Chapter 27
Paleontological Resources

27.1 Environmental Setting/Affected Environment

In this section, paleontological resources are described within the study area (the area in which impacts may occur), which is defined as the Plan Area (the area covered by the BDCP). The Plan Area consists of the Sacramento–San Joaquin Delta (Delta, Suisun Marsh area, and portions of the Yolo Bypass).Paleontological resources, typically called fossils, are the remains, traces, imprints, or life history artifacts (e.g., nests) of prehistoric plants and animals found in ancient sediments, which may be either unconsolidated or lithified (i.e., either poorly or well cemented). Fossils are considered nonrenewable scientific and educational resources. Fossils include the bones and teeth of animals, the casts and molds of ancient burrows and animal tracks, and very small remains such as the bones of birds and rodents. They also include plant remains such as logs, prehistoric leaf litter, and seeds. Recovered specimens in the Delta area range from the shells of marine invertebrates that occupied the Mesozoic seas before this part of California was uplifted and accreted to the North American continent more than 65 million years ago, to the bones and teeth of extinct Pleistocene megafauna such as mammoths and giant ground sloths that are less than 200,000 years old.

27.1.1 Potential Environmental Effects Area

This section addresses paleontological resources and the potential effects of the BDCP alternatives on paleontological resources in the Delta and Suisun Marsh areas (see Figure 1-9 in Chapter 1, *Introduction*). Information sources for this section include geological, geomorphic, and sedimentological studies, and data from the University of California Museum of Paleontology (UCMP) paleontological database collected for the Delta and its surrounding areas.

The probability of encountering fossils (paleontological sensitivity) depends on the type of geology at an excavation site; the information below is related to geological resources to the extent necessary to assess the presence of fossils. The geological units present in the Delta are discussed in Chapter 9, *Geology and Seismicity*. Figures from Chapter 9 that are helpful to understanding the information presented in this chapter include Figure 9-1, a map showing the geomorphic provinces of California and Figure 9-2, a geologic timescale. Figure 27-2, a geologic map of the Plan Area and vicinity shows surface exposures of geologic units with the potential to contain fossils.

The probability of paleontological resources being present in the Delta, as well as their likely nature and age, is discussed in the following subsections.

27.1.1.1 Physiographic Setting

The Delta encompasses the northern and lowest portion of the San Joaquin Valley and the southern and lowest portion of the Sacramento Valley, which together contain the axial streams of the Central Valley of California: the San Joaquin River to the south and the Sacramento River to the north. The northwest- to southeast-trending Great Valley geomorphic province (also known as the Central Valley physiographic province) is a geologically long-lived structural trough, approximately

400 miles long and 50 miles wide (California Geological Survey 2002). This nearly flat alluvial plain lies between the Sierra Nevada on the east and the Coast Ranges on the west and extends from the Tehachapi Mountains north of Los Angeles to the Klamath Mountains (e.g., Norris and Webb 1990:412–414; Bartow 1991).

The Great Valley is floored by a thick sequence of sedimentary deposits that range in age from Jurassic (about 144 to 208 million years before present [BP]) through Quaternary (present to 1.6 million BP. Under the eastern and central portions of the valley, the base of the sequence likely rests on Mesozoic crystalline rock related to the plutons of the Sierra Nevada; to the west, basement rocks are believed to be Franciscan metasediments (sediments that have undergone metamorphism) and/or mélange (large-scale breccia) similar to exposures in the Coast Ranges. Mesozoic sedimentary rocks now in the subsurface record marine deposition. They are overlain by Tertiary strata reflecting marine, estuarine, and terrestrial conditions, which are in turn overlain by Quaternary fluvial and alluvial strata (river and floodplain deposits) recording uplift and erosion of the Sierra Nevada and Coast Ranges to approximately their present shape (e.g., Norris and Webb 1990:412–414; Bartow 1991).

The region's proximity to the San Andreas Fault Zone results not only in tectonic activity but also in local deformation. The Montezuma Hills constitutes an area of active deformation and a recently upwarped crustal segment (Weber 2005), while the Carquinez Strait itself may have been closed prior to about 0.6 million BP as a result of this activity (Lettis and Unruh 1991). Prior to 0.6 million BP, a vast lake or network of lakes and marshes extended more than 200 miles along the floor of the Central Valley, primarily to the south along the axis of the San Joaquin River. The end of this period of lacustrine deposition during the Middle Pleistocene was likely due to the opening of the Carquinez Strait (Lettis and Unruh 1991), which led to the formation of the geologically "modern" Delta.

27.1.1.2 Geologic and Stratigraphic Setting

Near-Surface, Unconsolidated Geologic Units

The unnamed geological units in the Delta and Suisun Marsh consist of a variety of facies reflecting different environments of deposition, ranging from the clays, silts, and peats of flood basins and marshes to the sands of levee, dune, and river channel deposits. This section presents an overview, rather than a comprehensive listing, of these sediments and their relationships to the environment of the Delta and its contributory streams. The discussion of sediments younger than that of the Modesto Formation (i.e., less than 7,000 BP) is brief because these are usually considered too young (middle to late Holocene age) to yield scientifically significant paleontological specimens.

Recent Overburden and Artificial Fill

Recent overburden and artificial fill are typically considered to have no paleontological sensitivity because there is no potential for these sediments to yield scientifically significant fossils. Recent overburden and artificial fill includes agricultural soils, the sediments of artificially constructed levees, historical flood basin deposits, and the historical "pulse" of outwash sediment from higher elevations resulting not only from hydraulic gold mining in the late nineteenth century, but also from grazing and agricultural land clearance (Florsheim and Mount 2003). The effects of historical land management practices on sedimentation in the Delta have been pronounced, with many areas displaying 5–10 feet of recent sediment immediately below the surface. Other areas immediately

outside the Delta on the distal reaches of the alluvial fan plains of the Sierra Nevada and Coast Ranges did not experience this pulse of sedimentation because of their somewhat elevated topographic position.

Delta and Estuarine Sediments

Although the sedimentary sequence of the Central Valley is commonly thought to be relatively continuous, this is not the case for most of the Delta area. Periodic lowering of sea level occurred in the geologically recent past, resulting in sea level drops of as much as 400 feet during glacial advances over the last 0.7 million BP (Bloom 1983). These in turn caused stream entrenchment and hydrographic isolation of the current floodplains (Shlemon 1971). Concurrent with this entrenchment, the Delta system retreated to the west, and the Sierran alluvial fans expanded westward. Conversely, during interglaciations (periods of warmth comparable to today that punctuated late Quaternary glaciations) such as the current Holocene (the last 11,000 years), sea level rose to near present elevations, creating the present Delta system at the terminal reaches of the Sierra Nevada alluvial fans. The overall relationship between sedimentation, sea level rise and fall, and the glacial-interglacial climate cycle, is that the floodplains across this area are interglacial in age, and there is a lack of glacial-age sedimentation (Shlemon 1971). It also means that the present Delta is geologically quite young, and formed only within approximately the last 6,000 years (Shlemon and Begg 1975).

As sea level rose at the end of the last glacial age, the eastward transgression of estuarine and deltaic environments began. Atwater et al. (1977) noted that estuarine, and then marine, sedimentation began in San Francisco Bay about 10,000 BP. Shlemon (1971) noted the beginning of estuarine habitats in the western portion of the Delta area at about the same time. These authors concluded that, by about 6,000 BP, habitats that characterize the historic Delta occupied much of the area. Geographically, estuarine sediments are more common farther west in the vicinity of Suisun Marsh, and the channels and basins are subject to periodic inundation, especially during the spring and fall high tides. Older, middle Pleistocene delta and estuarine sediment dating to past sea-level high stands are assumed to occur at some depth below the surface of the current Delta. Data from Shlemon (1971; Shlemon and Begg 1975) suggest that this older sediment would occur below about 80 feet below sea level.

Younger Deposits of the Alluvial Fans

The bounding alluvial fans and the fan-delta habitats of their distal reaches—generally above the autumnal high-tide line—experienced a different sedimentary history than the Delta, and glacial-age sediments can be found in those areas at relatively shallow depth (Atwater 1982). Fluvial sedimentation in these areas occurs during overbank floods and from simple river meander after sea level had reached near its present elevation but before the historic channelization of the Delta (Lettis and Unruh 1991). The detailed mapping of the surficial geology of the fan-delta interface (Marchand and Atwater 1979; Atwater 1982) recognizes two units of the Modesto Formation here, as elsewhere. These mapping units consist chiefly of arkosic (quartz- and feldspar-rich) alluvium, chiefly sand, and are thought to represent two periods of glacial outwash from the Sierra Nevada.

- Qm_1, Qm_l: Lower member of the Modesto Formation consisting of arkosic alluvium of the Sierra Nevada alluvial fans; chiefly sand; probably glacial outwash. Finer-grained facies include the silts and clays of flood-basin deposits.

- Qm_2, Qm_u: Upper member of the Modesto Formation also consisting of arkosic alluvium of the alluvial fan of tributary rivers issuing from the Sierra Nevada; chiefly sand; probably glacial outwash. Finer-grained facies include the silts and clays of flood-basin deposits. Eolian facies include isolated, relict dune fields on both Delta islands and the broad plains of the alluvial fans.

  (Note: Qm and similar notations represent specific geological units in an area or region.)

Older Alluvium

Below the Modesto Formation is the older Riverbank Formation. The two formations are lithologically very similar because the sediments that compose each unit were derived from the same rocks in the headwaters of the contributory streams issuing from the Sierra Nevada and were deposited in similar alluvial fan environments. The primary differences between the Modesto and Riverbank Formations are age-related; they include the degree of consolidation/cementation, the amount of deformation (tilting and/or folding), and soil development. The older Riverbank Formation has been uplifted in some locations and can be distinguished based on tilted bedding from the flat-lying younger Quaternary alluvium. Closer to the Sierra Nevada, the Riverbank Formation forms higher terraces in an inverted topographic relationship with younger Modesto Formation deposits. However, discrimination of Modesto Formation alluvium from the Riverbank Formation is difficult in many cases. Where Modesto alluvium overlies the Riverbank Formation, the contact between the two units is frequently marked by a deeply developed paleosol with a pronounced clay horizon (Atwater 1982).

South of Suisun Marsh/Bay and along the southwestern margin of the Delta, an older alluvial unit crops out at the foot of the Coast Ranges. This is the Plio-Pleistocene Tulare Formation, which lies below the Riverbank Formation through much of the San Joaquin Valley (Lettis and Unruh 1991). Although it is normally found at depths exceeding 150 feet in the valley, uplift along the margin of the Coast Ranges has brought it to the surface. It is a poorly consolidated, nonmarine, gray to maroon siltstone, sandstone, and conglomerate. Near its base, the Tulare Formation contains a tuff (volcanic ash) correlated with the Putah Tuff, which has a potassium/argon age of 3.3+0.1 million BP (Graymer et al. 1994), while the upper member of the Tulare Formation contains the Corcoran Clay member, dated as early as 0.62 million BP. The Corcoran clay is a widespread lake deposit that formed approximately 800,000 to 600,000 BP when much of the Central Valley was filled by the Pleistocene Lake Clyde. The lake was drained by the down-cutting that created the modern day Carquinez Straits (Negrini et al. 2008).

In much of the Sacramento Valley north of the Delta, an older alluvial unit occurs stratigraphically below the Modesto Formation. This is the Tehama Formation (Lettis and Unruh 1991), which appears to be about the same age as the Tulare Formation of the San Joaquin Valley. North of Suisun Marsh and the Montezuma Hills on the distal portions of alluvial fans extending south and east from the Coast Ranges, the Tehama Formation forms terraces topographically inverted above the Modesto Formation. Helley and Harwood (1985) describe this partially lithified alluvial unit as a pale green to grey or tan sandstone and siltstone with lenses of cross-bedded pebble and cobble conglomerate.

The Montezuma Formation is another, older alluvial unit of early Pleistocene age, exposed by the local uplift of the Montezuma Hills. This poorly consolidated unit consists of orange-weathering, brown, poorly sorted quartz-lithic sand, silt, and pebble gravel. Pebbles include red chert and volcanics. It is mapped nowhere other than the uplift between Suisun Marsh on the west and the

Sacramento River channel and Brannan Island on the east (Graymer et al. 1994). Given its apparent age, it must be at least in part contemporaneous with the Tehama and Tulare Formations.

Bedrock Sedimentary Units

The Sacramento and the San Joaquin Rivers are the axial streams of their respective valleys, and define the bottom of the Central Valley. However, they are offset far to the west of what would be the geographic centerline of the Central Valley (Lettis and Unruh 1991). The Coast Ranges lie only a few miles to the west of the Delta, and essentially form its western boundary at Carquinez Strait. Conversely, the piedmont of the Sierra Nevada lies tens of miles to the east. Therefore, bedrock units that form the "rim" of the topographic depression encompassing the Delta and Suisun Marsh areas are those of the Coast Ranges, while Sierra Nevadan rocks do not occur in the area, except as clasts in Sierra-derived alluvium.

Neogene Units

The youngest Neogene sedimentary units in the area are the Pliocene to Pleistocene Tulare and Tehama Formations, described previously. They reflect terrestrial conditions after the Central Valley had been closed off to the sea. The next oldest unit reflects near-shore marine conditions. The Neroly Formation is a marine sandstone laid down in an increasingly shallow sea during the mid-Tertiary (late Miocene). With the Tulare Formation, it crops out as the most distal set of ridges and hills on the eastern and northern piedmont of the Coast Ranges, along the southern margin of the Delta.

Paleogene and Mesozoic Units

The Paleogene and Mesozoic sedimentary units of the eastern and northern margin of the Coast Ranges represent a sequence of increasingly deep ocean basins with increasing age. The Paleogene units are the Eocene Markley and Domengine Formations and the Paleocene Meganos Formation. These overlie and, in the tectonic setting of the eastern Coast Ranges south of Suisun Bay and west of the lower San Joaquin River, occur farther out into the valley than the marine sandstones, limestones, and shales that comprise the Great Valley Sequence. The sedimentary units that make up the Mesozoic and earliest Paleogene Great Valley Sequence reflect deep-water conditions when this area was an abyssal plain at the bottom of the ocean, some tens of miles west of an arc of volcanic islands that were situated where the Sierra Nevada is now located.

27.1.1.3 Paleontological Sensitivity of Potentially Affected Units

Paleontological sensitivity is a qualitative assessment made by a professional paleontologist taking into account the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may be germane to fossil preservation and potential yield. According to the Society of Vertebrate Paleontology (2010), standard guidelines for sensitivity are: (1) the potential for a geological unit to yield abundant or significant vertebrate fossils or to yield a few significant fossils, large or small, vertebrate, invertebrate, or paleobotanical remains; and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecological, or stratigraphic data (Table 27-1).

The assessment of the paleontological productivity of different stratigraphic units in the study area was based on the number of paleontological records attributed to those units. This determination was made through queries of the UCMP online database. In these database searches, invertebrate

and microfossil collecting sites were discriminated from the paleobotanical and vertebrate records because there have been many microfossil studies (pollen, radiolaria, diatoms, foraminifera) conducted on Cretaceous and Cenozoic sediments in this area. The associated collection sites are listed in the UCMP database, along with localities where more traditional paleontological "finds" have been made. Many sedimentary exposures that yield microfossils, or isolated invertebrate remains, lack plant or vertebrate megafossils. In addition, many invertebrate and microfossil localities in the UCMP database have no associated catalogued specimens (University of California Museum of Paleontology 2009). Finally, invertebrate localities include sites where a molluscan fauna has yielded important data and sites where only sponge spicules or echinoderm plates were noted. When microfossil and invertebrate localities are excluded, the resultant number of plant megafossil and vertebrate fossil sites is smaller and more reflective of the paleontological potential of the sedimentary unit.

