CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

Sacramento to Bakersfield

PALEONTOLOGICAL RESOURCES TECHNICAL EVALUATION

January 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

CALIFORNIA HIGH SPEED RAIL AUTHORITY

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Federal Railroad Administration

Sacramento to Bakersfield Paleontological Resources Technical Evaluation

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CALIFORNIA HIGH-SPEED RAIL AUTHORITY

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ACRONYMS

AUTHORITY	CALIFORNIA HIGH-SPEED RAIL
CEQA	CALIFORNIA ENVIRONMENTAL QUALITY ACT
COG	COUNCIL OF GOVERNMENTS
EIR	ENVIRONMENTAL IMPACT REPORT
EIS	ENVIRONMENTAL IMPACT STATEMENT
EPA	ENVIRONMENTAL PROTECTION AGENCY
FAA	FEDERAL AVIATION ADMINISTRATION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FRA	FEDERAL RAILROAD ADMINISTRATION
FTA	FEDERAL TRANSIT ADMINISTRATION
GIS	GEOGRAPHIC INFORMATION SYSTEM
MTA	METROPOLITAN TRANSPORTATION AUTHORITY
RTP	REGIONAL TRANSPORTATION PLAN

1.0 INTRODUCTION

The California High-Speed Rail Authority (Authority) was created by the Legislature in 1996 to develop a plan for the construction, operation, and financing of a statewide, intercity high-speed passenger train system.[1] After completing a number of initial studies over the past six years to assess the feasibility of a high-speed train system in California and to evaluate the potential ridership for a variety of alternative corridors and station areas, the Authority recommended the evaluation of a proposed high-speed train system as the logical next step in the development of California's transportation infrastructure. The Authority does not have responsibility for other intercity transportation systems or facilities, such as expanded highways, or improvements to airports or passenger rail or transit used for intercity trips.

The Authority adopted a *Final Business Plan* in June 2000, which reviewed the economic feasibility of a 1,127-kilometer-long (700-mile-long) high-speed train system. This system would be capable of speeds in excess of 321.8 kilometers per hour (200 miles per hour [mph]) on a dedicated, fully grade-separated track with state-of-the-art safety, signaling, and automated train control systems. The system described would connect and serve the major metropolitan areas of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego. The high-speed train system is projected to carry a minimum of 42 million passengers annually (32 million intercity trips and 10 million commuter trips) by the year 2020.

Following the adoption of the Business Plan, the appropriate next step for the Authority to take in the pursuit of a high-speed train system is to satisfy the environmental review process required by federal and state laws which will in turn enable public agencies to select and approve a high speed rail system, define mitigation strategies, obtain necessary approvals, and obtain financial assistance necessary to implement a high speed rail system. For example, the Federal Railroad Administration (FRA) may be requested by the Authority to issue a *Rule of Particular Applicability*, which establishes safety standards for the high-speed train system for speeds over 200 mph, and for the potential shared use of rail corridors.

The Authority is both the project sponsor and the lead agency for purposes of the California Environmental Quality Act (CEQA) requirements. The Authority has determined that a Program Environmental Impact Report (EIR) is the appropriate CEQA document for the project at this conceptual stage of planning and decision-making, which would include selecting a preferred corridor and station locations for future right-of-way preservation and identifying potential phasing options. No permits are being sought for this phase of environmental review. Later stages of project development would include project-specific detailed environmental documents to assess the impacts of the alternative alignments and stations in those segments of the system that are ready for implementation.

The decisions of federal agencies, particularly the Federal Railroad Administration (FRA) related to high-speed train systems, would constitute major federal actions regarding environmental review under the National Environmental Policy Act (NEPA). NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) if the proposed action has the potential to cause significant environmental impacts. The proposed action in California warrants the preparation of a Tier 1 Program-level EIS under NEPA, due to the nature and scope of the comprehensive high-speed train system proposed by the Authority, the need to narrow the range of alternatives, and the need to protect/preserve right-of-way in the future. FRA is the federal lead agency for the preparation of the Program EIS, and the Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency (EPA), the U.S. Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (USFWS), and the Federal Transit Administration (FTA) are cooperating federal agencies for the EIS.

[1] Chapter 796 of the Statutes of 1996; SB 1420, Kopp and Costa

A combined Program EIR/EIS is to be prepared under the supervision and direction of the FRA and the Authority in conjunction with the federal cooperating agencies. It is intended that other federal, state, regional, and local agencies will use the Program EIR/EIS in reviewing the proposed program and developing feasible and practicable programmatic mitigation strategies and analysis expectations for the Tier 2 detailed environmental review process which would be expected to follow any approval of a high speed train system.

The statewide high-speed train system has been divided into five regions for study: Bay Area-Merced, Sacramento-Bakersfield, Bakersfield-Los Angeles, Los Angeles-San Diego via the Inland Empire, and Los Angeles-Orange County-San Diego. This Paleontological Resources Technical Evaluation for the Sacramento to Bakersfield region is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES

1.1.1 No-Project Alternative

The No-Project Alternative serves as the baseline for the comparison of Modal and High-Speed Train alternatives (Figure 1). The No-Project Alternative represents the state's transportation system (highway, air, and conventional rail) as it existed in 1999-2000 and as it would be after implementation of programs or projects currently programmed for implementation and projects that are expected to be funded by 2020. The No-Project Alternative addresses the geographic area serving the same intercity travel market as the proposed high-speed train (generally from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego). The No-Project Alternative satisfies the statutory requirements under CEQA and NEPA for an alternative that does not include any new action or project beyond what is already committed.

