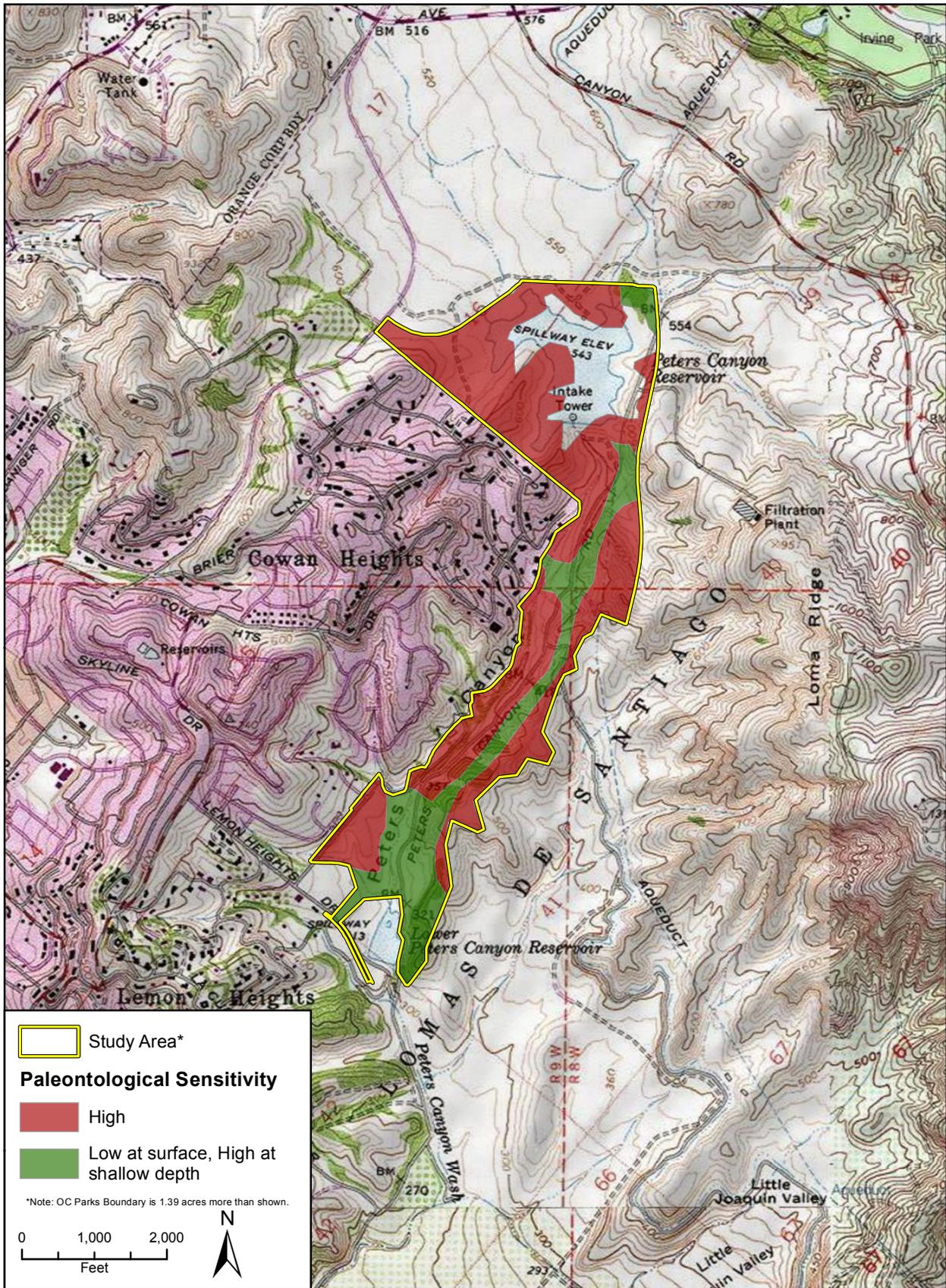
Table 1. Paleontological Resources of Surface And Underlying Geologic Units within the Project Area