Table 27-1. Paleontological Sensitivity Ratings

Potential	Definition
High	Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontological resources…Paleontological potential consists of both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data.
Undetermined	Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontological resources.
Low	Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or based on general scientific consensus only preserve fossils in rare circumstances and the presence of fossils is the exception not the rule.
No	Some rock units have no potential to contain significant paleontological resources, for instance high-grade metamorphic rocks (such as gneisses and schists) and plutonic igneous rocks (such as granites and diorites). Rock units with no potential require neither protection nor impact mitigation measures relative to paleontological resources.

Source: Society of Vertebrate Paleontology 2010.

The paleontological sensitivity of the geologic units found in the Plan Area is described below and summarized in Table 27-2.

Table 27-2. Summary of Paleontological Resource Sensitivity for Geologic Units in the Plan Area

Geologic Unit	Age	Potential to Contain Significant Fossils
Recent overburden and artificial fill	Modern	No
Near-surface delta and estuarine sediment (mainly the peat and muck unit)	Holocene	Low
Modesto Formation	Holocene and Late Pleistocene (collectively, Late Quaternary)	High
Tehama Formation	Early Pleistocene	High
Montezuma Formation	Early Pleistocene	High
Tulare Formation	Pliocene to Pleistocene	High
Riverbank Formation	Pleistocene	High
Neroly Formation	Miocene	High
Markley Formation	Eocene	High
Domengine Formation	Eocene	Low
Meganos Formation	Paleocene	Low
Great Valley Sequence	Mesozoic	Low

Recent Overburden and Artificial Fill

Artificial fill and recent overburden, such as agricultural soils, are distributed extensively in the Delta and along its margins. The practice of creating land by placing artificial fill on the gently sloping tidal flats along the margin of San Francisco, San Pablo, and Suisun bays began about the time of the gold rush when California's first economic boom created a critical need for development, particularly along the waterfront. Developers used whatever materials were available for fill, including dune sand, alluvium, sediment dredged from the Bay, excavation spoils, quarried rock, and human-made debris such as foundry slag and garbage. Both the thickness and type of fill vary widely over short distances. In other areas of the Delta, fill has been used to create artificial levees and transportation causeways and to "reclaim" agricultural lands. In many cases, fill is indistinguishable from agricultural soils that have been subject to repeated tillage over the last century, and are disturbed usually to a depth of at least 3–4 feet.

No intact fossil material is expected in this type of disturbed sediment, and even if fragmentary remains were encountered they would lack scientific significance because they would not be in stratigraphic context. Lack of stratigraphic context means that the age and geologic setting of the fossil would be uncertain; without this information, the fossil's scientific utility would be compromised. Therefore, recent overburden and artificial fill, including agricultural soils, possess no paleontological sensitivity.

Near-Surface Delta and Estuarine Sediment

In the Plan Area, delta and estuarine sediments are typically Holocene (less than 10,000 BP) in age and possess low paleontological sensitivity. This is partly because recent sediments are traditionally accorded less scrutiny by paleontologists because they seldom yield scientifically significant macroscopic fossil remains. Muds and peats provide a rich source of microfossils for paleoenvironmental studies, but microfossils exist in the uncounted trillions throughout deposits of

estuarine mud and peat. Therefore, because they are recent in age and because they seldom yield scientifically significant megafossils, estuarine sediments, including peat, are assigned low paleontological sensitivity. Underlying these sediments are older Pleistocene sediments, described below.

Quaternary Alluvium

As Florsheim and Mount (2003) described, the substantial lateral variability of environments near the toes of the Sierra Nevada alluvial fans and on the margin of the Delta can result in substantial change in the nature of sediment being deposited over a short distance. Prior to historical disturbance, peats, clays, silts, and sands were laid down through the Delta in response to both temporal and spatial changes in local environment. Fine-grained facies are indicative of low-energy depositional environments of flood basins, sloughs, and ox-bows. These silts and clays, if laid down under anaerobic conditions, would have the greatest paleontological potential. Higher energy sediments of channels and splay deposits are more coarse-grained, but the sands that usually constitute the bulk of this sediment also can be fossiliferous.

Modesto Formation Sediments

Holocene and Late Pleistocene (collectively, Late Quaternary) sediments are distributed in two distinct fashions across the Delta and surrounding area. The Delta consists of middle to Late Holocene sediments alone. However, surface exposures of older sediments assigned to the Late Pleistocene, and perhaps early Holocene, Modesto Formation are situated on the surrounding delta-fan areas and up to the first foothills of the Coast Ranges south of Suisun Bay and east of the lower San Joaquin River (Helley and Harwood 1985; Marchand and Atwater 1979). Table 27-3 lists the number of paleontological localities recorded at the UCMP attributed to the Modesto Formation or to undifferentiated sediments of Quaternary age. Examples of vertebrate fossils found in the Modesto Formation in the Plan Area include unspecified mammals and reptiles (University of California Museum of Paleontology 2012).

Table 27-3. Paleontological Localities Attributed to the Modesto Formation and Undifferentiated Quaternary Sediments

	Number of Localities	
County	Invertebrate and Microfossil	Paleobotanical and Vertebrate
Alameda	54	52
Contra Costa	99	45
Sacramento	3	1
San Joaquin	2	17
Solano	9	7
Sutter	0	4
Yolo	1	5

Source: University of California Museum of Paleontology 2009.

The generally higher numbers of fossil localities in Alameda and Contra Costa Counties in this summary partly reflect the fact that these counties extend across the Coast Ranges to San Francisco Bay and, therefore, encompass many fossiliferous exposures sampled by scientists for decades, as well as many sites where construction-related excavations have exposed fossils. Based on this data,

undifferentiated Quaternary sediment and sediment assigned to the Modesto Formation possess high paleontological sensitivity. Consideration of the data indicates that most fossil localities are from Late Pleistocene or older contexts.

Older Alluvium

Depending on the locality, stratigraphic setting, and authority, older alluvium in the region immediately surrounding the Delta and Suisun Marsh has been mapped as the Tehama and Montezuma Formations to the north, the Tulare Formation to the south, and the Riverbank Formation to the east and south of the Delta and Suisun Marsh (Table 27-4).

Table 27-4. Paleontological Localities Attributed to the Older Alluvium of the Riverbank, Montezuma, Tulare, and Tehama Formations

	Number of Localities	
County	Invertebrate and Microfossil	Paleobotanical and Vertebrate
Alameda	0	3
Contra Costa	5	14
Sacramento	0	6
San Joaquin	0	1
Solano	0	14
Sutter	0	0
Yolo	0	13

Source: University of California Museum of Paleontology 2009.

This tabulation of fossil sites found in older alluvium does not include those localities from the Irvington Gravels near Hayward or the Livermore Gravels, because they are well removed from the Delta and its periphery and have no bearing on the paleontological sensitivity of the area. However, consistent with the prevailing standard of care, California's Pleistocene nonmarine strata have yielded a wealth of stratigraphically important vertebrate fossils, including the assemblages that defined both the Rancholabrean and Irvingtonian Stages of the North American Land Mammal Chronology (Figure 27-1), which is used as a reference by paleontologists and stratigraphers across the country. Because of this wealth of information, continental deposits of Pleistocene age are almost universally treated as paleontologically sensitive in California. Therefore, older alluvium in the area possesses high paleontological sensitivity. Examples of vertebrate fossils found in the counties of the Plan Area in these units include mammoth, horses, rodents, reptiles, bony fish in the Tehama Formation; mammoth, bison, camel, horse, deer, ground sloth, rodents, birds, reptiles, amphibians, cartilaginous fish, bony fish in the Montezuma Formation; birds and bony fish in the Tulare Formation; and mammoth, bison, camel, horse, ground sloth, dire wolf, rodents, moles, and bony fish in the Riverbank Formation (University of California Museum of Paleontology 2012).

Bedrock Sedimentary Units

The Tertiary and Mesozoic sedimentary units of the eastern and northern margin of the Coast Ranges south of Suisun Bay, and also exposed in the Potrero Hills just north of Suisun Marsh, represent a sequence of increasingly shallow ocean basins with decreasing age. Some units are largely devoid of fossils, while others are quite fossiliferous. There is some correlation between

inferred depth at time of deposition and paleontological sensitivity, with sediments from abyssal plains (water depth exceeding 6,000 feet) generally lacking megafossils.

Tertiary Marine Sediments

Prior to the Plio-Pleistocene, sedimentary rocks are marine in origin and include the Miocene Neroly Formation indicating shallowing seas, and the deeper-water sediments of the Eocene Markley and Domengine formations (Table 27-5). The oldest Cenozoic unit mapped for fossils is the Paleocene Meganos Formation. These sediments encroach onto the Delta area and vicinity of Suisun Marsh only in extreme easterly Contra Costa and Alameda counties, and along the northern margin of Suisun Marsh in Solano County. Other marine rocks occur elsewhere in these counties, but they are removed from the Delta margin and the periphery of Suisun Marsh, and are not considered here.

Table 27-5. Paleontological Localities Attributed to Tertiary Marine Sediments of the Neroly, Markley, Domengine, and Meganos Formations

	Number of Localities	
County	Invertebrate and Microfossil	Paleobotanical and Vertebrate
Alameda	0	0
Contra Costa	188	14
Sacramento	0	0
San Joaquin	2	5
Solano	24	1
Sutter	0	0
Yolo	1	0

Source: University of California Museum of Paleontology 2009.

The Neroly and Markley Formations have yielded megafossils and plant remains, while the Domengine has yielded microfossils and some invertebrates. No fossil localities are ascribed to the Meganos Formation in the UCMP database for the seven counties under consideration here. The Neroly and Markley Formations possess high paleontological sensitivity depending on location, and the Domengine and Meganos Formations possess low paleontological sensitivity because they do not appear to yield megafossils of either plants or vertebrates. Examples of vertebrate fossils found in the counties of the Plan Area in these units include early canid, horse, and early pronghorn in the Neroly Formation and bony fish in the Markley Formation (University of California Museum of Paleontology 2012).

Mesozoic Great Valley Sequence

The Mesozoic Great Valley Sequence, representing deep-sea sediments laid down during the Jurassic and Cretaceous Periods prior to 65 million BP, is often difficult to subdivide into formations because the rocks exhibit few distinguishing characteristics that can be easily applied in the field to other outcrops in other counties (Dickinson and Rich 1972). Therefore, at the scale of this analysis, it would be inappropriate to focus a paleontological record search on the named Great Valley Sequence formations that lie closest to the Delta and Suisun Marsh, since in many areas they are not named. Examination of available mapping indicated that they are all of Cretaceous age; accordingly, Jurassic-age localities were excluded from the record review (Table 27-6).

Table 27-6. Paleontological Localities from Cretaceous Marine Sediments of the Great Valley Sequence

	Number of Localities	
County	Invertebrate and Microfossil	Paleobotanical and Vertebrate
Alameda	35	5
Contra Costa	159	6
Sacramento	0	0
San Joaquin	14	0
Solano	45	0
Sutter	4	1
Yolo	45	1

Source: University of California Museum of Paleontology 2009.

Of the 315 fossil localities recorded for the Cretaceous in the counties encompassing the Delta and Suisun Marsh, fully 96% (302) of those are microfossil or invertebrate collection sites. In contrast, only 4% (13 sites) are localities where vertebrate or paleobotanical remains have been recovered. The high number of microfossil and invertebrate locality records reflects the degree to which the Great Valley Sequence has been studied, particularly in Contra Costa County. The small number of fossil vertebrate and plant localities reflects the deep-water deposition of much of this marine sequence. At abyssal depths far from the coast, few macroscopic organic remains reach the sea floor and become entombed in sediment quickly enough to be preserved. Because there is low probability that macroscopic fossil remains would be encountered in these Cretaceous rocks, they are assigned low paleontological sensitivity.

Units Considered for Borrow Material

Several geologic units, some outside the Plan Area, are being considered for borrow material, as described in the conceptual engineering reports. These units are briefly described, and a paleontological sensitivity assigned, in Table 27-7.

Table 27-7. Units Considered for Borrow Material and Their Paleontological Sensitivity

Unit	Age	General Location	Suitability for Borrow	Potential Sensitivity for Paleontological Resources
Yuba River Gold Fields	Modern	East of Yuba City	High	Low, based on age
Floodplain Basin Deposits	Holocene	Found throughout the Sacramento and San Joaquin Valleys; prevalent in the Delta.	Variable	Low, based on age
Modesto Formation (alluvium)	Late Pleistocene	Alluvial deposits in the center of the Sacramento and San Joaquin Valleys.	Medium	High, see text description above
Montezuma Formation (poorly consolidated, clayey sand)	Early Pleistocene	Montezuma Hills, southwest of Rio Vista	High	High, see text description above
Turlock Lake Alluvium	Early Pleistocene	Eastern edge of the Sacramento and San Joaquin Valleys	Medium	Undetermined, based on lack of information in the UCMP database.
San Pablo Group (marine sediments)	Late Miocene	Southwestern border of Sacramento and San Joaquin Delta area	Low	High, based on vertebrate and other fossils records (University of California Museum of Paleontology 2011)
Upper Cretaceous Marine Sedimentary Rocks	Late Cretaceous	West of Clifton Court Forebay	Low	Low, see text above
Panoche Formation	Late Cretaceous	West and southwest of Clifton Court Forebay	Low	High, based on vertebrate and other fossils records (University of California Museum of Paleontology 2011)
Franciscan Complex (melange)	Late Cretaceous to Jurassic	Coast Ranges west of I- 5 and south of I-580	Low	High, based on vertebrate and other fossils records (University of California Museum of Paleontology 2011)

Note: Except for paleontological sensitivity, the source for this table is DWR's 2010 Conceptual Engineering Report, All Tunnel Option, March 2010 (California Department of Water Resources 2010).

27.2 Regulatory Setting

27.2.1 Federal Plans, Policies, and Regulations

27.2.1.1 Antiquities Act of 1906

The Antiquities Act of 1906 (Public Law 59-209; 16 United States Code [USC] 431 et seq.; 34 Stat. 225) requires protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. Paleontological resources are included in this

category by many federal agencies, such as the Bureau of Land Management. In addition, NEPA (USC 4321 et seq.; 40 Code of Federal Regulations [CFR] 1502.25), as amended, requires federal agencies to consider the impact of their actions (including the issuance of entitlements or permits, or financial support, to a project) on important historic, cultural, and natural aspects of our national heritage. Because federally managed lands may be affected by the alternatives and because federal entitlement or permits will be required, these statutes extend to paleontological resources in the Delta. A characterization of paleontological resources that may be affected by BDCP activities and an assessment of effects of the action alternatives are required.