The No-Project Alternative defines the existing and future statewide intercity transportation system based on programmed and funded (already in funded programs/financially constrained plans) improvements to the intercity transportation system through 2020, according to the following sources of information:

- State Transportation Improvement Program (STIP)
- Regional Transportation Plans (RTPs) for all modes of travel
- Airport plans
- Intercity passenger rail plans (California Rail Plan 2001-2010, Amtrak Five- and Twenty-year Plans)

As with all of the alternatives, the No-Project Alternative will be assessed against the purpose and need topics/objectives for congestion, safety, air pollution, reliability, and travel times.

1.1.2 Modal Alternative

There are currently only three main options for intercity travel between the major urban areas of San Diego, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco, and Sacramento: vehicles on the interstate highway system and state highways, commercial airlines serving airports between San

Figure 1
No-Project Alternative – California Transportation System

Diego and Sacramento and the Bay Area, and conventional passenger trains (Amtrak) on freight and/or commuter rail tracks. The Modal/System Alternative consists of expansion of highways, airports, and intercity and commuter rail systems serving the markets identified for the High-Speed Train Alternative (Figures 2 and 3). The Modal Alternative uses the same inter-city travel demand (not capacity) assumed under the high-end sensitivity analysis completed for the high-speed train ridership in 2020. This same travel demand is assigned to the highways and airports and passenger rail described under the No-Project Alternative, and the additional improvements or expansion of facilities is assumed to meet the demand, regardless of funding potential and without high-speed train service as part of the system.

1.1.3 High-Speed Train Alternative

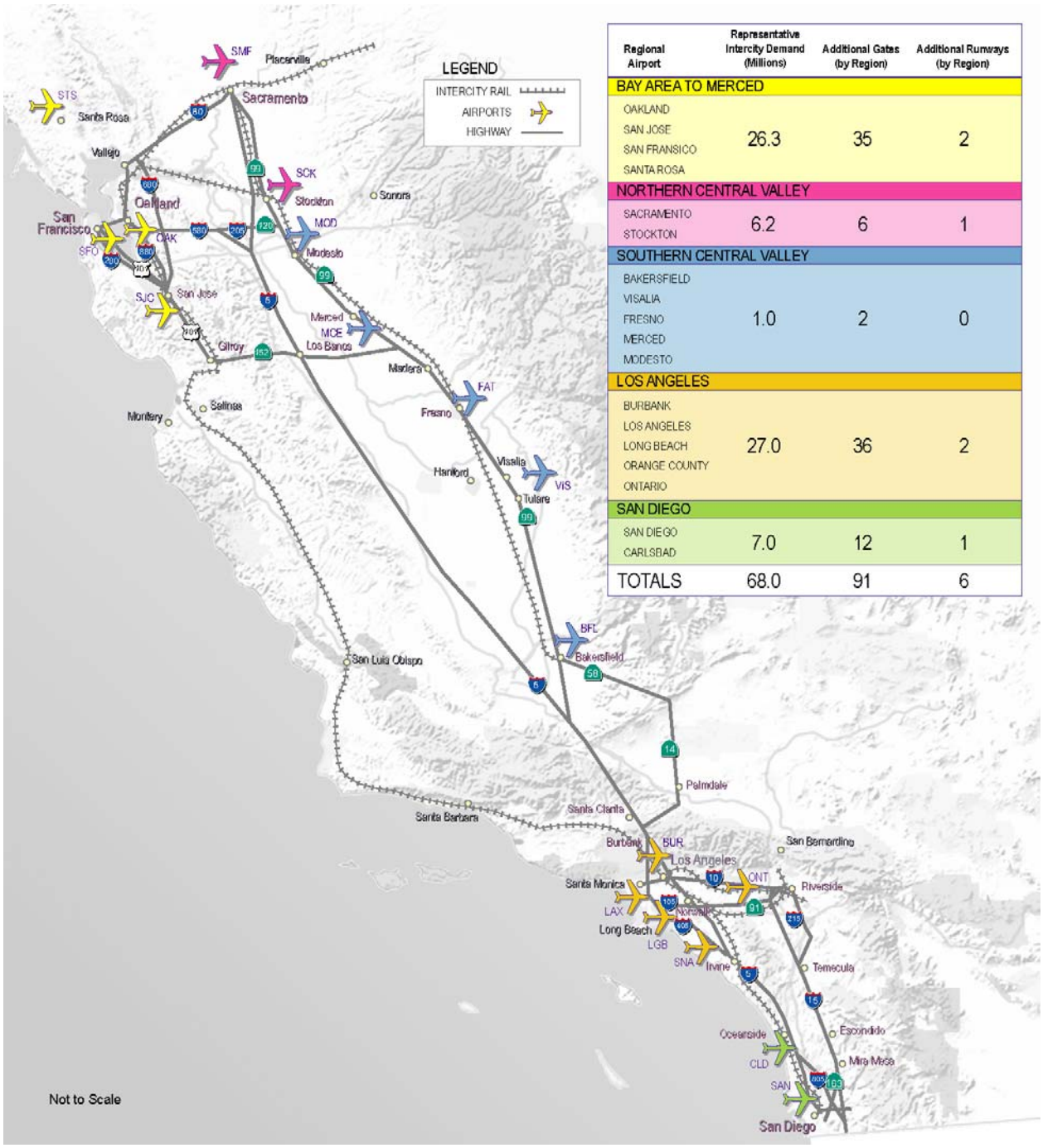
The Authority has defined a statewide high-speed train (HST) system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks, with state-of-the-art safety, signaling, and automated train control systems. State of the art high-speed steel-wheel-on-steel-rail technology is being considered for the system that would serve the major metropolitan centers of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego (Figure 4).