Map Unit	Symbol ¹	Age	Description	Sensitivity	Types of possible fossils
Quaternary landslide	Qls	Holocene & Pleistocene	Landslides in the park occur on steep slopes within and on top of Vaquero-Sespe deposits. Any fossils within landslides will likely be fragmentary and lacking provenience, both of which decrease their scientific significance	Low at surface, High at depths below 5 feet	None likely
Quaternary young fanglomerate	Qyf _{sa}	Holocene & late Pleistocene	Coarse- to fine-grained sands and conglomerates	Low at surface, High at depths below 5 feet	None likely
Quaternary very old fanglomerate	Qvof _a	Middle to early Pleistocene	Coarse- to fine-grained sands and conglomerates	High	Marine and terrestrial vertebrates
Topanga Group (undivided)	Tt	Middle Miocene	Cemented conglomerate with coarse- to fine-grained sand, silt, and vitric tuff	High	Terrestrial vertebrates
Vaqueros and Sespe formations (undifferentiated)	Tvs	Early Miocene, Oligocene, & late Eocene	Marine sandstones and continental conglomerates	High	Marine invertebrates and terrestrial vertebrates

Sources: Howard and Barnes (1987); Lucas et al. (1997); Hunt and Stepleton (2015); McLeod (2016, Appendix A); Morton and Miller (2006); Whistler and Lander (2003)

¹Unit symbol follows Morton and Miller (2006)





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Paleontological Sensitivity

Figure 3

4.0 IMPACT ANALYSIS AND RECOMMENDED MITIGATION

The project area contains three mapped units of high paleontological sensitivity: Quaternary very old fanglomerate (Pleistocene), undivided Topanga Group (middle Miocene), and Vaqueros-Sespe undifferentiated (Eocene to Miocene). These units have the potential to yield scientifically significant paleontological resources at the surface and at depth. One mapped unit, Quaternary young fanglomerate, has low paleontological sensitivity at the surface, but high sensitivity at shallow depths (below 5 feet) (see Table 1 and Figure 3).

New project or O&M activity associated within the Resource Management Plan that would result in ground disturbance could have the potential to impact paleontological sensitive geologic units, and as such could result in significant impacts to scientifically important paleontological resources. Excavations within the park have a potential to disturb the following three high-sensitivity geologic units:

- 1) Pleistocene-age fanglomerates;
- 2) Undivided Topanga Group; and
- 3) Vaqueros-Sespe formations.

Each of these units has the potential to yield significant vertebrate fossils. In addition, any excavations at depths greater than five feet in young fanglomerates and landslides in Vaqueros-Sespe deposits have the potential to encounter significant vertebrate fossils in the underlying bedrock. Impacts to paleontological resources resulting from ground disturbing construction activity could include the destruction of fossils, and would be considered a significant impact without mitigation. The following measures are recommended to reduce potential impacts to paleontological resources.

1. **Project-level Review for Potential Impacts to Paleontological Resources:** A qualified paleontologist should review project plans for all new development and for any O&M activity with a ground disturbing component, to determine if proposed activity could result in disturbance to geologic units with high paleontological sensitivity at the surface or units present below units with low sensitivity at the surface. If no project-level impacts are identified, no further mitigation is required. If project-level impacts are identified, Measure 2 below should be implemented.
2. **Paleontological Mitigation and Monitoring Plan and Paleontological Monitoring:** If potential impacts to paleontological resources are identified during the project-level review, then the following measures should be implemented:
 - a. **Paleontological Mitigation and Monitoring Plan:** Prior to any construction activity, a qualified paleontologist should prepare a Paleontological Mitigation and Monitoring Plan to be implemented during ground disturbance activity for the proposed project. This plan should outline the procedures for construction staff Worker Environmental Awareness Program (WEAP) training, paleontological monitoring extent and duration, salvage and preparation of fossils, the final mitigation and monitoring report, and paleontological staff qualifications.



- b. **Paleontological WEAP:** Prior to the start of construction, construction personnel should be educated about the appearance of fossils and the procedures for notifying paleontological staff should fossils be discovered by construction staff.
- c. **Paleontological Monitoring:** Any excavations or other ground disturbing activity in areas mapped as high paleontological sensitivity (Figure 3) should be monitored on a full-time basis by a qualified paleontological monitor. Should no fossils be observed during the first 50% of excavations, paleontological monitoring could be reduced to weekly spot-checking, but only at the discretion of the qualified paleontologist.
- d. **Salvage of Fossils:** If fossils are discovered, the qualified paleontologist (or paleontological monitor) should recover them. Typically fossils can be safely salvaged quickly by a single paleontologist and not disrupt construction activity. In some cases larger fossils (such as complete skeletons or large mammal fossils) require more extensive excavation and longer salvage periods. In this case the paleontologist should have the authority to temporarily direct, divert or halt construction activity to ensure that the fossil(s) can be removed in a safe and timely manner.
- e. **Preparation and Curation of Recovered Fossils:** Once salvaged, fossils should be identified to the lowest possible taxonomic level, prepared to a curation-ready condition and curated in a scientific institution with a permanent paleontological collection, along with all pertinent field notes, photos, data, and maps.
- f. **Final Paleontological Mitigation and Monitoring Report:** Upon completion of ground disturbing activity (and curation of fossils if necessary) the qualified paleontologist should prepare a final mitigation and monitoring report outlining the results of the mitigation and monitoring program. The report should include discussion of the location, duration and methods of the monitoring, stratigraphic sections, any recovered fossils, and the scientific significance of those fossils, and where fossils were curated.