27.2.1.2 Omnibus Public Land Management Act of 2009

On March 31, 2009, President Obama signed into law the Omnibus Public Land Management Act of 2009 (H.R. 146) (OPLMA). Title 6, Subtitle D of the OPLMA, *Paleontological Resources Preservation*, requires the secretaries of the Department of the Interior (exclusive of Indian trust lands) and the Department of Agriculture (insofar as U.S. Forest System lands are concerned) to "… manage and protect paleontological resources on Federal land using scientific principals and expertise… [and] develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources …" The OPLMA further excludes casual collection from restrictions under the law, and then describes the requirements for permitting collection on federal lands, stipulations regarding the use of paleontological resources in education, continued federal ownership of recovered paleontological resources, and standards for acceptable repositories of collected specimens and associated data (Sections 6303–6305). The OPLMA also provides for criminal and civil penalties for unauthorized removal of paleontological resources from federal land, and for rewards for reporting the theft of fossils (Sections 6306–6309).

27.2.1.3 Federal Land Policy and Management Act (1976)

The Federal Land Policy and Management Act of 1976 (FLPMA) mandates the treatment of paleontological resources as a scientific value (FLPMA section 102[8]). This act strengthens the references pertaining to suitability and compatibility of land areas, stresses the maintenance of productivity, and seeks to avoid the permanent impairment of the productive capability of the land. For the purpose of this analysis, and in accordance with existing BLM policy, scientifically significant paleontological resources are defined as vertebrate fossils that are identifiable to taxon and/or element, noteworthy occurrences of invertebrate and plant fossils, and vertebrate trackways.

27.2.1.4 Code of Federal Regulations, Title 43

Title 43 CFR, Subpart 8200: This addresses procedures and practices for the management of lands that have outstanding natural history values, including fossils, which are of scientific interest.

Title 43 CFR, Subpart 8365.1-5: This addresses the willful disturbance, removal, and/or destruction of scientific resources or natural objects and Subpart 8360.0-7 identifies the penalties for such violations.

27.2.1.5 Secretarial of the Interior Order 3104

This grants the BLM the authority to issue paleontological resource use permits for lands under its jurisdiction.

27.2.2 State Plans, Policies, and Regulations

State requirements for paleontological resource management are in Pub. Res. Code Chapter 1.7, Section 5097.5/5097.9 (Stats. 1965, c. 1136, p. 2792), *Archaeological, Paleontological, and Historical Sites*. This statute defines any unauthorized disturbance or removal of a fossil site or remains on public land as a misdemeanor, and specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources.

27.2.3 Regional and Local Plans, Policies, and Regulations

Historically, general plans did not provide for the preservation of paleontological resources; however, more recently, some plans have included such provisions and, as plans are updated, the updates often include oversight of paleontological resources in response to increased public awareness of the value of those resources. Where general plans in the study area do contain policies relating to paleontological resources, such policies have informed the evaluation and mitigation of impacts to such resources.

The general plans or development titles for Sacramento, Yolo, and San Joaquin Counties place emphasis on the preservation of historic and cultural values and on compliance with CEQA. However, their planning documents do not directly consider paleontological resources.

27.2.3.1 Alameda County

The Alameda County East County Area Plan (Alameda County 2000) places emphasis on the preservation of historic and cultural resources, including heritage resources, but does not address paleontological resources. Nevertheless, county approval of projects includes review for CEQA compliance, and the CEQA Environmental Checklist employed does include the Appendix G, Section V, part c question regarding paleontological resources. Alameda County is also home to the University of California Berkeley and the UCMP, which is one of the preeminent museums of paleontology in the United States.

27.2.3.2 Sacramento County

The Conservation Element of the County of Sacramento General Plan (Sacramento County 2011) emphasizes the educational, historic, and scientific importance of paleontological resources and notes that there are at least five recorded sites in Sacramento County which have revealed fossil remains dating back to 100,000 years ago. Policies within the Conservation Element that help to ensure that future finds of paleontological resources are protected include the following:

- **Policy CO-161:** As a condition of approval for discretionary projects, require appropriate mitigation to reduce potential impacts where development could adversely affect paleontological resources.
- **Policy CO-162:** Projects located within areas known to be sensitive for paleontological resources, should be monitored to ensure proper treatment of resources and to ensure crews follow proper reporting, safeguards and procedures.
- **Policy CO-163:** Require that a certified geologist or paleoresources consultant determine appropriate protection measures when resources are discovered during the course of development and land altering activities.

27.2.3.3 San Joaquin County

The Heritage Resources Element of the San Joaquin County General Plan (San Joaquin County 1992) addresses heritage resources, including paleontological resources. The San Joaquin County General Plan notes that the County is involved with paleontological (and archaeological) sites in two ways: (1) project applications requiring the gathering of information, and (2) ensuring that if paleontological sites are found during construction, that the project will be "stopped until a qualified archaeologist has investigated the area and has determined the appropriate actions to take to protect the resource" (San Joaquin County 1992).

27.2.3.4 Solano County

The updated 2008 Solano County General Plan addresses paleontological resources in its attendant EIR (Solano County 2008). Another component of the General Plan relevant to paleontological resources is the *Cultural and Paleontological Resources Background Report* in the General Plan EIR (Solano County 2006). In its impact analysis, the EIR notes:

> Development within Solano County in accordance with the 2008 Draft General Plan under the Preferred Plan [or the Maximum Development Scenario] may result in the destruction of paleontological resources. This impact would be potentially significant.

The EIR further states that, to reduce potentially significant impacts on paleontological resources to a less-than-significant level, the county will implement the following measures.

(a) Actions that do not meet the CEQA definition of a "project" and therefore do not require an environmental analysis under the CEQA process shall not be required to perform a paleontological resources analysis.

(b) All projects in Solano County that are subject to a CEQA evaluation shall include a site-specific analysis of paleontological resources. At a minimum, the site-specific analysis shall include a review of the types of the geologic formation(s) present at the project site and a determination of the likelihood that those formation(s) would contain a "unique paleontological resource" as stated in Title 14, California Code of Regulations, Appendix G (the CEQA checklist). If the site-specific analysis determines that a project may have an adverse effect on a "unique paleontological resource," the County shall require that project specific mitigation measures be implemented to address the following:

- Cessation of work in the vicinity of the find and notification of the County Planning Department and the lead agency for the project;
- Retention by the project applicant of a qualified paleontologist to evaluate the resource and prepare a proposed mitigation plan, which may include some or all of the following elements: a field survey, construction monitoring, sampling and data recovery procedures, museum storage coordination for any specimen recovered, and a report of findings; and
- Implementation of recommendations made by the paleontologist, where the lead agency for the project determines that said recommendations are necessary and feasible.

27.2.3.5 Yolo County

The Conservation and Open Space Element of the County of Yolo 2030 Countywide General Plan (County of Yolo 2009) includes policies to protect cultural resources, including paleontological resources. In particular, the Conservation and Open Space Element includes the following implementation actions related to paleontological resources:

- Action CO-A63: Require cultural resources inventories of all new development projects in areas where a preliminary site survey indicates a medium or high potential for archaeological, historical, or paleontological resources. In addition, require a mitigation plan to protect the resource before the issuance of permits. Mitigation may include:
    - Having a qualified archaeologist or paleontologist present during initial grading or trenching;
    - Redesign of the project to avoid historic or paleontologist present during the initial grading or trenching;
    - Capping the site with a layer of fill; and/or;
    - Excavation and removal of the historical or paleontological resources and curation in an appropriate facility under the direction of a qualified professional.

27.3 Environmental Consequences

27.3.1 Methods for Analysis

The primary source of information used in developing this section is the paleontological database at the University of California Museum of Paleontology. Effects on paleontological resources were analyzed qualitatively on a large-scale level, based on professional judgment and the Society of Vertebrate Paleontology (SVP) guidelines below.

SVP's *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* provides standard guidelines that are widely followed (Society of Vertebrate Paleontology 2010). These guidelines reflect the accepted standard of care for paleontological resources. The SVP guidelines identify two key phases in the process for protecting paleontological resources from project impacts.

- Assess the likelihood that the project's area of potential effect contains significant nonrenewable paleontological resources that could be directly or indirectly impacted, damaged, or destroyed as a result of the project.
- Formulate and implement measures to mitigate potential adverse impacts.

An important strength of SVP's approach to assessing potential impacts on paleontological resources is that the SVP guidelines provide some standardization in evaluating a Plan Area's paleontological sensitivity. Table 27-8 defines the SVP's sensitivity categories for paleontological resources and summarizes SVP's recommended treatments to avoid adverse effects in each sensitivity category.

Table 27-8. Society of Vertebrate Paleontology's Recommended Treatment for Paleontological Resources

Sensitivity Category	Mitigation Treatment
High or Undetermined	• An intensive field survey and surface salvage prior to earth moving, if applicable. • Monitoring by a qualified paleontological resource monitor of excavations. • Salvage of unearthed fossil remains and/or traces (e.g., tracks, trails, burrows). • Screen washing to recover small specimens, if applicable. • Preliminary survey and surface salvage before construction begins. • Preparation of salvaged fossils to a point of being ready for curation (i.e., removal of enclosing matrix, stabilization and repair of specimens, and construction of reinforced support cradles where appropriate). • Identification, cataloging, curation, and provision for repository storage of prepared fossil specimens. • A final report of the finds and their significance.
Low or no	Rock units with low or no potential typically will not require impact mitigation measures to protect fossils.

Source: Society of Vertebrate Paleontology 2010.

27.3.2 Determination of Effects

CEQA requires that public agencies and private interests identify the environmental consequences of their proposed projects on any object, or site, of significance to the scientific annals of California (Division I, California Pub. Res. Code: 5020.1 [b]). CEQA Guidelines define procedures, types of activities, persons, and public agencies required to comply with CEQA. Appendix G in Section 15023 provides an Environmental Checklist of questions that a lead agency should normally address to comply with CEQA. One of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section V, part c) is: "Would the project directly or indirectly destroy a unique paleontological resource or site …?"

SVP's guidelines also provide a working definition of *significance* as applied to paleontological resources. According to SVP, significant paleontological resources are those that fulfill one or more of the following criteria (Society of Vertebrate Paleontology 2010).

- Provide important information shedding light on evolutionary trends or helping to relate living organisms to extinct organisms.
- Provide important information regarding the development of biological communities.
- Demonstrate unusual circumstances in the history of life.
- Represent a rare taxon or a rare or unique occurrence; are in short supply and in danger of being destroyed or depleted.
- Have a special and particular quality, such as being the oldest of their type or the best available example of their type.
- Provide important information used to correlate strata for which it may be difficult to obtain other types of age dates.

Significant paleontological resources may include vertebrate fossils and their associated taphonomic (fossilization) and environmental indicators, invertebrate fossils, or plant fossils.

Effects on paleontological resources were analyzed qualitatively on the basis of professional judgment. This analysis focuses on (1) identifying activities with the potential to disturb, damage, or destroy paleontological resources if any are present on the work site and (2) developing a strategy to ensure that mitigation requiring paleontological sensitivity assessment and appropriate treatment developed on a site-specific basis is in place for those activities identified as likely to result in damage.

Two factors are considered when evaluating a proposed project's potential to disturb or damage significant paleontological resources. First, most vertebrate fossils are rare and are therefore considered important paleontological resources. Second, unlike archaeological sites, which are narrowly defined, paleontological sites are defined by the entire extent (both areal and stratigraphic) of a unit or formation. In other words, once a unit is identified as containing vertebrate fossils or other rare fossils, the entire unit is a paleontological site (Society of Vertebrate Paleontology 2010).

This impact analysis assumes that an action alternative would have an adverse effect (under NEPA) and a significant impact (under CEQA) on paleontological resources if the alternative would directly or indirectly destroy a unique or significant paleontological resource or site. For all action alternatives, operation and maintenance of BDCP facilities would not involve extensive ground-disturbing activities and modified operations and associated maintenance would not substantially increase erosion. Therefore, paleontological resources would not be disturbed and there would be no effect on paleontological resources as a result of operation or maintenance of any of the action alternatives.

27.3.2.1 Compatibility with Plans and Policies

Constructing the proposed water conveyance facility (CM1) and implementing CM2–CM22 could potentially result in incompatibilities with plans and policies related to paleontological resources. Section 27.2, *Regulatory Setting*, provides an overview of federal, state, regional and agency-specific plans and policies applicable to paleontological resources. This section summarizes ways in which BDCP is compatible or incompatible with those plans and policies. Potential incompatibilities with local plans or policies, or with those not binding on the state or federal governments, do not necessarily translate into adverse environmental effects under NEPA or CEQA. Even where an incompatibility "on paper" exists, it does not by itself constitute an adverse physical effect on the environment, but rather may indicate the potential for a proposed activity to have a physical effect on the environment. The relationship between plans, policies, and regulations and impacts on the physical environment is discussed in Chapter 13, *Land Use*, Section 13.2.3.

The Antiquities Act of 1906 (Public Law 59-209; 16 United States Code [USC] 431 et seq.; 34 Stat. 225) requires protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. In accordance with CEQ Regulations (40 CFR 1502.25), as amended, this EIR/EIS discusses the paleontological resources that may be affected by the BDCP alternatives.

Implementation of Mitigation Measures PALEO-1b through PALEO-1d (discussed below), will ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or

recovered and curated so they remain available for scientific study, which is consistent with the purpose of the Antiquities Act of 1906 as well as the OPLMA. These measures also further the intent of the local county plans in ensuring that there is oversight of paleontological resources during construction activities associated with the BDCP.

27.3.3 Effects and Mitigation Approaches

27.3.3.1 No Action Alternative

The No Action Alternative is the future condition that would occur in the Plan Area if none of the action alternatives were approved and if no change from current management direction or the level of management intensity occurred as of the year 2060. The No Action Alternative considers changes in ground disturbance that would take place as a result of the continuation of existing plans, policies, and operations, as described in Chapter 3, *Description of Alternatives*. The No Action Alternative includes projects and programs with defined management or operational plans, including facilities under construction as of February 13, 2009, because those actions would be consistent with the continuation of existing management direction or level of management for plans, policies, and operations by the lead agencies and other agencies. The No Action Alternative assumptions also include projects and programs that received approvals and permits in 2009 to remain consistent with existing management direction.

Unique or Significant Paleontological Resources

Many of the ongoing projects and programs in the Delta will require ground-disturbing construction to either construct new facilities or implement restoration and habitat enhancement goals. In addition, many planning documents that govern portions of the Delta include buildout footprints that allow development of undisturbed land that is likely to contain paleontological resources. Examples of these projects, programs, and planning documents are given below.

SWP/CVP operations, identified as continuing actions under the No Action Alternative, include repair, maintenance, or protection of infrastructure such as levees, and may also include actions for water quality management, habitat and species protection, and flood management. These continuing actions could occur throughout the Plan Area and could result in effects on paleontological resources, depending on the type of construction needed for repairs or adjustments to potential irrigation water and drainage needed for water quality and flood management. The projects identified in Table 27-9 below may affect paleontological resources. A complete list and description of programs and plans considered under the No Action Alternative is provided in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*.