The High-Speed Train Alternative includes several corridor and station options. A steel-wheel on steel-rail, electrified train, primarily on exclusive right-of-way with small portions of the route on shared track with other rail is planned. Conventional “non-electric” improvements are also being considered along the existing LOSSAN rail corridor from Los Angeles to San Diego. The train track would be either at-grade, in an open trench or tunnel, or on an elevated guideway, depending on terrain and physical constraints.

For purposes of comparative analysis, the HST corridors are described from station-to-station within each region, except where a by-pass option is considered when the point of departure from the corridor defines the end of the corridor segment. The Sacramento to Bakersfield region has been divided into six corridors: Corridor A runs generally from Sacramento to Stockton; Corridor B, from Stockton to Modesto; Corridor C, from Modesto to Merced; Corridor D, from Merced to Fresno; Corridor E, from Fresno to Tulare; and Corridor F, from Tulare to Bakersfield. Within any given corridor, various alignment options have been developed. Each alignment option is named with an alpha-numeric designation: The letter corresponds to the corridor, and the number refers to a specific route within that corridor. The corridors and alignment routes for HST for this region are defined and presented in Appendix A.

Figure 2
Modal Alternative-Highway Component

Figure 3
Modal Alternative-Aviation Component



Regional Airport	Representative Intercity Demand (Millions)	Additional Gates (by Region)	Additional Runways (by Region)
BAY AREA TO MERCED			
OAKLAND SAN JOSE SAN FRANSICO SANTA ROSA	26.3	35	2
NORTHERN CENTRAL VALLEY			
SACRAMENTO STOCKTON	6.2	6	1
SOUTHERN CENTRAL VALLEY			
BAKERSFIELD VISALIA FRESNO MERCED MODESTO	1.0	2	0
LOS ANGELES			
BURBANK LOS ANGELES LONG BEACH ORANGE COUNTY ONTARIO	27.0	36	2
SAN DIEGO			
SAN DIEGO CARLSBAD	7.0	12	1
TOTALS	68.0	91	6

Figure 4
HST Alternative – Corridors and Stations for Continued Investigation

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA

The Study Area for paleontological resources is defined as 100 feet from centerline of the different alternative corridors and around stations. A two-hundred foot wide corridor for urban railways, freeways, and airports is appropriate because very little additional right-of-way would be affected in these areas. This two-hundred-foot width incorporates all geologic cross sections with the exception of deep cuts and fills. Comparisons of alternative alignments were generally made for this screening level document based on length of alignment in the various geologic conditions.

The location of easements and construction-related facilities, such as equipment staging areas, borrow and disposal areas, access roads, and utilities, have not been identified, and are not considered in the program level Tier-1 analysis. Such locations would be identified as part of the construction design program for the alternative(s) selected for more detailed analysis in the next phase of the project.

2.2 REGULATORY SETTING

2.2.1 Federal Regulations

There are two federal statutes that incorporate provisions for the protection of paleontological resources: the Federal Antiquities Act of 1906 and the National Environmental Policy Act of 1969.

- The Federal Antiquities Act of 1906 (P.L. 59 - 209, 32 Stat. 225) forbids, and establishes criminal sanctions for, disturbance of any object of antiquity on Federal land without a permit issued by an authorizing authority.

- The National Environmental Policy Act of 1969 (P.L. 91 - 190, 83 Stat. 852, 42 USC 4321 – 4327, Section 101.b4) mandates policies to preserve important historic, cultural and natural aspects of our national heritage.

2.2.2 State of California Requirements

The California Office of Historic Preservation considers fossil remains to be a limited, nonrenewable, highly sensitive, scientific resource. These resources are afforded protection against adverse impacts under the authority of five State of California legislative Acts: the California Environmental Quality Act of 1970, the Guidelines for the Implementation of CEQA (amended December 2001), the Warren-Alquist Act, Public Resources Code, Section 5097.5, and Public Resources Code, Section 30244.

- The California Environmental Quality Act of 1970 (13 Public Resources Code, 21000 et seq), requires public agencies and private interests to identify the potential adverse impacts and/or environmental consequences of their proposed project(s) to any object or site scientific to the scientific annals of California (Division 1, Public Resources Code: 5020.1 [b]).

- Section 15064.5 of the Guidelines for the Implementation of CEQA (amended 1 December 2001), provides protection for paleontological resources by requiring that they be identified and mitigated as historical resources under CEQA. The CEQA Guidelines define historical resources broadly to include any object, site, area or place that a lead agency determines to be historically significant. The regulation goes on to provide that, in general, a resource shall be considered

historically significant if it has yielded, or may be likely to yield, information important in prehistory. Paleontological resources fall within this broad category, and are included in the CEQA checklist under Cultural Resources.

- Warren-Alquist Act (PRC 25000 et seq.), requires the California Energy Commission to evaluate energy facility siting in unique areas of scientific concern (section 25527).

- Public Resources Code, Section 5097.5 (Stats 1965, c. 1136, p. 2792), prohibits excavation or removal of any vertebrate paleontological site or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands.

- Public Resources Code, Section 30244 requires reasonable mitigation of adverse impacts to paleontological resources from development on public land.