Preparation and implementation of the Paleontological Mitigation and Monitoring Plan should be supervised by a qualified paleontologist. A qualified paleontologist is defined as an individual with an M.S. or Ph.D. in paleontology or geology who is experienced with paleontological procedures and techniques, who is knowledgeable in the geology of southern California, and who has worked as a paleontological mitigation project supervisor for a least one year. Monitoring should be conducted by a qualified paleontological monitor, who is defined as an individual who has experience with collection and salvage of paleontological resources.



5.0 REFERENCES

- Agenbroad, L.D. 2003. New localities, chronology, and comparisons for the pygmy mammoth (*Mammuthus exilis*). In J. Reumer (ed.): *Advances in Mammoth Research, Proceedings of the 2nd International Mammoth Conference, Rotterdam, the Netherlands*. DEINSEA 9:1-16.
- Bell, C.J., E.L. Lundelius, Jr., A.D. Barnosky, R.W. Graham, E.H. Lindsay, D.R. Ruez, Jr., H.A. Semken, Jr., S.D. Webb, and R.J. Zakrzewski. 2004. *The Blancan, Irvingtonian, and RanchoLabrean Mammal Ages*. In Woodburne, M.O. (ed.) *Late Cretaceous and Cenozoic Mammals of North America: Biostratigraphy and Geochronology*. Columbia University Press, New York, pp. 232-314.
- California Geologic Survey (CGS). 2002. *California Geomorphic Provinces*. Note 36.
- Campbell, R.H., T.H. McCulloh, and J.G. Vedder. 2009. *The Miocene Topanga Group of southern California: A 100 year history of changes in stratigraphic nomenclature*. U.S. Geological Survey, Open-File Report 2007-1385, version 1.1, revised 2009.
- Cushman, J.A. and L.W. Leroy. 1938. A microfauna from the Vaqueros Formation, Lower Miocene, Simi Valley, Ventura County, California. *Journal of Paleontology* 12(2):117-126.
- Dickinson, W.R. 1981. Plate tectonics and the continental margin of California. In W.G. Ernst (ed.) *Rubey Volume I, The Geotectonic Development of California*, p.2-73.
- Howard, H. and L.G. Barnes. 1987. Middle Miocene marine birds from the foothills of the Santa Ana Mountains, Orange County, California. *Natural History Museum of Los Angeles County Contributions in Science* 383:1-9.
- Hunt, R.M., Jr. and E. Stepleton. 2015. A skull of the immigrant Eurasian bearded dog *Cynelos* (Carnivora, Amphicyonidae) from the early Miocene of southern California. *Journal of Vertebrate Paleontology* 35(1):19 pp.
- Jefferson, G.T. 1985. Review of the Late Pleistocene avifauna from Lake Manix, central Mojave Desert, California. *Contributions in Science, Natural History Museum of Los Angeles County*, 362:1-13.
- Jefferson, G.T. 1991. A catalogue of late Quaternary vertebrates from California. Part two, mammals. *Natural History Museum of Los Angeles County Technical Report*, 7:1-129.
- Loel, W. and W.H. Corey. 1932. *The Vaqueros Formation, Lower Miocene of California (Part 1)*. University of California Publications, Bulletin of the Department of Geological Sciences 22(3):31-410.
- Lucas, S.G., D.P. Whistler, and H.M. Wagner. 1997. Giant Entelodont (Mammalia, Artiodactyla) from the Early Miocene of southern California. *Natural History Museum of Los Angeles County, Contributions in Science* 466:1-9.