Table 27-9. Effects on Paleontological Resources from the Plans, Policies, and Programs for the No Action Alternative

Agency	Program/Project	Status	Description of Program/Project	Effect on Paleontological Resources
California Department of Water Resources and Solano County Water Agency	North Bay Aqueduct Alternative Intake Project	Draft EIR is ongoing	This project will construct an alternative intake on the Sacramento River and a new segment of pipeline to connect it to the North Bay Aqueduct system.	The pipeline segment of the project could have adverse impacts on paleontological resources. Ground-disturbing activities associated with construction of the intake and pipeline could disturb units sensitive for paleontological resources, such as the Modesto and Riverbank Formations.
Reclamation District 2093	Liberty Island Conservation Bank		This project includes the restoration of inaccessible, flood prone land zoned as agriculture but not actively farmed, to area enhancement of wildlife resources.	No known record exists of any paleontological resources on the project site and no known unique geological features were identified or are known to exist on the project site. The presence of paleontological resources is highly unlikely.
California High Speed Rail Authority and Federal Railroad Administration	California High-Speed Rail System, Sacramento to Merced Section	Briefing on Initial Alternatives completed. Sacramento to Merced section is part of Phase 2.	Development of new high-speed rail service. Near-term improvements could include right-of-way preservation, interim operation on existing tracks, and passing sidings. Future improvements would construct a new rail line.	No paleontological resources are expected to be disturbed within this corridor, based on the sedimentary units occurring between Sacramento and Stockton
Bureau of Reclamation	Delta-Mendota Canal/California Aqueduct Intertie	Completed in 2012	The purpose of the intertie is to better coordinate water delivery operations between the California Aqueduct (state) and the Delta-Mendota Canal (federal) and to provide better pumping capacity for the Jones Pumping Plant. New project facilities include a pipeline and pumping plant.	No impacts to paleontological resources are expected.

Agency	Program/Project	Status	Description of Program/Project	Effect on Paleontological Resources
Yolo Basin Foundation and the Delta Protection Commission	Lower Yolo Bypass Planning Forum	Conservation Measures and a draft of Management Recommendation Planning Goals have been completed.	Documents include recommendations, goals, and strategies for management of the Yolo Bypass.	No impacts to paleontological resources are expected.
City of Stockton	Delta Water Supply Project (Phase 1)	Currently under construction	This project consists of a new intake structure and pumping station adjacent to the San Joaquin River; a water treatment plant along Lower Sacramento Road; and water pipelines along Eight Mile, Davis, and Lower Sacramento Roads.	This project could disturb units sensitive for paleontological resources, such as the Riverbank Formation.
Bureau of Reclamation and California Department of Water Resources	SWP/CVP operations	Continuing actions	Includes repair, maintenance, or protection of imperiled infrastructure such as levees, and may also include actions for water quality management, habitat and species protection, or flood management	Repair, maintenance or protection of levees could disturb paleontological resources.
Zone 7 Water Agency and California Department of Water Resources	South Bay Aqueduct Improvement and Enlargement Project	Completed	The South Bay Aqueduct Improvement and Enlargement Project will improve and expand the existing South Bay Aqueduct. The project will increase the existing capacity of the water conveyance system up to its design capacity of 300 cfs, and expand capacity in a portion of the project to add 130 cfs (total of 430 cfs).	This project could disturb units sensitive for paleontological resources, such as the Panoche and Neroly Formations.
Yolo County	Yolo County General Plan Update	Continuing actions	County of Yolo's 2030 Countywide General Plan allows for additional growth in unincorporated areas of the county of just under 31,000 people, up to 10,462 homes, and 1.5% growth in average annual employment.	Buildout contemplated under the updated general plan will result in ground-disturbing construction that could affect geologic units sensitive for paleontological resources, such as the Modesto and Tehama Formations.

Agency	Program/Project	Status	Description of Program/Project	Effect on Paleontological Resources
CALFED Levee Stability Program	Existing project levees in the Delta	Continuing actions	Protection of resources in the Delta through maintenance and improvement of existing levees	This program will result in the repair of project and non-project levees in the Delta. Ground-disturbing construction and borrow activity necessary to complete typical improvements could disturb geologic units sensitive for paleontological resources, such as the Modesto and Riverbank Formations.
NMFS/USFWS	2008 and 2009 Biological Opinion	Ongoing	The Biological Opinions issued by NMFS and USFWS establish certain RPAs to be implemented. Some of the RPAs require habitat restoration.	The location of the required 8,000 acres of habitat restoration has not yet been identified, but construction of this habitat may disturb geologic units sensitive for paleontological resources.

These plans and projects are examples of planning frameworks and project-level actions that exist and are ongoing in the Delta. Because of the ground-disturbing activities associated with these undertakings, the suite of all ongoing projects and programs in the Delta could both singly and collectively result in adverse effects on paleontological resources.

Catastrophic Seismic Risks

The Delta and vicinity is within a highly active seismic area, with a generally high potential for major future earthquake events along nearby and/or regional faults, and with the probability for such events increasing over time. Based on the location, extent and non-engineered nature of many existing levee structures in the Delta area, the potential for significant damage to, or failure of, these structures during a major local seismic event is generally moderate to high. In the instance of a large seismic event, levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region. (See Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies* for more detailed discussion). Reclaiming land or rebuilding levees after a catastrophic event due to climate change or a seismic event could result in the destruction of unique paleontological resources.

***CEQA Conclusion*:** Under the No Project Alternative, no BDCP-related water conveyance facilities would be constructed (CM1) and none of the other conservation measures would be implemented (CM2–CM22). Existing approved projects and programs in the Plan Area would continue. Many of these programs would result in ground-disturbing work in the Plan Area and surrounding region. Because the region is sensitive for paleontological resources, these actions could collectively result in disturbance of paleontological resources and a potentially significant impact.

27.3.3.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 1A in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10. A detailed depiction of the Pipeline/Tunnel alternative is provided in Figure M3-1 in the Mapbook Volume.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Construction of water conveyance facilities under Alternative 1A could cause the destruction of unique paleontological resources as a result of excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to the Jones and Banks pumping plants, other water facility components, roads, and borrow sites.

The depth, extent, and location of excavation and other ground-disturbing activities vary greatly across the Plan Area (Table 27-10). Accordingly, this discussion considers these activities on the basis of their location and the depth of excavation.

The five intakes and the intermediate forebay (Figure 27-2) would entail deep and extensive excavation in the northern portion of the Plan Area (Table 27-10). The five intakes and the pumping plant and sedimentation basin associated with each intake would be along the east bank of the Sacramento River between Clarksburg and Walnut Grove. The intermediate forebay and its associated pumping plant would be located adjacent to the west of South Stone Lake. Ground-disturbing activities include clearing and grubbing, rough grading, excavation, pile driving, constructing foundations, and final grading. Construction of the intakes, pumping plants, and sedimentation basins would involve excavation to a depth of between 20–35 feet over an area of 330 acres. The staging/storage area and construction zone preparation would involve 76–148 acres per intake structure. Construction for the intermediate forebay would involve excavation of approximately 760 acres to a depth of approximately 15–20 feet below existing grade.

Table 27-10. Summary of Conveyance Construction Activities and Geologic Units Sensitive for Paleontological Resources That Could Be Disturbed under Alternative 1A

Alternative 1A	Location	Construction/Excavation	Sensitive Units Disturbed
Five new north Delta intakes	East bank Sacramento River between Clarksburg and Walnut Grove	30 ft below existing grade; 330 ac total, including pumping plants and sedimentation basins	Riverbank and Modesto Formations
New intake pumping plants and sedimentation basins	Adjacent to intakes	Sedimentation basin 20–30 ft below existing grade; pumping plant 25–30 ft below existing grade; staging/storage area and construction zone prep (76–148 ac per intake structure, including sedimentation basin and pumping plant)	Riverbank and Modesto Formations
New intermediate pumping plant	South side of Intermediate Forebay	Slab invert 15–20 ft below existing grade; 3 ac total	Riverbank Formation and Modesto Formations
Byron Tract Forebay, canals to Jones and Banks pumping plants	Just south of Clifton Court Forebay	592 ac to a depth of 15–20 ft below existing grade	Modesto Formation eolian deposits, alluvium from Corral Hollow Drainage to Brushy Creek
Intermediate forebay	Near Hood	760 ac to a depth of 15–20 ft below existing grade	Riverbank Formation and Modesto Formations
Tunnel 1	Single-bore 29-ft-diameter tunnel, 29,200 ft from intake pumping plants to Intermediate Forebay between South Stone Lake and the Sacramento River	Shaft to 100–150 ft below existing grade; tunnel invert at 150 ft; boring using pressurized face mechanized tunneling machines, including earth pressure balance (EPB) machines and slurry tunneling machines	Riverbank and Modesto Formations
Tunnel 2	Dual-bore 33-ft-diameter tunnel, 176,496 feet from Intermediate Forebay to Byron Tract Forebay	Same as Tunnel 1	Riverbank and Modesto Formations

Excavation for the intakes and intermediate forebay would be conducted in geologic units both sensitive and nonsensitive for paleontological resources (Figure 27-2). Although most of the surficial geologic units in the area affected by excavation for the intakes and forebays are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation, which is of Pleistocene age and sensitive for paleontological resources, is exposed at the surface in some locations or underlies the Holocene units in the shallow subsurface. The Modesto Formation, another Pleistocene-age unit that is sensitive for paleontological resources, also occurs in the area and likely is exposed at the surface and in the shallow subsurface. These Pleistocene units likely

occur at a depth of less than 5 feet and would therefore be disturbed during excavation of the intakes and intermediate forebay (Figure 27-3).

Pipeline construction would involve excavation in the northern portion of the Plan Area (Figure 27-2; Table 27-10). The pipelines would extend from the intakes to the sedimentation basin and intake pumping plants and from the intake pumping plants to the intermediate forebay. Pipeline excavation would use open trenching to a minimum depth of approximately 30 feet but could be deeper, depending on local conditions. Trench widths would be approximately 220 feet.

Excavation for the pipelines would, like that for the intakes and the intermediate forebay, occur in both sensitive and nonsensitive units. Although most of the surficial geologic units in the area affected by excavation for the pipelines are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation and Modesto Formation are exposed at the surface and occur in the shallow subsurface. These Pleistocene units likely occur at a depth of 0 to 10 feet and would therefore be disturbed during excavation for pipelines.

Construction of Tunnels 1 and 2 would entail deep excavation using a tunnel-boring machine (TBM) (Table 27-10). Tunnel 1 would extend from the intake pumping plants to the intermediate forebay between South Stone Lake and the Sacramento River, just south of Hood. The main construction or launching shafts for each tunnel would be about 60 feet in diameter. The TBM retrieval shaft would be approximately 45 feet in diameter, and 12-foot-diameter intermediate ventilation shafts would be constructed approximately every 3 miles along the tunnel route. The amount of material that would be excavated, which is the least of the tunnel or canal options, is shown in Table 27-11. The tunnels would be excavated at a depth of approximately 100–150 feet at the tunnel invert, mainly to avoid the peaty Holocene soils. The TBMs would be mechanized soft-ground tunneling machines designed for use in soft soils with high groundwater pressure. The tunnels would be lined with precast concrete bolted-and-gasketed segments. The tunnel concrete liner would serve as permanent ground support and would be installed immediately behind the TBM, forming a continuous watertight vessel.

Table 27-11. Amount of Excavated Material by Feature

	Material Excavated (cubic yards)			
Alternative	Borrow	Tunnel	Canals	Tunnel and Canal Combined
1A	13,500,000	14,319,000	378,000	14,697,000
1B	200,000,000	475,000	38,427,000	38,902,000
1C	200,000,000	3,379,000	25,282,000	28,660,000
4	13,700,000 [a]	18,744,000	1,897,000	20,640,000
9	2,670,000	0	1,938,000	1,938,000

Note: These numbers are very preliminary and for comparison purposes only.

[a] While the amount of borrow material excavated for this alternative could be up to this amount, it is anticipated that it may be less due to Alternative 4 including only 3 intakes.

Shafts and tunnels would be excavated through Holocene and Pleistocene deposits (Figures 27-2 and 27-3). Shafts would be excavated through surficial Holocene deposits and then through Pleistocene deposits of the Riverbank or Modesto Formations. Tunnels would be bored wholly through Pleistocene deposits. Construction of the Byron Tract Forebay would involve deep and extensive excavation directly southeast of Clifton Court Forebay (Figure 27-2). Excavation would

involve approximately 592 acres to a depth of approximately 15–20 feet below existing grade, except locally at the inlet and outlet connections (Table 27-10). The invert of the incoming canal would be at -28 feet msl before discharging to the tunnel.

Excavation for the Byron Tract Forebay would occur in both sensitive and nonsensitive units (Figure 27-2). Although much of the area surrounding the Clifton Court Forebay is covered in surficial units of Holocene age such as the Holocene alluvial-floodplain deposits (Qfp), which are not sensitive for paleontological resources, units sensitive for paleontological resources are also exposed at the surface and underlie the area (Figure 27-2). These units include the Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek (Qch), which is sensitive for paleontological resources.

Construction of a new canal, between the Clifton Court Forebay and Union Pacific Railroad, would connect the forebay to the existing approach canal to the Banks Pumping Plant. The new canal would be excavated to a depth of 12–15 feet below existing grade. The forebay would be connected to the existing approach canal to the Jones Pumping Plant by breaching a section of the existing canal's embankment adjacent to Byron Tract Forebay.

Excavation for the Byron Tract Forebay and new approach to the Banks Pumping Plant would disturb these Pleistocene units. Breaching of the existing canal embankment would not disturb Pleistocene units.

The temporary and permanent access roads required for Alternative 1A would involve shallow excavation and grading, primarily along existing farm roads or across lands disturbed by agricultural activity. It is unlikely that this shallow ground disturbance would affect significant paleontological resources.

Borrow material would be needed primarily for forebay embankments and levee reconstruction at intake sites, but also for access roads. The amount of material that would be needed for borrow, which is the least of the tunnel or canal options, is shown in Table 27-11. Borrow material would be excavated from targeted units described in the engineering report (California Department of Water Resources 2010). Some of these units, including the Modesto and Montezuma Formations, are sensitive for paleontological resources. Excavation of borrow material from these units could disturb paleontological resources. In addition, borrow/spoil areas are designated in the area of the intakes, along the intermediate forebay, and along the Byron Tract Forebay (Figure 27-2). As described above, units sensitive for paleontological resources in these areas include the Riverbank and Modesto Formations (potentially in the shallow subsurface) in the area of the intakes and intermediate forebay, and the alluvium of creeks from the Corral Hollow Drainage to Brushy Creek along the Byron Tract Forebay. Excavation of borrow material from these units could also disturb sensitive paleontological resources.

NEPA Effects: The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities described above. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Therefore, excavation for the intakes, pipelines, intermediate forebay, Byron Tract Forebay and the new approach to the Banks Pumping Plant necessary for Alternative 1A would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 1A could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 1A would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for the tunnels necessary for Alternative 1A would most likely destroy unique or significant paleontological resources in the Plan Area and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Before ground-breaking construction begins, BDCP proponents will retain a qualified paleontologist or geologist (as defined by the SVP Standard Procedures [Society of Vertebrate Paleontology 2010]) to develop a comprehensive Paleontological Resources Monitoring and Mitigation Plan (PRMMP) for the BDCP, to help avoid directly or indirectly destroying a unique or significant paleontological resource.

The PRMMP will be consistent with the SVP Standard Procedures (Society of Vertebrate Paleontology 2010) and the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996) and will require the following.