2.3 STUDY AREA SETTING

The Central Valley is a great structural depression located between the tilted Sierra Nevada block on the east and the complexly folded and faulted Coast Ranges on the west. The Valley is filled with thick Mesozoic (**Ku** on Table 2, presented later in Section 4.0) and Tertiary (**E** and **M** on Table 2) marine sediments and adjacent Tertiary continental and volcanic sediments (**Mc**, **Tc**, and **Tvp** on Table 2) covered by Quaternary alluvial sediments (**Qs** on Table 2) (Bailey 1966). Along both sides of the Valley are a series of individual and coalescing alluvial fans, with their apices located where streams issue from the adjacent mountain ranges. These low-relief alluvial fans form a discontinuous belt between the dissected uplands of the Sierra Nevada and the nearly flat surface of the valley bottom. These alluvial fans are composed of un-deformed to slightly deformed sediments deposited in Quaternary time by streams that drain the adjacent uplands. Each alluvial fan consists of a mass of coarse to fine rock debris that splays outward from the mouth of its stream channel onto the valley floor as a fan-like deposit of well-sorted sand and gravel encased in a matrix of finer sediments, chiefly poorly sorted fine sand and silt deposited away from the stream channels on the alluvial plain.

The task of subdividing alluvial fan deposits into formal stratigraphic units is complicated by the fact that alluvial sediments are often lithologically similar. Davis and Hall (1959) addressed this problem by stating:

> An important problem in attempting to differentiate geologic units in alluvial areas is that the sediments often are derived from a common source and are deposited in similar environments. All or nearly all of the alluvium of the east side of the (Central) Valley is derived from granitic and associated rocks of the Sierra Nevada, which lie to the east. Thus, the formations offer no textural or lithologic basis for subdivision. Nevertheless, the use of the topographic expression of the units in conjunction with the development of their soils makes it possible to define formations.

Two undivided stratigraphic units (from youngest to oldest), the Modesto-Riverbank and the Turlock Lake-Laguna formations, have been reported to yield fossil remains at numerous sites in the Sacramento to Bakersfield region.

Modesto-Riverbank Formations

The Modesto-Riverbank formations are Middle to Late Pleistocene formations (included in **QPc** on Table 2) composed of interbedded, largely unconsolidated, and poorly sorted, brownish sandstone and siltstone with lesser amounts of pebble to cobble conglomerate. The beds of these two formations are primarily fluvial (stream) deposits and are believed to represent the depositional cycle between two major

glacial stages in the Sierra Nevada (Davis and Hall, 1959). The Modesto-Riverbank formations have yielded fossils including clams, fish, turtles, frogs, snakes, birds, bison, mammoths, mastadons, ground sloths, camels, horses, deer, dire wolves, coyotes, rabbits, rodents and land plants remains (including wood, leaves, and seeds). Because fossil vertebrates have been reported previously from these formations and because depositional conditions are favorable for the preservation of fossils, the Modesto-Riverbank formations are judged to have high sensitivity for paleontological resources. There is a high probability of adverse impacts resulting from ground disturbance during construction.

Turlock Lake-Laguna Formations

The Turlock Lake-Laguna formations (included in **QPc** on Table 2) are Pliocene in age and are composed if interbedded and poorly sorted, reddish-brown siltstone and sandstone with lenses of pebble to cobble conglomerate. These beds are fluvial deposits, primarily, but lacustrine (lake) beds are not uncommon. The Turlock Lake-Laguna formations have yielded fossil remains at numerous sites in the Sacramento to Bakersfield region. These remains include petrified wood and the bones and teeth of a diversity of extinct land mammals. Because these units have produced significant fossils in the past, under the Society of Vertebrate Paleontology criteria, the Turlock Lake-Laguna formations are judged to have high sensitivity. Any identifiable fossil remains recovered from these formations during project construction would be scientifically important and significant.

Franciscan Formation

The Franciscan formation (**KJf** on Table 2) sediments range in age from Jurassic to Cretaceous-age sediments. This formation consists mainly of sandstone and shale (or mudstone) but contains lesser amounts of chert, serpentinite, and greenstone. Fossil vertebrates from the Franciscan formation are rare. Molluscan fossils and “modern fresh-water gastropods and pelecypods” have been reported from this formation. Other known invertebrate fauna consists of radiolaria and foraminifera from chert, sandstone, shale, and mudstone sediments. These fossils usually are not considered relevant fossil remains.

3.0 METHODOLOGY FOR PALEONTOLOGICAL RESOURCES

The analysis is focused on a broad comparison of potential impacts to significant nonrenewable paleontological resources along corridors for each of the build alternatives (high-speed train and modal alternatives) and around stations. The potential impacts for each of these alternatives are compared with the No-Project Alternative.

3.1 DATA COLLECTION

The study area for paleontological resources was defined as 100 feet on each side of the centerline of proposed rail routes. For freeway routes and around airports, the study area was defined as 100 feet beyond the existing freeway right-of-way and 100 feet beyond the existing airport property boundary. In non-urban areas, the study area may need expansion to 500 feet on each side of the proposed project centerline, if subsequent design features indicate that paleontological resources beyond the presently defined study area might be affected.

GIS queries of the rock unit descriptors database for California provided by Kleinfelder, Inc. (see *Sacramento-Bakersfield Segment Geology and Soils Technical Evaluation,* March 2003) yielded the geographic distribution of sedimentary rocks and deposits along the various alternative alignments. The potentially fossil-bearing units were given a preliminary ranking for paleontological significance, as described below. Each segment was rated as high of low for paleontological sensitivity, depending on the likelihood of disturbance of paleontologically significant units.

3.2 INTERPRETING PALEONTOLOGICAL SENSITIVITY

Under both state and federal guidelines for cultural resources (including paleontological resources), impacts are potentially significant only if the resource being impacted has been determined to be significant. Section V(c) of Appendix G of CEQA makes reference to “unique paleontological resource(s) or site(s) or unique geological feature(s)”. No definition of what constitutes a "unique" resource or site is provided. Some interpretation is therefore necessary to provide proper resource protection.