- Merriam, J.C. 1911. *The Fauna of Rancho La Brea; Part I: Occurrence*. *Memoirs of the University of California*, 1(2):197-213.
- Morton, D.M., K.R. Bovard, and R.M. Alvarez. 2004. Preliminary digital geologic map of the Santa Ana 30'X60' quadrangle, southern California. U.S. Geological Survey, Open-File Report 99-172, Southern California Areal Mapping Project. Map scale 1:100,000.
- Morton, D.M. and F.K. Miller. 2006. Geologic map of the San Bernardino and Santa Ana 30'X60' quadrangles, California. U.S. Geological Survey, Open-File Report 2006-1217. Map scale 1:100,000.
- Prothero, D.R. and L.L. Donohoo. 2001. Magnetic stratigraphy of the lower Miocene (Early Hemingfordian) Sespe-Vaqueros formations, Orange County, California. In D.R. Prothero (ed.) *Magnetic Stratigraphy of the Pacific Coast Cenozoic*. Pacific Section SEPM (Society for Sedimentary Geology), Book 91, pp. 242-253.
- Reynolds, R.E. 1990. Paleontologic Mitigation Program, Cajon Pass Truck Escape Ramp, Cajon Summit, San Bernardino County, California. Caltrans, District 8, San Bernardino.
- Reynolds, R.E., R.L. Reynolds, and A.F. Pajak, III. 1991. Blancan, Irvingtonian, and Rancho La Brea(?) land mammal age faunas from western Riverside County, California. In *Inland southern California: the last 70 million years*. M.O. Woodburne, R.E. Reynolds, and D.P. Whistler (eds.) *San Bernardino County Museum Association Quarterly*, 38(3-4):37-40.
- Savage, D.E., T. Downs, and O.J. Poe. 1954. Cenozoic land life of southern California. in R.H. Jahns ed., *Geology of southern California*. *California Division of Mines and Geology*, 170, Ch III, pp. 43-58.
- Schoellhamer, J.E., J.G. Vedder, R.F. Yerkes, and D.M. Kinney. 1981. *Geology of the northern Santa Ana Mountains, California*. U.S. Geological Survey, Professional Paper 420-D.
- Scott, E. and S.M. Cox. 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) from the Mojave Desert of southern California and Nevada. In X. Wang and L.G. Barnes (eds.) *Geology and vertebrate paleontology of western and southern North America: Contributions in Honor of David P. Whistler*. *Natural History Museum of Los Angeles County, Science Series*, 41:359-82.
- Society of Vertebrate Paleontology, 2010. *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources*. Society of Vertebrate Paleontology Impact Mitigation Guidelines Revision Committee.
- Springer, K., E. Scott, J.C. Sagebiel, and L.K. Murray. 2009. The Diamond Valley Lake local fauna: Late Pleistocene vertebrates from inland southern California. In Albright, L.B. III (ed.), *Papers on Geology, Vertebrate Paleontology, and Biostratigraphy in Honor of Michael O. Woodburne*. *Museum of Northern Arizona Bulletin* 65:217-36.



- Van Ee N.J., K.E. Cooper, D.S. Kaufman, and G.P. Eberli. 2012. Evaluation of amino acid racemization variability in Quaternary corals. Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012. 8D Effects of ocean acidification. 5 pp.
- Whistler, D.P. and E.B. Lander. 2003. New Late Uintan to Early Hemingfordian land mammal assemblages from the undifferentiated Sespe and Vaqueros formations, Orange County, and from the Sespe and equivalent marine formations in Los Angeles, Santa Barbara, and Ventura counties, southern California. Bulletin American Museum of Natural History No. 279, Chapter 11, pp. 231-268.
- Wilkerson, G., T. Elam, and R. Turner. 2011. Lake Thompson Pleistocene mammalian fossil assemblage, Rosamond. In Reynolds, R.E. (ed.) The Incredible Shrinking Pliocene: The 2011 Desert Symposium Field Guide and Proceedings. California State University Desert Studies Consortium, Pp. 88-90.
- Winters, H.H. 1954. The Pleistocene fauna of the Manix Beds in the Mojave Desert, California. Master's Thesis, California Institute of Technology. 71 pp.
- Zullo, V.A. 1992. Revision of the balanid barnacle genus *Concaous* Newman, 1982, with the description of a new subfamily, two new genera, and eight new species. The Paleontological Society Memoir 27:1-46.