- A paleontological resources specialist (PRS) will be designated or retained for construction activities. The PRS will have paleontological resources management qualifications consistent with the description of a qualified paleontologist in the SVP Standard Procedures (Society of Vertebrate Paleontology 2010). The PRS will be responsible for implementing all aspects of the PRMMP, managing any additional paleontological monitors needed for construction activities, and serving as a qualified resource in the event of unanticipated paleontological finds. The PRS may, but need not necessarily, be the same individual who prepared the PRMMP. The PRS will be retained or designated prior to the start of ground-breaking construction. A qualified PRS is defined as a person with a M.S. or Ph.D. in paleontology, paleobiology, or geology, with strong working knowledge of local paleontology and geology, and professional expertise with paleontological procedures and

techniques. The PRS may designate a paleontological monitor to be present during earth-moving activities. A paleontological monitor is defined as a person with a BS/BA in geology or paleontology and a minimum of 1 year of monitoring experience in local sedimentary rocks. Experience may be substituted for academic training on approval from the contracting agency. The PRS and paleontological monitor(s) will be notified by the Lead Agency or Resident Engineer in advance of the start of construction activity. The PRS and paleontological monitor(s) will attend any required safety training programs.

- Preconstruction surveys (with salvage and/or protection in place, as appropriate) will be conducted in areas where construction activities would result in surface disturbance of geologic units identified as highly sensitive for paleontological resources.
- Preconstruction and construction-period coordination procedures and communications protocols will be established, including procedures to alert all construction personnel involved with earthmoving activities about the possibility of encountering fossils as set forth in Mitigation Measure PALEO-1c and communications regarding the *stop work, evaluate and treat appropriately response* in the event of a paleontological discovery, as discussed in Mitigation Measure PALEO-1d.
- All ground-disturbing activities involving highly sensitive units will be monitored by qualified monitors. Monitoring will initially be conducted full time for grading and excavation, but the PRMMP may provide for monitoring frequency in any given location to be reduced once 50% of the ground-disturbing activity in that location has been completed, if the reduction is appropriate based on the implementing PRS's professional judgment in consideration of actual site conditions. Monitoring will also be conducted throughout drilling operations. The monitoring program for tunneling operations will be developed in conjunction with the facility design and geotechnical teams, in consideration of the tunneling method selected.
- Sampling and data recovery procedures that are consistent with the SVP Standard Procedures (Society of Vertebrate Paleontology 2010) and the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996) will be established.
- A repository plan will be developed that provides for appropriate curation of recovered materials, if necessary.
- Mitigation monitoring report preparation guidelines will be established that are consistent with the SVP Standard Procedures guidelines (Society of Vertebrate Paleontology 2010). The report will include, at a minimum, discussions of effects, regulatory requirements, purpose of mitigation, regional geologic context, Plan Area stratigraphy, stratigraphic and geographic distribution of paleontological resources, field and laboratory methods and procedures, fossil recovery, and paleontological significance. The report will also include geological cross sections and stratigraphic sections depicting fossil discovery localities and excavated rock units; maps showing the activity location and vicinity, as well as geology and location of discovered fossil localities; appropriate illustrations depicting monitoring conditions, field context of collecting localities, quarry maps, and laboratory activities; and appendices including an itemized listing of catalogued fossil specimens, complete descriptions of all fossil collecting localities, an explanation of report acronyms and terms, and a signed curation agreement with an approved paleontological repository.

- Procedures for preparing, identifying, and analyzing fossil specimens and data recovered will be established, consistent with the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996 and 2010) and any specific requirements of the designated repository institution.

Implementation of this measure will ensure that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

To help avoid directly or indirectly destroying a unique or significant paleontological resource, the BDCP proponents will have a qualified individual review the 90% design submittal to finalize the identification of construction activities involving geologic units considered highly sensitive for paleontological resources. Evaluation will consider the anticipated depth of disturbance, the selected construction technique, and the geology of the alignment. This work may be carried out in conjunction with or as part of the development of the PRMMP (Mitigation Measure PALEO-1a). The evaluation may be carried out by the PRS or an individual meeting the SVP's requirements for a qualified vertebrate paleontologist (per Society of Vertebrate Paleontology 2010) and will be conducted in collaboration with the BDCP design and geotechnical teams. If the evaluation is performed by a paleontologist, it will be reviewed and verified by a California-licensed professional geologist. The purpose of this evaluation will be to develop specific language identifying how the mitigation measures will be applied to the various phases of construction along the alignment (e.g., which areas would require monitors). This language will be included in the BDCP construction documents for implementation by BDCP proponents. The language will be based on the following framework.

- One onsite paleontological monitor will likely be sufficient to handle observation of most ground-disturbing activities. However, if additional paleontological monitors are needed, the PRS will coordinate with the Resident Engineer. This communication is imperative and fundamental to the success of this PRMMP and to compliance with CEQA and NEPA.
- Whenever possible, sedimentary rocks exposed during trenching and other deep excavation work will be inspected. Ideally, this monitoring will involve inspection of fresh bedrock exposures. However, observation of some work may not be possible for safety reasons and inspection from these operations will be restricted to spoils. In this case, the monitor will inspect spoils as they are stockpiled and remove any matrix blocks containing paleontological resources. Construction personnel, namely the Resident Engineer/Lead, must communicate depths of excavated materials and their approximate location to the field monitor.
- Recording of stratigraphic data will be an ongoing aspect of excavation monitoring, to provide context for any eventual fossil discoveries. Outcrops exposed in active cuts and finished slopes will be examined and geologic features recorded on grading plans and in field notes. The goal of this work is to delimit the nature of fossiliferous unconsolidated sedimentary deposits within the Plan Area, determine their areal distribution and depositional contacts, and record any evidence of structural deformation. Standard geologic

and stratigraphic data collected include lithologic descriptions (e.g., color, sorting, texture, structures, and grain size), stratigraphic relationships (e.g., bedding type, thickness, and contacts), and topographic position. Stratigraphic sections will be routinely measured, areas containing exposures of fossiliferous sedimentary rocks will be documented, and fossil localities will be recorded on measured stratigraphic sections.

- If fossils are discovered, the following procedures will be followed. The monitor or PRS will inform the Resident Engineer who will determine the appropriate course of action. For all excavations except those relating to the tunnels, mitigation shall consist of one of the following: diverting, directing, or temporarily halting ground-disturbing activities in the area of discovery to allow for preliminary evaluation of potentially significant paleontological resources and to determine whether additional mitigation (i.e., collection, curation or other preservation) is required. Where excavations relate to construction of the tunnels, such measures will be infeasible because the fossils will most likely have been destroyed by the tunnel boring machines before they could have been identified.

The significance of the discovered resources will be determined by the PRS in consultation with appropriate contractor representatives. 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.

- Provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct.
- 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.
- Provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas.
- Demonstrate unusual or spectacular circumstances in the history of life.
- 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.

They can include fossil remains of large to very small aquatic and terrestrial vertebrates (including animal trackways), 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.

- Recovery methods will vary to some degree depending on the types of fossils discovered (e.g., invertebrate macrofossils, invertebrate microfossils, vertebrate macrofossils, vertebrate microfossils, or plant fossils). Many fossil specimens discovered during excavation monitoring are readily visible to the naked eye and large enough to be easily recognized and removed. Upon discovery of such macrofossils, the paleontological monitor will temporarily flag the discovery site for avoidance and evaluation, as described above. Actual recovery of unearthed macrofossils can involve several techniques, including immediate collection, hand quarrying, plaster-jacketing, and/or large-scale quarrying. The

PRS and the contracting agency representative will evaluate the discovery and take action to protect or remove the resource within the shortest period of time possible.

- Many significant vertebrate fossils (e.g., small mammal, bird, reptile, amphibian, or fish remains) often are too small to be readily visible in the field, but are nonetheless significant and worthy of attention. The potential discovery of microvertebrate sites is anticipated and can include sites that produce remains of large vertebrate fossils from fine-grained deposits, sites with an obvious concentration of small vertebrate fossil remains, and sites that based on lithology alone (e.g., paleosols) appear to have a potential for producing small vertebrate fossil remains. Microvertebrate sites will be sampled by collecting bulk quantities of sedimentary matrix. An adequate sample comprises approximately 12 cubic meters (6,000 lbs or 2,500 kg) of matrix for each formation, or as determined by the PRS (Society of Vertebrate Paleontology 2010). The uniqueness of the recovered fossils may dictate salvage of larger amounts. However, conditions in the field may make it impossible to recover such large samples. To avoid construction delays, bulk matrix samples will be transported to an offsite location for processing.
- The discovery of fossil plants is possible in the Plan Area. Paleobotanical specimens typically occur in fine-grained, laminated strata (e.g., shale) and will require special recovery techniques. Large blocks (>2 feet) of sedimentary rock are hand quarried from the temporary outcrop and then split along bedding plains to reveal compressed fossil plant material (e.g., leaves, stems, and flowers). Individual slabs are then wrapped in newsprint to minimize destructive desiccation of the fossils. Specimens that are delaminating or flaking badly may need to be coated with special consolidants.
- Oriented matrix samples may be collected for paleomagnetic analysis. Such sampling will likely only be necessary in instances where long, continuous sections of stratified rocks are producing fossils from several different stratigraphic horizons or where vertebrate fossils are being collected in stratigraphic sections lacking in biochronologically useful microfossils. Likewise, it may be necessary to collect stratigraphically positioned samples of fine matrices pollen analysis or aid in addressing questions of geologic age, depositional environment, or paleoecology.
- All fossil discoveries will include the collection of stratigraphic data to delimit the nature of the fossil-bearing sedimentary rock unit, determine its areal distribution and depositional contacts, record any evidence of structural deformation, generate lithologic descriptions of fossil-bearing strata, determine stratigraphic relationships (bedding type, thickness, and contacts), and topographic position, measure stratigraphic sections, and describe taphonomic details.

Implementation of this measure will ensure that mitigation procedures are followed so that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

In order to reduce the likelihood of directly or indirectly destroying a unique or significant paleontological resource, BDCP proponents will require that all construction personnel receive training provided by a qualified paleontologist experienced in teaching non-specialists, to

ensure that they can recognize fossil materials in the event any are discovered during construction. Training will include information on the possibility of encountering fossils during construction, the types of fossils likely to be seen and how to recognize them, and proper procedures in the event fossils are encountered. All field management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take this training prior to beginning work. Training materials will include an informational brochure that provides contacts and summarizes procedures in the event paleontological resources are encountered.

Implementation of this measure will ensure that unique or scientifically significant paleontological resources have a high likelihood of being identified during construction so they can be avoided or treated appropriately.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

To help avoid directly or indirectly destroying a unique or significant paleontological resource, the BDCP proponents will ensure that if substantial potentially unique or significant fossil remains (particularly vertebrate remains) are discovered during ground-disturbing activities, the construction crew will be directed to immediately cease work in the vicinity of the find and notify the PRS, consistent with the PRMMP described under Mitigation Measure PALEO-1a. A newly discovered resource may need to be fenced off to protect it from inadvertent intrusions by machinery or protect the location from vandalism. If extensive recovery and jacketing is needed, the area will be fenced off with temporary fencing and a 3- to 5-meter (10- to 15-foot) buffer will be included in the fenced area around the locality. If specific construction activities preclude placement of a buffer of this width, the monitor will stake a mutually agreeable buffer prior to fencing. The PRS will evaluate the resource and prepare a mitigation plan in accordance with SVP guidelines (2010). The mitigation plan may include a field survey, construction monitoring, sampling and data recovery procedures, museum storage coordination for any specimen recovered, and a report of findings. Recommendations determined by BDCP proponents to be necessary and feasible will be implemented before construction can resume at the site where the paleontological resources were discovered.

Except for the fossils destroyed by tunnel boring machines, implementation of this measure will ensure that unique or scientifically significant paleontological resources identified during construction are protected from damage or treated and documented appropriately to preserve their scientific value.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are evaluated below by conservation measure. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

CM2 (Yolo Bypass Fisheries Enhancement)

- Construct four experimental ramps at the Fremont Weir.

- Construct up to three sets of up to three fish ladders.
- Construct fish screens on small Yolo Bypass diversions.
- Construct new or replacement operable check-structures at Tule Canal/Toe Drain.
- Replace the Lisbon Weir with a fish-passable gate structure.
- Realign Putah Creek.
- Modify a section of the Fremont Weir.
- Construct and operate nonphysical or physical barriers in the Sacramento River.
- Construct associated support facilities (operations buildings, parking lots, access facilities such as roads and bridges) necessary to provide safe access for maintenance and monitoring.
- Construct and test flood-neutral fish barriers.

Of these ground-disturbing activities, only the realignment of Putah Creek has the potential to disturb sensitive paleontological resources. If this realignment includes excavating a new channel, Pleistocene deposits associated with the older alluvium of Putah Creek could be disturbed. The other CM2 activities would occur in basin deposits of Holocene origin, which have low potential sensitivity for paleontological resources, based on age.

CM4 (approximately 65,000 acres of restored freshwater and brackish tidal habitat within the BDCP Restoration Opportunity Areas)

Ground-disturbing activities associated with CM4 range from relatively shallow, localized excavation to deep or extensive excavation. Two types of activities involve deeper excavation.

- Modify existing land elevations through grading and filling or subsidence reversal.
- Relocate existing roads and utilities to support construction and postconstruction activities at the restoration site or services to adjacent lands protected by levees.

Sensitive Pleistocene deposits occur at the surface or in the shallow subsurface in all the Restoration Opportunity Areas (ROAs), except the South Delta ROA (Figures 27-2 and 3-1). Shallow, localized excavation in areas where sensitive units occur at the surface could disturb paleontological resources in these units. Deeper or extensive excavation could disturb sensitive units in all of the ROAs.

CM5 (approximately 10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta)

Ground-disturbing activities associated with CM5 include clearing and grubbing, demolition of existing structures, setting back levees and removing existing levees, removal of riprap to allow for channel meander between setback levees, grading to restore drainage patterns and increase inundation frequency and duration, and establishment of riparian habitat. Most of these activities would involve shallow excavation or excavation in disturbed materials (levees), but grading to restore drainage patterns could involve deeper excavation. This floodplain-related excavation could occur in the northern, eastern, or southern sections of the Delta, but the most promising areas for paleontological resources are expected along the San Joaquin River in Conservation Zone 7 (for a description and map of the Conservation Zones, see Chapter 3, *Description of Alternatives*, and Figure 3-1). This area includes sensitive Modesto Formation and Corral Hollow/Brushy Creek drainage

units at or near the surface (Figures 27-2 and 3-1); sensitive paleontological resources could be disturbed in this area.

CM6 (20 linear miles of channel margin habitat enhancement in the Delta)

Ground-disturbing activities associated with CM6 include clearing and grubbing, demolition of existing structures, modification of levees or setting back levees, removing riprap where levees are set back, and modifying channel geometry in unconfined channel reaches or along channels where levees are set back. Most of these activities would involve shallow excavation or excavation in disturbed materials (levees), but modifying channel geometry could involve deeper excavation. Sensitive Pleistocene deposits may be encountered at shallow depths along the San Joaquin River in Conservation Zone 7 (Figures 27-2 and 3-1), should there be channel geometry modification in this area.

CM7 (approximately 5,000 acres of restored valley/foothill riparian habitat)

Ground-disturbing activities associated with CM7 include clearing and grubbing, and demolition of existing structures. Earthwork activities for development of the riparian habitat areas would be minimal and focused on removal of riprap and minor landform modifications to restore water circulation. These activities are shallow and unlikely to disturb paleontological resources.