3.2.1 Paleontological Resources

Paleontological resources are the fossilized evidence of past life found in the geologic record. Despite the tremendous volume of sedimentary rock deposits preserved worldwide, and the enormous number of organisms that have lived through time, preservation of plant or animal remains as fossils is an extremely rare occurrence. Because of the infrequency of fossil preservation, fossils (particularly vertebrate fossils) are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they can provide, fossils are highly significant records of ancient life. They can provide information about the interrelationships of living organisms, their ancestry, their development and change through time, and their former distribution. Progressive changes observed in fossil lineages may provide critical information on the evolutionary process itself i.e., the ways in which new species arise and adapt to changing environmental circumstances. Fossils can serve as important guides to the ages of the rocks and sediments in which they are contained, and may prove useful in determining the temporal relationships of rock deposits from one area to another and the timing of geologic events. Time scales established by fossils provide chronologic frameworks for geologic studies of all kinds.

3.2.2 Defining Paleontological Significance

Because of the infrequency of fossil preservation, fossils are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they provide, fossils can be highly significant records of ancient life. Given this, fossils can be considered to be of significant scientific interest if one or more of the following criteria apply:

1) The fossils provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct;

2) The fossils provide data useful in determining the age(s) of the rock unit or sedimentary stratum, including data important in determining the depositional history of the region and the timing of geologic events therein;

3) The fossils provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas;

4) The fossils demonstrate unusual or spectacular circumstances in the history of life; and/or

5) The fossils are in short supply and/or in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and are not found in other geographic locations.

As so defined, significant paleontological resources are determined to be fossils or assemblages of fossils that are unique, unusual, rare, uncommon, diagnostically or stratigraphically important, and/or those that add to an existing body of knowledge in specific areas: stratigraphically, taxonomically, and/or regionally. They can include fossil remains of large to very small aquatic and terrestrial vertebrates, remains of plants and animals previously not represented in certain portions of the stratigraphy, and fossils that might aid stratigraphic correlations, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology, and the relationships of aquatic and terrestrial species.

Final determinations of the significance of paleontological resources can be made only by qualified, trained paleontologists familiar with the fossils under consideration. Such determinations are best advanced in the light of a well-conceived and clearly defined treatment plan. With an efficient sampling plan based upon such a treatment program in effect, the ability of the paleontologists to recognize, recover and preserve significant paleontological resources is greatly enhanced.

A preliminary determination of paleontological significance for each sedimentary unit was made based on the five criteria listed above. Of the nine units shown in Table 2 presented later in Section 4.0, Quaternary Dune Sand (Qs), the Franciscan formation (KJf), and the Tertiary volcanics (Tvp) are considered not to contain significant paleontological resources for the purposes of this study because of their low potential to meet any of the criteria. Of the remaining six units, the Pliocene-Pleistocene non-marine units (QPc), the Miocene continental units (Mc), and the Tertiary continental units (Tc) are considered potentially the most significant because of their very good possibility of containing terrestrial fossils (see below). The other three units are marine or mostly marine in origin, and may contain substantial collections of fossils that are less rare than those in the continental units. They are, perhaps, not as sensitive as the continental units, but, nevertheless would be expected to have a good possibility of yielding significant paleontological information.

3.3 DETERMINATIONS OF SEDIMENTARY UNIT SENSITIVITY

Sedimentary units which are paleontologically sensitive are those units which have a high potential of containing significant paleontological resources, i.e., rock units within which vertebrate fossils or significant invertebrate fossils have been determined to be present or likely to be present. These units include, but are not limited to, sedimentary formations that contain significant paleontological resources anywhere within their geographical extent, as well as sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Therefore, determinations of paleontological sensitivity must consider the potential for yielding abundant vertebrate fossils, as well as the potential for production of a few significant fossils, large or small, vertebrate or invertebrate, which may provide new and significant taxonomic, phylogenetic, and/or stratigraphic data. Areas that may contain datable organic remains older than the Recent geologic period (1.6 million years) and areas that may contain unique new vertebrate deposits, traces, and/or trackways must be considered paleontologically sensitive.

3.3.1 Invertebrate Fossils

Generally, invertebrate fossils recovered from marine sediments are widely distributed throughout a given outcrop or formation, are found in predictable locations, and are both abundant and well preserved. In fact, many invertebrate fossils (particularly marine invertebrate fossils) can number in the millions, and can be exposed over miles of outcrop. Some invertebrate fossils are so prolific that they constitute major rock material, such as diatomaceous clay.

Given these general observations, it is clear that sedimentary exposures containing abundant, well-preserved, and extensively-distributed invertebrates, but lacking vertebrate fossils (see below), are less paleontologically sensitive than limited exposures containing few fossils from a restricted depositional zone: for example, a narrow near-shore environment. In the first case, paleontologically significant data lost to adverse impacts (development-related or otherwise) probably could be recovered easily from any other exposures of the impacted formation containing similar fossil density and species diversity. In the second instance (that of the limited exposures from restricted depositional environments) adverse impacts to paleontological resources might not be ameliorated by fossil salvage elsewhere in the formation, because the fossil abundance and species representation probably would be very different. Therefore, in this second case, the sediments under consideration would have higher paleontological sensitivity.