Databases

NEOMAP Database. Accessed on May 2, 2016. www.ucmp.berkeley.edu/neomap/search.html

Paleobiology Database. Accessed on May 2, 2016. <http://fossilworks.org/?a=home>

University of California Museum of Paleontology Locality Database. Accessed on May 2, 2016. <http://ucmpdb.berkeley.edu/>



Appendix A

Museum Paleontological Collections Search Results



Table A1. Fossils from High Sensitivity (Topanga and Vaqueros-Sespe) and High at shallow depths (Pleistocene-aged) geologic units in the vicinity of Peters Canyon Regional Park

Geologic Unit	Representative Taxa	Locality¹
Pleistocene-aged deposits	<i>Equus, Thomomys</i>	LACM 4934, 7867
Topanga (Tt)	<i>Diomedea, Puffinus, Alcodes</i> , Sulidae, Anatidae, sharks, rays, <i>Copemys</i> , <i>Parapliohippus</i> , <i>Merychippus</i> ,	LACM 4464, 4545, 4546, 4547; LC 152
Vaqueros-Sespe (undifferentiated) (Tvs)	<i>Desmostylus</i> , toothed whales, <i>Myliobatis</i> , <i>Isurus</i> , Chelonia, <i>Gerrhonotus</i> , <i>Parasauromalus</i> , <i>Xantusia</i> , Boidae, Colubridae, <i>Herpetotherium</i> , Erinaceidae, Heterosoricidae, <i>Limnoecus</i> , <i>Cynelos</i> , Mustelidae, <i>Cynarctoides</i> , <i>Phlaocyon</i> , <i>Leptocyon</i> , Felidae, <i>Cuyamalgus</i> , <i>Gripholagomys</i> , <i>Archaeolagus</i> , <i>Nototamias</i> , <i>Miospermophilus</i> , <i>Petauristodon</i> , <i>Pseudotheridomys</i> , <i>Heliscomys</i> , <i>Cupidinimus</i> , <i>Proheteromys</i> , <i>Trogomys</i> , <i>Schizodontomys</i> , <i>Leidymys</i> , <i>Yatkolamys</i> , <i>Menoceras</i> , <i>Kalobatippus</i> , <i>Parahippus</i> , <i>Daeodon</i> , <i>Cynorca</i> , <i>Sespia</i> , <i>Merychyus</i> , <i>Michenia</i> , <i>Tanymykter</i> , <i>Miolabis</i> , <i>Aletomeryx</i> , <i>Nanotragulus</i> , <i>Machaeromeryx</i> , <i>Pseudoblastomeryx</i> ,	LACM 449, 3983, 3984, 3985, 4554, 4555, 6624, 6666, 6927, 6928, 6929, 6930, 6935, 6938, 6940, 6941, 6942, 6943, 6944, 7326, 7327, 7328; LC 151, 152, 163, 167, 171, 173, 196, 198, 199, 200, 201, 202, 203, 204; OCPC 2008, 2012, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2024, 2027, 2040; LSA SR-73

¹ Locality abbreviations: LACM=Natural History Museum of Los Angeles County; LC=Ralph B. Clark Interpretive Center, Los Coyotes Regional Park; OCPC=Orange County Paleontological Collection; LSA=LSA Associate, Inc.

Sources: Howard and Barnes (1987); Lucas et al. (1997); Hunt and Stepleton (2015); McLeod (2016, Appendix A); Whistler and Lander (2003)



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22 April 2016

Rincon Consultants, Inc.
180 Grand Avenue, Suite 400
Oakland, CA 94612

Attn: Kyle Brudvik, Paleontologist / Geoarchaeologist / Archaeologist

re: Paleontological resources for the proposed Peters Canyon Regional Park Project, Rincon Project # 15-02270, in or near the City of Tustin, Orange County, project area

Dear Kyle:

I have conducted a thorough search of our paleontology collection records for the locality and specimen data for the proposed Peters Canyon Regional Park Project, Rincon Project # 15-02270, in or near the City of Tustin, Orange County, project area as outlined on the portion of the Orange USGS topographic quadrangle map that you sent to me via e-mail on 8 April 2016. We do not have any vertebrate fossil localities that lie directly within the proposed project boundaries, but we do have fossil vertebrate localities nearby or at some distance from the same sedimentary deposits that occur in the proposed project area.

In the lower lying terrain in the drainages and especially around Peters Canyon Reservoir in the north and the Lower Peters Canyon Reservoir in the south, the surface deposits consist of younger Quaternary Alluvium, derived as alluvial fan deposits from the surrounding elevated terrain. In the very northwestern portion of the proposed project area there are older Quaternary terrace deposits at the surface. Otherwise the proposed project area has exposures of the Oligocene Vaqueros and Sespe Formations undifferentiated except in the very southeastern-most portion of the proposed project area where there are exposures of the Eocene Santiago Formation.