CM8 (approximately 2,000 acres of restored grassland and 8,000 acres of protected or enhanced grassland within BDCP Conservation Zones 1, 8, and/or 11)

Ground-disturbing activities associated with CM8 entail little or no ground disturbance. Any grading for this restoration would be at shallow depths and would not be likely to affect paleontological resources.

CM3 and CM9 (approximately 67 acres of restored vernal pool complex and 600 acres of protected vernal pool complex within Conservation Zones 1, 8, and/or 11)

Ground-disturbing activities associated with CM9 entail some land disturbance, such as minor grading to improve connectivity between complexes. Any grading for this restoration would be at shallow depths and would not be likely to affect paleontological resources.

CM10 (approximately 1,200 acres of restored nontidal marsh within Conservation Zones 2 and 4 and/or 5)

Ground-disturbing activities associated with CM10 entail grading to establish an elevation gradient to support open water perennial aquatic habitat intermixed with shallower marsh habitat. The Pleistocene Riverbank and Modesto Formations are exposed throughout Conservation Zone 4 and may occur in the older alluvium of Putah Creek in Conservation Zone 2. Where sensitive Pleistocene deposits are exposed at the surface or are overlain by a shallow veneer of Holocene deposits in these two conservation zones (Figures 27-2 and 3-1), paleontological resources could be disturbed as grading is undertaken for CM10.

NEPA Effects: Although excavation associated with these conservation measures under Alternative 1A would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect,

although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d would be available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 1A would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservations measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.3 Alternative 1B—Dual Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario A)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 1B in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-12. A detailed depiction of East Alignment alternative is provided in Figure M3-2 in the Mapbook Volume.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Construction of water conveyance facilities under Alternative 1B could cause the destruction of unique paleontological resources as a result of excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert and tunnel siphons, Byron Tract Forebay and canals to the Jones and Banks pumping plants, other water facility components, roads, and borrow sites.

The depth, extent, and location of excavation and other ground-disturbing activities vary greatly across the Plan Area (Table 27-12). Therefore, this discussion considers these activities on the basis of their location and depth of excavation.

Table 27-12. Summary of Conveyance Construction Activities and Geologic Units Sensitive for Paleontological Resources that Could be Disturbed under Alternative 1B

Alternative 1B	Location	Construction/Excavation	Sensitive Units Disturbed
Five new north Delta intakes	Same as 1A	Same as 1A	Same as 1A
New intake pumping plants and sedimentation basin	Same as 1A	Same as 1A	Same as 1A
Conveyance canal	From intakes to Byron Tract Forebay	Excavation depth of 30 ft, top width up to 220 ft (700 ft with right-of-way), bottom width up to 100 feet (340 ft with right-of-way)	Modesto and Riverbank Formations, alluvium of creeks from Corral Hollow Drainage to Brushy Creek
Intermediate pumping plant	Just north of Holt	Excavation 24 ft below ground surface; 8 ac total	
Byron Tract Forebay	Just south of Clifton Court Forebay	Same as 1A	Modesto Formation eolian deposits, alluvium from Corral Hollow Drainage to Brushy Creek
26- by 26-foot culvert siphons	Where alignment crosses a major waterway	At least 47 ft below the existing slough invert	Riverbank and Modesto Formations
Tunnel siphons	Lost Slough and Mokelumne River floodway (7,444 ft), San Joaquin River (3,233 ft), and Old River (1,914 ft)	Same as tunnel	Riverbank and Modesto Formations

The intakes and associated pumping plants and sedimentation basins would be the same under Alternative 1B as under Alternative 1A. See the discussion under Alternative 1A.

The main conveyance feature of Alternative 1B would be a 42-mile-long lined or unlined canal that would begin at the intakes in the northern end of the Plan Area and follow the eastern edge of the Plan Area to the Byron Tract Forebay immediately southeast of Clifton Court Forebay (Figure 27-2). Culvert siphons (discussed below) would be used to convey flow under existing sloughs and a railroad, and tunnel siphons (discussed below) would be used to convey flow under rivers and floodways.

Canal construction would involve excavating to a depth of 30 feet with a top width of 220 feet (up to 700 feet with right-of-way) and a bottom width of up to 100 feet (340 feet with right-of-way). The amount of material that would be excavated, which is the greatest of all alternatives, is shown in Table 27-11. In this alignment, Pleistocene deposits sensitive for paleontological resources occur at or near the surface from the intakes to the San Joaquin River and at shallow depth from the river to the Byron Tract Forebay (Figures 27-2 and 27-3). These deposits would therefore be disturbed during excavation of the canal. In addition, canal construction requires that the organic-rich peaty soils, which may be up to 25 feet thick, be removed, thereby increasing the likelihood that Pleistocene deposits would be encountered. At the southern end of the canal, the Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek (Qch), which is sensitive for paleontological resources, is exposed at the surface. Excavation of the canal would therefore likely disturb several Pleistocene units sensitive for paleontological resources.

Where the alignment crosses a major waterway, culvert siphons would be constructed. Culvert siphons would be constructed using cut-and-cover methods. The depth of trenches for these culvert siphons would vary by location, but the roof of the 26- by 26-foot concrete structures would be installed at least 47 feet below the existing slough invert. In most cases, peat soil would be excavated so that the culvert foundation would be founded on alluvial sand (Pleistocene). Given the depth of the culverts and the need to remove peat soil in some locations, excavation of the culvert siphons would therefore likely disturb Pleistocene units sensitive for paleontological resources (Figure 27-3).

Construction of the intermediate pumping plant, which would be located on the canal just north of Holt, would disturb approximately 8 acres. The area of the pumping plant would be excavated to a depth of 24 feet below ground surface. In this area, Holocene deposits form a veneer over the Pleistocene deposits (Figures 27-2 and 27-3). Excavation for the intermediate pumping plant would therefore likely disturb Pleistocene units sensitive for paleontological resources.

Excavation for the conveyance canal, culvert siphons, and intermediate pumping plant would all likely disturb Pleistocene units sensitive for paleontological resources.

Tunnel siphons would be constructed at three locations along the canal: at the Lost Slough and Mokelumne River floodway (7,444 feet long), at the San Joaquin River (3,233 feet long), and at Old River (1,914 feet long). Each tunnel siphon would consist of dual bores with finished inside diameters of 33 feet. The amount of material that would be excavated for the tunnel siphons is shown in Table 27-11. Although only a fraction of the length of the conveyance tunnels described under Alternative 1A, these tunnel siphons would use the same construction methods, such as use of TBM to excavate tunnels at a depth of approximately 150 feet. Shafts and tunnels would be excavated through Holocene and Pleistocene deposits (Figures 27-2 and 27-3). Shafts would be

excavated through surficial Holocene deposits and then through Pleistocene deposits of the Riverbank or Modesto Formations. Tunnels would be bored wholly through Pleistocene deposits.

Pipelines under Alternative 1B would be similar to those under Alternative 1A, except that they would extend from each of the five intakes to the main conveyance canal. General location, excavation depth and width, and geologic units that would be encountered would be the same as under Alternative 1A.

The construction and excavation for the Byron Tract Forebay and new approach canals to the Banks and Jones pumping plants would be the same under Alternative 1B as under 1A. Please refer to the discussion under Alternative 1A.

The effects of road construction under Alternative 1B would be less extensive than those under Alternative 1A and would not be likely to have adverse effects on sensitive paleontological resources because of the shallow nature of these ground-disturbing activities.

Borrow material would be needed for canal embankment construction, levee reconstruction at intake sites, and to a lesser extent for access roads under Alternative 1B. Although cut and fill would be nearly balanced in some segments, other segments would require about 200,000,000 cubic yards of borrow material, compared to 13,500,000 cubic yards under Alternative 1A (Table 27-11) (Chapter 26, *Mineral Resources*). The same geologic units would be used for borrow material as would be used under Alternative 1A (see description under Alternative 1A), but much greater quantities of borrow material would be needed for the canal embankments, necessitating large borrow/spoil areas in several locations along the canal alignment. In this alignment, Pleistocene deposits occur at or near the surface from the intakes to the San Joaquin River and at shallow depth from the river to the Byron Tract Forebay. Excavation of borrow material from these units could disturb paleontological resources.

NEPA Effects: If fossils are present in the Plan Area, the ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect under NEPA because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and PALEO-1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities described above. However, while these measures could be applied to the excavation of the tunnel shafts (for tunnel siphons), no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered. Implementing these measures will ensure that mitigation procedures are followed so that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Excavation for the new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert and tunnel siphons, Byron Tract Forebay and canals to the Jones and Banks pumping plants necessary for Alternative 1B would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 1B could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 1B would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO 1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for the intakes, pumping plants, conveyance canal, culvert siphons, intermediate pumping plant, Byron Tract Forebay, and the new approach to the Banks Pumping Plant necessary for Alternative 1B would most likely destroy unique or significant paleontological resources and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 1B would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 1B would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.4 Alternative 1C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 1C in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-13. A detailed depiction of the West Alignment alternative is provided in Figure M3-3 in the Mapbook Volume.

Table 27-13. Summary of BDCP Construction Activities and Geologic Units Sensitive for Paleontological Resources that Could be Disturbed under Alternative 1C

Alternative 1C	Location	Construction/Excavation	Sensitive Units Disturbed
Five new north Delta intakes	West bank Sacramento River between Clarksburg and Walnut Grove	Same as 1A except slightly smaller area of 291 ac	Riverbank and Modesto Formations and possibly Putah Creek alluvium
New intake pumping plants and sedimentation basins	Adjacent to intakes	Same as 1A except slightly smaller area of 104–144 ac	
Conveyance canal	Intakes to intermediate pumping plant on Ryer Island and Hotchkiss Slough to Byron Tract Forebay	Excavation depth of 30 ft, top width up to 220 ft (700 ft with right-of-way), bottom width up to 100 feet (340 ft with right-of-way)	Modesto Formation and other Pleistocene units and upper Pleistocene eolian deposits of the Modesto Formation, Holocene and upper Pleistocene younger alluvium of Marsh Creek, and alluvium of creeks from Corral Hollow Drainage to Brushy Creek
Intermediate Pumping Plant		Slab invert 15–20 ft below existing grade; 8 ac total	Upper Pleistocene deposits
Byron Tract Forebay	Just northwest of Clifton Court Forebay	630 ac to a depth of 15–20 ft below existing grade	Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek and younger alluvium of Marsh Creek
Tunnel	Dual-bore 33-ft-diameter tunnel, 17 mi from Intermediate Pumping Plant to southern section of conveyance canal	Shaft to 100–150 ft; tunnel invert at 150 ft; boring using pressurized face mechanized tunneling machines, including earth pressure balance (EPB) machines and slurry tunneling machines	Riverbank and Modesto Formations
26- by 26-ft culvert siphons	Same as 1B	Same as 1B	Same as 1B

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Construction of water conveyance facilities under Alternative 1C could cause the destruction of unique paleontological resources as a result of excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and tunnel, intermediate pumping plant, culvert siphons, Byron Tract Forebay and canals to Jones and Banks pumping plants, other water facility components, roads, and borrow sites.

The depth, extent, and location of excavation and other ground-disturbing activities vary greatly across the Plan Area (Table 27-13). Therefore, this discussion considers these activities on the basis of their location and the depth of excavation.

The five intakes would involve deep and extensive excavation in the northern portion of the Plan Area (Table 27-13). The five intakes and the pumping plant and sedimentation basin associated with each intake would be similar to those under Alternative 1A, except that the intakes would be along the west bank of the Sacramento River between Clarksburg and Walnut Grove. Ground-disturbing activities include clearing and grubbing, rough grading, excavation, pile driving, constructing foundations, and final grading. Construction of the intakes, pumping plants, and sedimentation basins would involve excavation to a depth of 20–30 feet over an area of 291 acres. The staging/storage area and construction zone preparation would involve 76–148 acres per intake structure.

As with Alternative 1A, excavation for the intakes would occur in both sensitive and nonsensitive units (Figure 27-2). Although most of the surficial geologic units in the area affected by excavation for the intakes and forebays are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation, which is of Pleistocene age and sensitive for paleontological resources, is exposed at the surface in some locations or underlies the Holocene units in the shallow subsurface (Figure 27-2). Other Pleistocene units that occur in the area include the younger and older alluvium of Putah Creek; whether this unit has the potential to contain fossils is unknown, but nonmarine Pleistocene deposits are generally considered sensitive for paleontological resources. The Riverbank and other Pleistocene units likely occur at a depth of 0–10 feet and would therefore be disturbed during excavation of the intakes (Figure 27-3).

One of the main features of Alternative 1C would be two canals, either lined or unlined (Figure 27-2). The first canal would begin at the intakes in the northern portion of the Plan Area and continue to an intermediate pumping plant on Ryer Island at the tunnel transition structure. The second canal would begin at the second tunnel transition structure at Hotchkiss Slough and continue to the Bryon Tract Forebay in the southern portion of the Plan Area. Culvert siphons (discussed below) would be used to convey flow under existing waterways and a railroad.

Canal construction would involve excavating to a depth of 30 feet with a top width of 220 feet (up to 700 feet with right-of-way) and a bottom width of up to 100 feet (340 feet with right-of-way). The amount of material that would be excavated, which is more than under Alternative 1A but less than under Alternative 1B, is shown in Table 27-11. In the canal alignment between the intakes and intermediate pumping plant, the geologic units exposed at the surface are the Holocene flood-basin and peat and mud deposits (Figure 27-2). These units are estimated to be from 0 to more than 30 feet thick and are not likely to contain fossils (i.e., not sensitive for paleontological resources) (Figure 27-3). Underlying these Holocene deposits are Pleistocene units, such as the Modesto

Formation. The Modesto Formation is sensitive for paleontological resources, and the other Pleistocene units are also likely to be sensitive for paleontological resources.

In the canal alignment from Hotchkiss Slough to Byron Tract Forebay, the geologic units exposed at the surface are the upper Pleistocene eolian deposits of the Modesto Formation and the Holocene and upper Pleistocene younger alluvium of Marsh Creek and alluvium of creeks from the Corral Hollow Drainage to Brushy Creek (Figure 27-2). The Modesto Formation is sensitive for paleontological resources; consequently, sensitive Pleistocene deposits would be disturbed during excavation of this section of the canal.

Culvert siphons would be constructed where canals would cross major waterways. Culvert siphons would be constructed using cut-and-cover methods. The depth of trenches for these culvert siphons would vary by location, but the roof of the 26- by 26-foot concrete structures would be installed 47 feet below the existing slough invert. In most cases, peat soil would be excavated so that the culvert foundation would be founded on alluvial sand (Pleistocene). Given the depth of the culverts and the need to remove peat soil in some locations, excavation of the culvert siphons would likely disturb Pleistocene units sensitive for paleontological resources.

Construction of the intermediate pumping plant would also involve construction of an approach channel, and construction of a substation. The slab invert of the pumping plant would be 15–20 feet below existing grade. Excavation for these facilities would be in both Holocene peat and mud deposits and flood-basin deposits and in upper Pleistocene deposits (Figures 27-2 and 27-3). Consequently, excavation for the intermediate pumping plant would likely disturb Pleistocene units sensitive for paleontological resources.

Under Alternative 1C, a 17-mile, 33-ft inside diameter dual-bore tunnel would convey water from the intermediate pumping plant to the second canal. The amount of material that would be excavated is shown in Table 27-11. With the exception of its reduced length, construction of this tunnel would be the same as described under Alternative 1A, such as use of TBM to excavate tunnels at a depth of approximately 150 feet.