3.3.2 Vertebrate Fossils

Vertebrate fossil (fossils representing animals with backbones, including mammals, birds, reptiles, amphibians and fish) are much more rare than invertebrate fossils and often are more poorly preserved. In marine rock units, significant vertebrate fossils generally are much less common than invertebrate fossils. Paleontological resource localities yielding vertebrate fossils frequently represent terrestrial environments, i.e., non-marine deposits. These continental deposits generally are less depositionally uniform than marine deposits, and, consequently, fossilization is even more infrequent. Further, in life vertebrates often are far less abundant than invertebrates (picture the difference between a herd of hundreds or even thousands of bison versus marine beds containing *hundreds of millions* of bivalves). The infrequency of fossilization and the vicissitudes of the many burial factors involved result in vertebrate fossils being extremely rare relative to their original numbers in life. For these reasons, vertebrate fossil resources are considered to have very high paleontological significance; geologic formations that have the potential to yield vertebrate fossil remains are therefore considered to have the greatest paleontological significance and the highest paleontological sensitivity.

3.3.3 Definitions

GIS queries have resulted in the designation of portions of the study area as having high or low, paleontological sensitivity. Provisions for mitigation of adverse impacts to significant nonrenewable

paleontological resources present within the boundaries of the study area are based on these determinations of potential paleontological sensitivity. The terms “high sensitivity” or “low sensitivity” are described below.

High Sensitivity: a sedimentary unit with a high potential for containing significant nonrenewable paleontological resources is considered to have high paleontological sensitivity.

Low Sensitivity: a sedimentary unit which contains no, or very low density of, recorded resource localities, has produced little or no fossil remains within the study area and/or the vicinity, and is not likely to yield any remains within the study area.

4.0 PALEONTOLOGICAL IMPACTS

4.1 NO-PROJECT ALTERNATIVE

The No-Project Alternative is considered to have a low potential to encroach upon paleontological resources, because planned improvements would have little impact on already disturbed sedimentary and lithologic deposits.

4.2 MODAL ALTERNATIVE

4.2.1 Sacramento to Stockton Corridor

No paleontological resources are expected to be disturbed within this corridor, based on the sedimentary units occurring between Sacramento and Stockton (see Table 2).

4.2.2 Stockton to Modesto Corridor

Approximately 453 acres of sedimentary units with good or very good potential to yield paleontological deposits occur within the study areas defined around the highway widenings of the Modal Alternative. Therefore, there is a high potential to affect paleontological resources.

4.2.3 Modesto to Merced Corridor

Approximately 47 acres of sedimentary units with good or very good potential to contain paleontological deposits are found along the highway improvements proposed for the Modal Alternative. Therefore, the Modal Alternative is rated as having a high potential to disturb paleontological resources between Modesto and Merced.

4.2.4 Merced to Fresno Corridor

Approximately 479 acres of sedimentary deposits with good or very good potential to yield paleontological deposits are within the Modal Alternative study area. Whereas Pliocene-Pleistocene nonmarine sedimentary units and Upper Cretaceous units are found here and in other corridors, the magnitude of sedimentary units suggests a high potential to affect paleontological resources.

4.2.5 Fresno to Tulare Corridor

This reach of the Modal Alternative through the Sacramento to Bakersfield region is considered to have a high potential to encounter paleontological resources, based on the approximately 155 acres of Pliocene-Pleistocene non-marine sedimentary units (very good potential) within the highway study area.

4.2.6 Tulare to Bakersfield Corridor

Approximately 744 acres of sedimentary units known to contain very good or good potential paleontological deposits occur within the study area. Therefore, there is a high potential to disturb paleontological resources in the Tulare to Bakersfield Corridor.

Table 2
Sacramento to Bakersfield Region
Paleontological Resources Impacts

	Formation (acres)								
	Mc[1]	QPc[2]	Qs[3]	E[4]	KJf[5]	Ku[6]	M[7]	Tc[8]	Tvp[9]
Modal									
Sacramento to Stockton	0	0	0	0	0	0	0	0	0
Stockton to Modesto	0	204.6	0	0	0	241.5	7.0	0	0
Modesto to Merced	0	22.1	451.5	25.3	0	0	0	0	0
Merced to Fresno	0	300.5	0	0	214.3	178.8	0	0	0
Fresno to Tulare	0	155.1	0	0	0	0	0	0	0
Tulare to Bakersfield	19.5	650.5	0	0	0	0	17.6	30.9	25.5
HST Corridor & Station Options (10)									
Sacramento to Stockton									
Alignments									
A1	0	0	0	0	0	0	0	0	0
A2	0	33.2	0	0	0	0	0	0	0
A3	0	0	0	0	0	0	0	0	0
A4	0	33.2	0	0	0	0	0	0	0
A5	0	0	0	0	0	0	0	0	0
A6	0	33.2	0	0	0	0	0	0	0
A7	0	0	0	0	0	0	0	0	0
A8	0	33.2	0	0	0	0	0	0	0
Stations									
Sacramento Downtown Depot	0	0	0	0	0	0	0	0	0
Power Inn Road Station (BNSF Option)	0	0	0	0	0	0	0	0	0
Power Inn Road Station (UPRR Option)	0	0	0	0	0	0	0	0	0
Stockton ACE Downtown Station	0	0	0	0	0	0	0	0	0
Maintenance Facilities									
Sacramento Maintenance Facility BNSF Alt	0	0	0	0	0	0	0	0	0
Sacramento Maintenance Facility UPRR Alt	0	0	0	0	0	0	0	0	0