The younger Quaternary Alluvium and older Quaternary deposits may not contain significant vertebrate fossils in the uppermost layers, but they may be underlain by older sedimentary deposits that do contain significant fossil vertebrate remains. Our closest fossil locality in older Quaternary sediments is LACM 4943, situated northwest of the proposed project area east of the Santa Ana River along Fletcher Avenue east of Glassell Street, that produced a specimen of fossil horse, *Equus*, at a depth of 8-10 feet below the surface. Our closest vertebrate fossil locality from older Quaternary deposits beneath the younger Quaternary Alluvium is LACM 7867, just east of south of the proposed project area in what is now the Orange County Great Park, that produced fossil specimens of pocket gopher, *Thomomys*, from a depth of 25 feet below the surface.

Rocks of the mostly marine Vaqueros Formation and the mostly terrestrial Sespe Formation, ranging in age from the late Eocene through the early Miocene, intergrade and interdigitate so that they are difficult to distinguish, and in the vicinity of the proposed project area are typically referred to as the Sespe / Vaqueros Formation undifferentiated. Our closest localities from the nominally Sespe / Vaqueros Formation undifferentiated are LACM 3983-3985, northeast of the northern portion of the proposed project area immediately east of Irvine Park, that produced fossil specimens of eagle ray, *Myliobatis*, bonito shark, *Isurus planus*, four-legged marine mammal, *Desmostylus*, and toothed whales, Odontoceti, although it is possible that these localities came from the Topanga Formation rather than the Vaqueros / Sespe undifferentiated. Just north of east of the northern-most portion of the proposed project area, just north of the Santiago Dam, our Sespe / Vaqueros undifferentiated locality LACM 6624 produced another specimen of *Desmostylus*. In Little Joaquin Valley, southeast of the southern portion of the proposed project area, our Sespe / Vaqueros undifferentiated locality LACM 6666 produced another fossil specimen of *Desmostylus*.

We have no fossil vertebrate localities from the Santiago Formation in Orange County, but we have several localities from this rock unit in San Diego County. Our closest vertebrate fossil locality from the Santiago Formation is LACM 5347, situated in San Onofre Canyon east of Interstate 5, that produced fossil specimens of the insectivore *Sespedectes*. Our other Santiago Formation vertebrate fossil localities include LACM 3881, 3883-3884, 3979, 4022, 5346-5347, 6926 and 68102, clustered around Carlsbad, that produced a composite fauna of primarily mammals (see appendix). David J. Golz (1976. Eocene Artiodactyla of Southern California. Los Angeles County Museum Science Bulletin, 26:1-85) published on the LACM specimens of the protoceratid artiodactyl *Leptoreodon leptolophus* and the camels *Protylopus petersoni* and *Protylopus stocki* from our Santiago Formation locality LACM 68102.

Shallow excavations in the younger Quaternary Alluvium and in the older Quaternary terrace deposits probably will not uncover significant fossil vertebrate material. Deeper excavations in the those deposits that extend down into older sedimentary deposits, as well as any excavations in exposures of the Vaqueros and Sespe Formations undifferentiated or the Santiago Formation within the proposed project area, may well encounter significant vertebrate fossil remains. Any substantial excavations in the proposed project area, therefore, should be

monitored closely to quickly and professionally recover any fossil remains discovered while not impeding development. Sediment samples should also be collected from the sedimentary deposits in the proposed project area and processed to determine their small fossil potential. Any fossils recovered during mitigation should be deposited in an accredited and permanent scientific institution for the benefit of current and future generations.

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

Sincerely,

A handwritten signature in cursive script that reads "Samuel A. McLeod". The signature is written in black ink and is positioned above the typed name.

Samuel A. McLeod, Ph.D.
Vertebrate Paleontology

enclosures: appendix; invoice

Composite Santiago Formation fossil fauna based on specimens in the LACM collections

Reptilia

Chelonia

Testudinidae

Trionychidae

Crocodylia

Aves

Mammalia

Artiodactyla

Camelidae

Protylopus *petersoni*

Protylopus *stocki*

Protoceratidae

Leptoreodon *leptolophus*

Dinocerata

Uintatheriidae

Insectivora

Dormaliidae

Proterixoides

Sespedectes

Perissodactyla

Amynodontidae

Amynodon *intermedius*

Brontotheriidae

Rodentia

Aplodontidae

Eohaplomys

Geomyidae

Griphomys

Paramyidae

Microparamys