As under Alternative 1A, shafts and tunnels would be excavated through Holocene and Pleistocene deposits. Shafts would be excavated through surficial Holocene deposits and then through Pleistocene deposits of the Riverbank or Modesto Formations. Tunnels would be bored wholly through Pleistocene deposits.

The construction and excavation for the Byron Tract Forebay north of the Clifton Court Forebay would take place in the surficial deposits of the Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek and younger alluvium of Marsh Creek, which are sensitive for paleontological resources, and the Holocene younger alluvium of Montezuma Hills and vicinity and alluvial flood-plain deposits (Figures 27-2 and 27-3). Excavation for the forebay would disturb Pleistocene units sensitive for paleontological resources.

Construction of temporary and permanent access roads would involve shallow excavation and grading and would not be expected to adversely affect sensitive paleontological resources.

Borrow material would be needed for canal embankment construction, levee reconstruction at intake sites, and access roads under Alternative 1C. The same geologic units would be targeted for borrow material as under Alternative 1A (see description under Alternative 1A) but much greater quantities of borrow material would be needed for the canal embankments (200,000,000 cubic yards compared to 13,500,000 cubic yards tons under Alternative 1A) (Table 27-11). In addition,

borrow/spoil areas are designated in several areas along the canal alignment. In the canal alignment between the intakes and intermediate pumping plant, the geologic units exposed at the surface are the Holocene flood-basin and peat and mud deposits. These units are estimated to be 5–30 feet thick and are not likely to contain fossils (i.e., not sensitive for paleontological resources). Underlying these Holocene deposits are Pleistocene units, such as the Modesto Formation. The Modesto Formation is sensitive for paleontological resources, and the other Pleistocene units are also likely to be sensitive for paleontological resources. In the canal alignment from Hotchkiss Slough to Byron Tract Forebay, the geologic units exposed at the surface are the upper Pleistocene eolian deposits of the Modesto Formation and the Holocene and upper Pleistocene younger alluvium of Marsh Creek and alluvium of creeks from the Corral Hollow Drainage to Brushy Creek. The Modesto Formation is sensitive for paleontological resources; consequently, sensitive Pleistocene deposits would be disturbed during excavation of the canals.

NEPA Effects: The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d. The effects associated with the borrow sites would be greater than under Alternative 1A but less than under Alternative 1B.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related activities described above. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring and the boring area could not be accessed even if fossils were encountered. Because the length of the dual-bore tunnel would be considerably less under Alternative 1C than under Alternative 1A, the severity of this effect would be reduced. However, excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and tunnel, intermediate pumping plant, culvert siphons, Byron Tract Forebay and canals to Jones and Banks pumping plants necessary for Alternative 1C would most likely still destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 1C could cause the destruction of unique paleontological resources. Ground-disturbing activities associated with Alternative 1C in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and tunnel, intermediate pumping plant, culvert siphons, Byron Tract Forebay and canals to Jones and Banks pumping plants necessary for Alternative 1C would most likely destroy unique or significant paleontological resources in the Plan Area and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 1C would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 1 would be fairly shallow, CM2, CM4–CM6, and

CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.5 Alternative 2A—Dual Conveyance with Pipeline/Tunnel and Five Intakes (15,000 cfs; Operational Scenario B)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 2A in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 2A would include the same physical/structural components as Alternative 1A, but could entail two different intakes and intake pumping plant locations and an operable barrier at the head of Old River. The two alternate intakes, if selected, would be downstream of Sutter and Steamboat Sloughs. These two intakes are in the same geologic units and would not substantially change the effects on paleontological resources. The operable barrier would be constructed in units of Holocene age and not sensitive for paleontological resources and, possibly, the Modesto Formation, which occurs in the shallow subsurface. The operable barrier is in the same geologic units as the canals to Jones and Banks pumping plants and would not substantially change the effects on paleontological resources. The effects of Alternative 2A would, therefore, be the same as those under Alternative 1A. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures 1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 2A. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for the intakes, pipelines, intermediate forebay, Byron Tract Forebay and the new approach to the Banks Pumping Plant necessary for construction of the tunnels would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 2A could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 2A would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO 1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants necessary for Alternative 2A would most likely destroy unique or significant paleontological resources in the Plan Area and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 2A would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 2A would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could

damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.6 Alternative 2B—Dual Conveyance with East Alignment and Five Intakes (15,000 cfs; Operational Scenario B)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 2B in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-12.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 2B would include the same physical/structural components as Alternative 1B, but, like Alternative 2A, it could entail two different intakes and intake pumping plant locations and an operable barrier at the head of Old River. The two alternate intakes, if selected, would be downstream of Sutter and Steamboat Sloughs. These intake locations, however, would be in the same geologic units and would not substantially change the effects on paleontological resources. The operable barrier would be constructed in units of Holocene age and not sensitive for paleontological

resources and, possibly, the Modesto Formation, which occurs in the shallow subsurface. The operable barrier is in the same geologic units as the canals to Jones and Banks pumping plants and would not substantially change the effects on paleontological resources. The effects of Alternative 2B would, therefore, be the same as those under Alternative 1B. See the discussion of Impact PALEO-1 under Alternative 1B.

If fossils are present in the Plan Area, the ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and PALEO-1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities described above. However, while these measures could be applied to the excavation of the tunnel shafts (for tunnel siphons), no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered. Implementing these measures will ensure that mitigation procedures are followed so that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Excavation for the new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert and tunnel siphons, Byron Tract Forebay and canals to the Jones and Banks pumping plants necessary for Alternative 2B would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 2B could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 2B would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for the new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert and tunnel siphons, Byron Tract Forebay and canals to the Jones and Banks pumping plants necessary for Alternative 2B would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 2B would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM6, and CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 2B would be fairly shallow, CM2,

CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.7 Alternative 2C—Dual Conveyance with West Alignment Intakes W1–W5 (15,000 cfs; Operational Scenario B)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 2C in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-13.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Alternative 2C would include the same physical/structural components as Alternative 1C, but like Alternative 2A, it could entail two different intakes and intake pumping plant locations and an operable barrier at the head of Old River. The two alternate intakes, if selected, would be downstream of Sutter and Steamboat Sloughs. These intake locations, however, would be in the same geologic units and would not substantially change the effects on paleontological resources. The operable barrier would be constructed in units of Holocene age and not sensitive for paleontological resources and, possibly, the Modesto Formation, which occurs in the shallow subsurface. The operable barrier is in the same geologic units as the canals to Jones and Banks pumping plants and would not substantially change the effects on paleontological resources. The effects of Alternative 2C would, therefore, be the same as those under Alternative 1C. See the discussion of Impact PALEO-1 under Alternative 1C.

NEPA Effects: The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and PALEO-1d. The effects associated with the borrow sites would be greater than under Alternative 2A but less than under Alternative 2B.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 2C. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring and the boring area could not be accessed even if fossils were encountered.

Because the length of the dual-bore tunnel would be considerably less under Alternative 2C than under Alternatives 1A and 2A, the severity of this effect would be reduced. However, excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert siphons, tunnel, Byron Tract Forebay and canals to Jones and Banks pumping plants would still most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 2C could cause the destruction of unique paleontological resources. Ground-disturbing activities associated with Alternative 2C in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 2C would most likely destroy

unique or significant paleontological resources in the Plan Area and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 2C would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 2C would be fairly shallow, CM2, CM4-CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.8 Alternative 3—Dual Conveyance with Pipeline/Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 3 in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 3 would include the same physical/structural components as Alternative 1A, but would entail only two intakes and two intake pumping plants. The effects of Alternative 3 would, therefore, be the same as those under Alternative 1A but of a lesser magnitude. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 3. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, and canals to Jones and Banks pumping plants would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 3 could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 3 would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 3 would most likely destroy unique or significant paleontological resources in the Plan Area and would cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 3 would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 3 would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or

protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Construction of water conveyance facilities under Alternative 4 could cause the destruction of unique paleontological resources as a result of excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to the Jones and Banks pumping plants, an operable barrier at the head of Old River, other water facility components, roads, and borrow sites.

The depth, extent, and location of excavation and other ground-disturbing activities vary greatly across the Plan Area (as shown in Table 27-14). Accordingly, this discussion considers these activities on the basis of their location and the depth of excavation.

Table 27-14. Summary of Conveyance Construction Activities and Geologic Units Sensitive for Paleontological Resources That Could Be Disturbed under Alternative 4

Alternative 4	Location	Construction/Excavation	Sensitive Units Disturbed
Three new north Delta intakes	East bank Sacramento River between Clarksburg and Walnut Grove	30 ft below existing grade; 330 ac total, including pumping plants and sedimentation basins	Riverbank and Modesto Formations
New intake pumping plants and sedimentation basins	Adjacent to intakes	Sedimentation basin 20–30 ft below existing grade; pumping plant 25–30 ft below existing grade; staging/storage area and construction zone prep (76–148 ac per intake structure, including sedimentation basin and pumping plant)	Riverbank and Modesto Formations
Expanded Clifton Court Forebay, canals to Jones and Banks pumping plants	Just south of existing Clifton Court Forebay	592 ac to a depth of 15–20 ft below existing grade	Modesto Formation eolian deposits, alluvium from Corral Hollow Drainage to Brushy Creek
Intermediate forebay	Glannvale Tract	245 ac to a depth of 6–11 ft below existing grade	Riverbank Formation
Tunnel 1a	Single-bore 20-ft-diameter tunnel, 46,700 ft from Intakes 2 and 3 to Intermediate Forebay	Shaft to 75 ft below existing grade; tunnel invert at 125 ft; boring using pressurized face mechanized tunneling machines, including earth pressure balance (EPB) machines and slurry tunneling machines	Riverbank and Modesto Formations
Tunnel 1b	Single-bore 20-ft-diameter tunnel, 25,100 ft from Intake 5 to Intermediate Forebay	Same as Tunnel 1a	Riverbank Formation
Tunnel 2	Dual-bore 40-ft-diameter tunnel, 159,000 ft from Intermediate Forebay to Clifton Court Forebay	Same as Tunnel 1a and 1b but tunnel invert depth down to 163 ft	Riverbank and Modesto Formations

The three intakes and the intermediate forebay (Figure 27-2) would entail deep and extensive excavation in the northern portion of the Plan Area (Table 27-14). The three intakes and the pumping plant and sedimentation basin associated with each intake would be along the east bank of the Sacramento River between Clarksburg and Walnut Grove. The intermediate forebay would be located on the west side of Glannvale Tract. No pumping plant is associated with the intermediate forebay due to the fact that water would flow via gravity to the south Delta. Ground-disturbing activities include clearing and grubbing, rough grading, excavation, pile driving, constructing foundations, and final grading. Construction of the intakes, pumping plants, and sedimentation basins would involve excavation to a depth of between 20–35 feet over an area of 330 acres. The

staging/storage area and construction zone preparation would involve 70–114 acres per intake structure. Construction for the intermediate forebay would involve excavation of approximately 245 acres to a depth of approximately 6-11 feet below existing grade.

Excavation for the intakes and intermediate forebay would be conducted in geologic units both sensitive and nonsensitive for paleontological resources (Figure 27-2). Although most of the surficial geologic units in the area affected by excavation for the intakes and forebays are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation, which is of Pleistocene age and sensitive for paleontological resources, is exposed at the surface in some locations or underlies the Holocene units in the shallow subsurface. The Modesto Formation, another Pleistocene-age unit that is sensitive for paleontological resources, also occurs in the area and likely is exposed at the surface and in the shallow subsurface. These Pleistocene units likely occur at a depth of less than 5 feet and would therefore be disturbed during excavation of the intakes and intermediate forebay (Figure 27-3).

Pipeline construction would involve excavation in the northern portion of the Plan Area (Figure 27-2; Table 27-10). The pipelines would extend from the intakes to the sedimentation basin and intake pumping plants and from the intake pumping plants to the intermediate forebay. Pipeline excavation would use open trenching to a minimum depth of approximately 30 feet but could be deeper, depending on local conditions. Trench widths would be approximately 220 feet. The Tunnel 2 segment as shown in Table 27-14, would be a dual-bore with finished inside diameters of 40 feet. The amount of material that would be excavated for the tunnels is shown in Table 27-14. The distance between the two bores of the tunnel would increase, as would the width of the retrieval shaft. The effects of tunneling under Alternative 4 would be greater than those under Alternative 1A due to the larger tunnel diameters and therefore an increased likelihood of disturbing sensitive paleontological units, but of a lesser magnitude than alternatives along the East or West alignment.

Excavation for the pipelines would, like that for the intakes and the intermediate forebay, occur in both sensitive and nonsensitive units. Although most of the surficial geologic units in the area affected by excavation for the pipelines are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation and Modesto Formation are exposed at the surface and occur in the shallow subsurface. These Pleistocene units likely occur at a depth of 0 to 10 feet and would therefore be disturbed during excavation for pipelines.

Construction of Tunnels 1a, 1b and 2 would entail deep excavation using a tunnel-boring machine (TBM) (Table 27-10). Tunnel 1a would connect a pipeline adjacent to Intake Pumping Plant 2, a pipeline adjacent to Intake Pumping Plant 3 to the intermediate forebay on Glannvale Tract. Tunnel 1b would run between Intake Pumping Plant 5 and the intermediate forebay. Tunnel 2 would extend between the intermediate forebay and Clifton Court Forebay. The main construction or launching shafts for each tunnel would be about 60 feet in diameter. The TBM retrieval shaft would be approximately 45 feet in diameter, and 12-foot-diameter intermediate ventilation shafts would be constructed approximately every 3 miles along the tunnel route. The amount of material that would be excavated, which is the least of the tunnel or canal options, is shown in Table 27-11. The tunnels would be excavated at a depth of approximately 100–150 feet at the tunnel invert, mainly to avoid the peaty Holocene soils. The TBMs would be mechanized soft-ground tunneling machines designed for use in soft soils with high groundwater pressure. The tunnels would be lined with precast concrete bolted-and-gasketed segments. The tunnel concrete liner would serve as permanent ground support and would be installed immediately behind the TBM, forming a continuous watertight vessel.

Shafts and tunnels would be excavated through Holocene and Pleistocene deposits (Figures 27-2 and 27-3). Shafts would be excavated through surficial Holocene deposits and then through Pleistocene deposits of the Riverbank or Modesto Formations. Tunnels would be bored wholly through Pleistocene deposits. Construction of the expanded Clifton Court Forebay would involve deep and extensive excavation directly southeast of Clifton Court Forebay (Figure 27-2). Excavation would involve approximately 592 acres to a depth of approximately 15–20 feet below existing grade, except locally at the inlet and outlet connections (Table 27-10). The invert of the incoming canal would be at -28 feet msl before discharging to the tunnel.

Excavation for the expanded Clifton Court Forebay would occur in both sensitive and nonsensitive units (Figure 27-2). Although much of the area surrounding the Clifton Court Forebay is covered in surficial units of Holocene age such as the Holocene alluvial-floodplain deposits (Qfp), which are not sensitive for paleontological resources, units sensitive for paleontological resources are also exposed at the surface and underlie the area (Figure 27-2). These units include the Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek (Qch), which is sensitive for paleontological resources.

A new section of canal, approximately 800 feet long and situated between Clifton Court Forebay and Union Pacific Railroad, will connect the expanded Clifton Court Forebay to the existing approach channel to the Banks Pumping Plant.