	Formation (acres)								
	Mc[1]	QPc[2]	Qs[3]	E[4]	KJf[5]	Ku[6]	M[7]	Tc[8]	Tvp[9]
Stockton to Modesto									
Alignments									
B1	0	0	0	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0
Stations									
Modesto Downtown Station	0	0	0	0	0	0	0	0	0
Modesto Briggsmore Station	0	0	0	0	0	0	0	0	0
Modesto to Merced									
Alignments									
C1	0	0	343.4	0	0	0	0	0	0
C2	0	0	412.4	0	0	0	0	0	0
C3	0	0	343.4	0	0	0	0	0	0
C4	0	0	412.4	0	0	0	0	0	0
C5	0	0	290.7	0	0	0	0	0	0
C6	0	0	347.1	0	0	0	0	0	0
C7	0	0	290.7	0	0	0	0	0	0
C8	0	0	347.1	0	0	0	0	0	0
C9	0	0	412.4	0	0	0	0	0	0
C10	0	0	412.4	0	0	0	0	0	0
C11	0	0	288.7	0	0	0	0	0	0
C12	0	0	288.7	0	0	0	0	0	0
C13	0	0	480.9	0	0	0	0	0	0
C14	0	0	482.9	0	0	0	0	0	0
C15	0	0	480.9	0	0	0	0	0	0
C16	0	0	482.9	0	0	0	0	0	0
Stations									
Merced Downtown Station	0	0	0	0	0	0	0	0	0
Merced Municipal Airport Station	0	0	0	0	0	0	0	0	0
Castle Air Force Base Station	0	0	10.0	0	0	0	0	0	0
Merced to Fresno									
Alignments									
D1	21.5	0	0	0	0	0	0	0	0
D2	21.5	0	0	0	0	0	0	0	0
D3	21.5	0	0	0	0	0	0	0	0
D4	21.5	0	0	0	0	0	0	0	0
D5	0	0	0	0	0	0	0	0	0
D6	0	0	0	0	0	0	0	0	0
D7	0	0	0	0	0	0	0	0	0
D8	0	0	0	0	0	0	0	0	0
Stations									
Fresno Downtown Station	0	0	0	0	0	0	0	0	0

	Formation (acres)								
	Mc[1]	QPc[2]	Qs[3]	E[4]	KJf[5]	Ku[6]	M[7]	Tc[8]	Tvp[9]
Fresno to Tulare									
Alignments									
E1	0	0	0	0	0	0	0	0	0
E2	0	0	0	0	0	0	0	0	0
Stations									
Visalia Airport Station	0	0	0	0	0	0	0	0	0
Hanford Station	0	0	0	0	0	0	0	0	0
Tulare to Bakersfield									
Alignments									
F1	0	0	0	0	0	0	0	0	0
F2	0	0	0	0	0	0	0	0	0
F3	0	0	0	0	0	0	0	0	0
F4	0	0	0	0	0	0	0	0	0
F5	0	0	0	0	0	0	0	0	0
F6	0	0	0	0	0	0	0	0	0
F7	0	0	0	0	0	0	0	0	0
F8	0	0	0	0	0	0	0	0	0
F9	0	0	0	0	0	0	0	0	0
F10	0	0	0	0	0	0	0	0	0
F11	0	0	0	0	0	0	0	0	0
F12	0	0	0	0	0	0	0	0	0
F13	0	0	0	0	0	0	0	0	0
F14	0	0	0	0	0	0	0	0	0
F15	0	0	0	0	0	0	0	0	0
F16	0	0	0	0	0	0	0	0	0
F17	0	0	0	0	0	0	0	0	0
F18	0	0	0	0	0	0	0	0	0
F19	0	0	0	0	0	0	0	0	0
F20	0	0	0	0	0	0	0	0	0
F21	0	0	0	0	0	0	0	0	0
F22	0	0	0	0	0	0	0	0	0
F23	0	0	0	0	0	0	0	0	0
F24	0	0	0	0	0	0	0	0	0
Stations									
Bakersfield Airport Station	0	0	0	0	0	0	0	0	0
Golden State Station	0	0	0	0	0	0	0	0	0
Truxtun (Union Avenue) Station	0	0	0	0	0	0	0	0	0
Truxtun (Amtrak) Station	0	0	0	0	0	0	0	0	0
Maintenance Facilities									
Main Maintenance Facility BNSF Alt	0	0	0	0	0	0	0	0	0
Main Maintenance Facility UPRR Alt	0	0	0	0	0	0	0	0	0

Formation

[1] Mc - Miocene (continental)
[2] OPc - Pliocene-Pleistocene nonmarine sedimentary
[3] Os - Quaternary Dune Sand
[4] E - Eocene marine sedimentary
[5] KJf - Franciscan formation
[6] Ku - Upper Cretaceous
[7] M - Miocene marine sedimentary
[8] Tc - Tertiary (continental)
[9] Tvp - Tertiary (volcanic)

[10] The HST alignment options for each of the six corridors making up the Sacramento to Bakersfield region are described in Appendix A.

4.3 HIGH-SPEED TRAIN ALTERNATIVE

4.3.1 Alignments

Sacramento to Stockton Corridor

There are eight alignment options in this corridor. The four routes that follow the CCT alignment (i.e., A2, A4, A6 and A8) each overlie about 30 acres of Pleistocene continental deposits. This amount of contact with sedimentary units having a very good potential is considered to rate a high potential for disturbance to paleontological resources. None of the other four routes that follow the UP right-of-way encroach onto sedimentary units with good or very good potential.

Stockton to Modesto Corridor

Neither of the two alignment options in this corridor encroaches onto sedimentary units with a likelihood of paleontological deposits.

Modesto to Merced Corridor

All sixteen HST alignment options between Modesto and Merced cross between 288 and 483 acres of Quaternary dune sand deposits. Because of the low likelihood of these units containing significant paleontological resources, all the alignments are rated as having a low potential to encounter paleontological deposits.

Merced to Fresno Corridor

Eight optional routes are considered in the Merced to Fresno Corridor. The alignment options following the UP (D5, D6, D7 and D8) do not encroach on potential deposits. The alignments following the BNSF (D1, D2, D3 and D4) each cross about 22 acres of Miocene continental deposits, resulting in a high potential to affect paleontological resources.

Fresno to Tulare Corridor

Neither of the two alignments in this corridor crosses potential paleontological deposits.

Tulare to Bakersfield Corridor

All 24 alignment options between Tulare and Bakersfield avoid potential paleontological deposits.

4.3.2 Station and Maintenance Facilities

None of the station or maintenance facility locations in the Sacramento to Bakersfield region cross potentially significant paleontological deposits. At Castle Air Force Base Station in the Merced area, about 10 acres of the station area footprint encroaches into quaternary dune sand, which is not considered a potentially significant paleontological deposit. Therefore, the station locations have low potential to affect significant paleontological deposits.

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APPENDICES

APPENDIX – A

Corridor and Design Options for High-Speed Train Alternative

CORRIDOR AND DESIGN OPTIONS FOR HIGH-SPEED TRAIN ALTERNATIVE

SACRAMENTO TO BAKERSFIELD

Corridor Definition

The Central Valley region has been divided into six discrete corridors:

Corridor A, Sacramento to Stockton

Corridor B, Stockton to Modesto

Corridor C, Modesto to Merced

Corridor D, Merced to Fresno

Corridor E, Fresno to Tulare

Corridor F, Tulare to Bakersfield

Design Options

There are two or more HST alignment alternatives within each Corridor, distinguished by parallel route (UPRR or BNSF), station site served, route connection (UPRR or BNSF) to the south, and station configuration (off-line "loop" or standard). HST alternatives are shown on the alignment exhibits in this Appendix.

Within the Sacramento to Bakersfield region, the HST project would be built primarily at-grade. With the exception of specific and localized grade separations, which may include structures to carry the HST alignment over existing roadway or railroad facilities, proposed aerial structures within the Central Valley would include those listed below. The specific location, number, and length of structures will be determined during the next phase of design.

Aerial Structure Locations			
HST Alignment Option(s)	**Aerial Structure Location**	**Approximate Limits**	**Length (ft)**
Corridor A			
Sacramento Depot alignments: A1 thru A4	Sacramento	Sacramento Downtown Depot to the Elvas Wye	17,000
Sacramento Depot alignments parallel to UPRR north of Stockton: A1, A3	Sacramento	Folsom Blvd to 14th Avenue	6,000
All alignments: A1 thru A8	Stockton	Harding Way to Mormon Slough	7,000
Corridor B			
Modesto Downtown Station alignment: B1	Modesto	Kansas Avenue to Tuolumne River	9,000
Modesto Briggsmore Station alignment: B2	Escalon	Yosemite Avenue to St. John Road	5,000
Modesto Briggsmore Station alignment: B2	Riverbank	South of Patterson Road to Claribel Road	7,000
Corridor C			
All alignments parallel to UPRR north of Merced: C1, C2, C3, C4, C9, C10	Turlock	Broadway to Berkeley Avenue	12,000

Aerial Structure Locations			
HST Alignment Option(s)	**Aerial Structure Location**	**Approximate Limits**	**Length (ft)**
All alignments parallel to UPRR north of Merced: C1, C2, C3, C4, C9, C10	South of Delhi	High Fine Canal to Merced River	8,000
All alignments parallel to UPRR north of Merced: C1, C2, C3, C4, C9, C10	Atwater	Atwater Canal/Jordan Canal to SR99 Overpass	13,000
Corridor D			
All alignments parallel to UPRR north of Fresno: D5, D6, D7, D8	Madera	Fresno River to Olive Avenue	8,000
All alignments: D1 thru D8	Fresno	Ashlan Avenue to Clinton Avenue	12,000
All alignments: D1 thru D8	Fresno	Belmont Avenue to SR180 Overpass	4,000
Corridor E			
Visalia Airport Station alignment: E1	Selma	Floral Avenue to Nebraska Avenue	8,000
Hanford Station alignment: E2	Hanford	11th Avenue to south of 3rd Street	6,000
Corridor F			
All alignments thru Tulare: F1, F2, F7, F8, F13, F15, F16, F19, F20	Tulare	Prosperity Avenue/Avenue 240 to Bardsley Avenue	11,000
All alignments parallel to UPRR north of Bakersfield: F1 thru F4, F7 thru F10, F13 thru F22	Delano	Cecil Avenue to High Street	8,000
All alignments parallel to BNSF north of Bakersfield: F5, F6, F11, F12, F23, F24	Corcoran	Orange Avenue to Pickerell Avenue	6,000
All alignments parallel to BNSF north of Bakersfield: F5, F6, F11, F12, F23, F24	Shafter	Tulare Avenue to Lerdo Highway	4,000
Truxtun (Amtrak) Station (without loop) alignments parallel to UPRR north of Bakersfield: F15 thru F18	Famoso	North of Poso Creek to south of SR99	16,000
Bakersfield Airport Station, Golden State Station, Truxtun (Union Avenue) Station, and Truxtun (Amtrak) Station (with high-speed loop) alignments: F1 thru F6, F7 thru F12 F13, F14, F19 thru F22	Bakersfield	North of Norris Road to Olive Drive	6,000
Bakersfield Airport Station, Golden State Station, Truxtun (Union Avenue) Station, and Truxtun (Amtrak) Station (with high-speed loop) alignments: F1 thru F6, F7 thru F12 F13, F14, F19 thru F22	Bakersfield	Beale Avenue to Mount Vernon Avenue	7,000
Truxtun (Amtrak) Station alignments: F15 thru F24	Bakersfield	North of Mohawk Street to Carrier Canal	8,000
Truxtun (Amtrak) Station alignments: F15 thru F24	Bakersfield	F Street to Truxtun Avenue	14,000