Excavation for the expanded Clifton Court Forebay and new approach to the Banks Pumping Plant would disturb these Pleistocene units. Breaching of the existing canal embankment would not disturb Pleistocene units.

An operable barrier would be constructed at the head of Old River. The operable barrier would be constructed in units of Holocene age and not sensitive for paleontological resources and, possibly, the Modesto Formation, which occurs in the shallow subsurface. The operable barrier is in the same geologic units as the canals to Jones and Banks pumping plants.

The temporary and permanent access roads required for Alternative 4 would involve shallow excavation and grading, primarily along existing farm roads or across lands disturbed by agricultural activity. It is unlikely that this shallow ground disturbance would affect significant paleontological resources.

Borrow material would be needed primarily for forebay embankments and levee reconstruction at intake sites, but also for access roads. The amount of material that would be needed for borrow, which is the least of the tunnel or canal options, is shown in Table 27-11. Borrow material would be excavated from targeted units described in the engineering report (California Department of Water Resources 2010). Some of these units, including the Modesto and Montezuma Formations, are sensitive for paleontological resources. Excavation of borrow material from these units could disturb paleontological resources. In addition, borrow/spoil areas are designated in the area of the intakes, along the intermediate forebay, and along the expanded Clifton Court Forebay (Figure 27-2). As described above, units sensitive for paleontological resources in these areas include the Riverbank and Modesto Formations (potentially in the shallow subsurface) in the area of the intakes and intermediate forebay, and the alluvium of creeks from the Corral Hollow Drainage to Brushy Creek along the expanded Clifton Court Forebay. Excavation of borrow material from these units could also disturb sensitive paleontological resources.

NEPA Effects: The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 4. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new/expanded forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 4 would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 4 could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 4 would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for the tunnels necessary for Alternative 4 would most likely destroy unique or significant paleontological resources in the Plan Area and would potentially cause a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Before ground-breaking construction begins, BDCP proponents will retain a qualified paleontologist or geologist (as defined by the SVP Standard Procedures [Society of Vertebrate Paleontology 2010]) to develop a comprehensive Paleontological Resources Monitoring and Mitigation Plan (PRMMP) for the BDCP, to help avoid directly or indirectly destroying a unique or significant paleontological resource.

The PRMMP will be consistent with the SVP Standard Procedures (Society of Vertebrate Paleontology 2010) and the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996) and will require the following.

- A paleontological resources specialist (PRS) will be designated or retained for construction activities. The PRS will have paleontological resources management qualifications consistent with the description of a qualified paleontologist in the SVP Standard Procedures (Society of Vertebrate Paleontology 2010). The PRS will be responsible for implementing all

aspects of the PRMMP, managing any additional paleontological monitors needed for construction activities, and serving as a qualified resource in the event of unanticipated paleontological finds. The PRS may, but need not necessarily, be the same individual who prepared the PRMMP. The PRS will be retained or designated prior to the start of ground-breaking construction. A qualified PRS is defined as a person with a M.S. or Ph.D. in paleontology, paleobiology, or geology, with strong working knowledge of local paleontology and geology, and professional expertise with paleontological procedures and techniques. The PRS may designate a paleontological monitor to be present during earth-moving activities. A paleontological monitor is defined as a person with a BS/BA in geology or paleontology and a minimum of 1 year of monitoring experience in local sedimentary rocks. Experience may be substituted for academic training on approval from the contracting agency. The PRS and paleontological monitor(s) will be notified by the Lead Agency or Resident Engineer in advance of the start of construction activity. The PRS and paleontological monitor(s) will attend any required safety training programs.

- Preconstruction surveys (with salvage and/or protection in place, as appropriate) will be conducted in areas where construction activities would result in surface disturbance of geologic units identified as highly sensitive for paleontological resources.
- Preconstruction and construction-period coordination procedures and communications protocols will be established, including procedures to alert all construction personnel involved with earthmoving activities about the possibility of encountering fossils as set forth in Mitigation Measure PALEO-1c and communications regarding the *stop work, evaluate and treat appropriately response* in the event of a paleontological discovery, as discussed in Mitigation Measure PALEO-1d.
- All ground-disturbing activities involving highly sensitive units will be monitored by qualified monitors. Monitoring will initially be conducted full time for grading and excavation, but the PRMMP may provide for monitoring frequency in any given location to be reduced once 50% of the ground-disturbing activity in that location has been completed, if the reduction is appropriate based on the implementing PRS's professional judgment in consideration of actual site conditions. Monitoring will also be conducted throughout drilling operations. The monitoring program for tunneling operations will be developed in conjunction with the facility design and geotechnical teams, in consideration of the tunneling method selected.
- Sampling and data recovery procedures that are consistent with the SVP Standard Procedures (Society of Vertebrate Paleontology 2010) and the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996) will be established.
- A repository plan will be developed that provides for appropriate curation of recovered materials, if necessary.
- Mitigation monitoring report preparation guidelines will be established that are consistent with the SVP Standard Procedures guidelines (Society of Vertebrate Paleontology 2010). The report will include, at a minimum, discussions of effects, regulatory requirements, purpose of mitigation, regional geologic context, Plan Area stratigraphy, stratigraphic and geographic distribution of paleontological resources, field and laboratory methods and procedures, fossil recovery, and paleontological significance. The report will also include geological cross sections and stratigraphic sections depicting fossil discovery localities and excavated rock units; maps showing the activity location and vicinity, as well as geology and

location of discovered fossil localities; appropriate illustrations depicting monitoring conditions, field context of collecting localities, quarry maps, and laboratory activities; and appendices including an itemized listing of catalogued fossil specimens, complete descriptions of all fossil collecting localities, an explanation of report acronyms and terms, and a signed curation agreement with an approved paleontological repository.

- Procedures for preparing, identifying, and analyzing fossil specimens and data recovered will be established, consistent with the SVP Conditions of Receivership (Society of Vertebrate Paleontology 1996 and 2010) and any specific requirements of the designated repository institution.

Implementation of this measure will ensure that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

To help avoid directly or indirectly destroying a unique or significant paleontological resource, the BDCP proponents will have a qualified individual review the 90% design submittal to finalize the identification of construction activities involving geologic units considered highly sensitive for paleontological resources. Evaluation will consider the anticipated depth of disturbance, the selected construction technique, and the geology of the alignment. This work may be carried out in conjunction with or as part of the development of the PRMMP (Mitigation Measure PALEO-1a). The evaluation may be carried out by the PRS or an individual meeting the SVP's requirements for a qualified vertebrate paleontologist (per Society of Vertebrate Paleontology 2010) and will be conducted in collaboration with the BDCP design and geotechnical teams. If the evaluation is performed by a paleontologist, it will be reviewed and verified by a California-licensed professional geologist. The purpose of this evaluation will be to develop specific language identifying how the mitigation measures will be applied to the various phases of construction along the alignment (e.g., which areas would require monitors). This language will be included in the BDCP construction documents for implementation by BDCP proponents. The language will be based on the following framework.

- One onsite paleontological monitor will likely be sufficient to handle observation of most ground-disturbing activities. However, if additional paleontological monitors are needed, the PRS will coordinate with the Resident Engineer. This communication is imperative and fundamental to the success of this PRMMP and to compliance with CEQA and NEPA.
- Whenever possible, sedimentary rocks exposed during trenching and other deep excavation work will be inspected. Ideally, this monitoring will involve inspection of fresh bedrock exposures. However, observation of some work may not be possible for safety reasons and inspection from these operations will be restricted to spoils. In this case, the monitor will inspect spoils as they are stockpiled and remove any matrix blocks containing paleontological resources. Construction personnel, namely the Resident Engineer/Lead, must communicate depths of excavated materials and their approximate location to the field monitor.

- Recording of stratigraphic data will be an ongoing aspect of excavation monitoring, to provide context for any eventual fossil discoveries. Outcrops exposed in active cuts and finished slopes will be examined and geologic features recorded on grading plans and in field notes. The goal of this work is to delimit the nature of fossiliferous unconsolidated sedimentary deposits within the Plan Area, determine their areal distribution and depositional contacts, and record any evidence of structural deformation. Standard geologic and stratigraphic data collected include lithologic descriptions (e.g., color, sorting, texture, structures, and grain size), stratigraphic relationships (e.g., bedding type, thickness, and contacts), and topographic position. Stratigraphic sections will be routinely measured, areas containing exposures of fossiliferous sedimentary rocks will be documented, and fossil localities will be recorded on measured stratigraphic sections.
- If fossils are discovered, the following procedures will be followed. The monitor or PRS will inform the Resident Engineer who will determine the appropriate course of action. For all excavations except those relating to the tunnels, mitigation shall consist of one of the following: diverting, directing, or temporarily halting ground-disturbing activities in the area of discovery to allow for preliminary evaluation of potentially significant paleontological resources and to determine whether additional mitigation (i.e., collection, curation or other preservation) is required. Where excavations relate to construction of the tunnels, such measures will be infeasible because the fossils will most likely have been destroyed by the tunnel boring machines before they could have been identified.

The significance of the discovered resources will be determined by the PRS in consultation with appropriate contractor representatives. 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.

- Provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct.
- 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.
- Provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas.
- Demonstrate unusual or spectacular circumstances in the history of life.
- 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.

They can include fossil remains of large to very small aquatic and terrestrial vertebrates (including animal trackways), 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.

- Recovery methods will vary to some degree depending on the types of fossils discovered (e.g., invertebrate macrofossils, invertebrate microfossils, vertebrate macrofossils,

vertebrate microfossils, or plant fossils). Many fossil specimens discovered during excavation monitoring are readily visible to the naked eye and large enough to be easily recognized and removed. Upon discovery of such macrofossils, the paleontological monitor will temporarily flag the discovery site for avoidance and evaluation, as described above. Actual recovery of unearthed macrofossils can involve several techniques, including immediate collection, hand quarrying, plaster-jacketing, and/or large-scale quarrying. The PRS and the contracting agency representative will evaluate the discovery and take action to protect or remove the resource within the shortest period of time possible.

- Many significant vertebrate fossils (e.g., small mammal, bird, reptile, amphibian, or fish remains) often are too small to be readily visible in the field, but are nonetheless significant and worthy of attention. The potential discovery of microvertebrate sites is anticipated and can include sites that produce remains of large vertebrate fossils from fine-grained deposits, sites with an obvious concentration of small vertebrate fossil remains, and sites that based on lithology alone (e.g., paleosols) appear to have a potential for producing small vertebrate fossil remains. Microvertebrate sites will be sampled by collecting bulk quantities of sedimentary matrix. An adequate sample comprises approximately 12 cubic meters (6,000 lbs or 2,500 kg) of matrix for each formation, or as determined by the PRS (Society of Vertebrate Paleontology 2010). The uniqueness of the recovered fossils may dictate salvage of larger amounts. However, conditions in the field may make it impossible to recover such large samples. To avoid construction delays, bulk matrix samples will be transported to an offsite location for processing.
- The discovery of fossil plants is possible in the Plan Area. Paleobotanical specimens typically occur in fine-grained, laminated strata (e.g., shale) and will require special recovery techniques. Large blocks (>2 feet) of sedimentary rock are hand quarried from the temporary outcrop and then split along bedding plains to reveal compressed fossil plant material (e.g., leaves, stems, and flowers). Individual slabs are then wrapped in newsprint to minimize destructive desiccation of the fossils. Specimens that are delaminating or flaking badly may need to be coated with special consolidants.
- Oriented matrix samples may be collected for paleomagnetic analysis. Such sampling will likely only be necessary in instances where long, continuous sections of stratified rocks are producing fossils from several different stratigraphic horizons or where vertebrate fossils are being collected in stratigraphic sections lacking in biochronologically useful microfossils. Likewise, it may be necessary to collect stratigraphically positioned samples of fine matrices pollen analysis or aid in addressing questions of geologic age, depositional environment, or paleoecology.
- All fossil discoveries will include the collection of stratigraphic data to delimit the nature of the fossil-bearing sedimentary rock unit, determine its areal distribution and depositional contacts, record any evidence of structural deformation, generate lithologic descriptions of fossil-bearing strata, determine stratigraphic relationships (bedding type, thickness, and contacts), and topographic position, measure stratigraphic sections, and describe taphonomic details.

Implementation of this measure will ensure that mitigation procedures are followed so that unique or scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

In order to reduce the likelihood of directly or indirectly destroying a unique or significant paleontological resource, BDCP proponents will require that all construction personnel receive training provided by a qualified paleontologist experienced in teaching non-specialists, to ensure that they can recognize fossil materials in the event any are discovered during construction. Training will include information on the possibility of encountering fossils during construction, the types of fossils likely to be seen and how to recognize them, and proper procedures in the event fossils are encountered. All field management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take this training prior to beginning work. Training materials will include an informational brochure that provides contacts and summarizes procedures in the event paleontological resources are encountered.

Implementation of this measure will ensure that unique or scientifically significant paleontological resources have a high likelihood of being identified during construction so they can be avoided or treated appropriately.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

To help avoid directly or indirectly destroying a unique or significant paleontological resource, the BDCP proponents will ensure that if substantial potentially unique or significant fossil remains (particularly vertebrate remains) are discovered during ground-disturbing activities, the construction crew will be directed to immediately cease work in the vicinity of the find and notify the PRS, consistent with the PRMMP described under Mitigation Measure PALEO-1a. A newly discovered resource may need to be fenced off to protect it from inadvertent intrusions by machinery or protect the location from vandalism. If extensive recovery and jacketing is needed, the area will be fenced off with temporary fencing and a 3- to 5-meter (10- to 15-foot) buffer will be included in the fenced area around the locality. If specific construction activities preclude placement of a buffer of this width, the monitor will stake a mutually agreeable buffer prior to fencing. The PRS will evaluate the resource and prepare a mitigation plan in accordance with SVP guidelines (2010). The mitigation plan may include a field survey, construction monitoring, sampling and data recovery procedures, museum storage coordination for any specimen recovered, and a report of findings. Recommendations determined by BDCP proponents to be necessary and feasible will be implemented before construction can resume at the site where the paleontological resources were discovered.

Except for the fossils destroyed by tunnel boring machines, implementation of this measure will ensure that unique or scientifically significant paleontological resources identified during construction are protected from damage or treated and documented appropriately to preserve their scientific value.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are evaluated below by conservation measure. Conservation measures to address reduction of other stressors (CM11–

CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

CM2 (Yolo Bypass Fisheries Enhancement)

- Construct four experimental ramps at the Fremont Weir.
- Construct up to three sets of up to three fish ladders.
- Construct fish screens on small Yolo Bypass diversions.
- Construct new or replacement operable check-structures at Tule Canal/Toe Drain.
- Replace the Lisbon Weir with a fish-passable gate structure.
- Realign Putah Creek.
- Modify a section of the Fremont Weir.
- Construct and operate nonphysical or physical barriers in the Sacramento River.
- Construct associated support facilities (operations buildings, parking lots, access facilities such as roads and bridges) necessary to provide safe access for maintenance and monitoring.
- Construct and test flood-neutral fish barriers.

Of these ground-disturbing activities, only the realignment of Putah Creek has the potential to disturb sensitive paleontological resources. If this realignment includes excavating a new channel, Pleistocene deposits associated with the older alluvium of Putah Creek could be disturbed. The other CM2 activities would occur in basin deposits of Holocene origin, which have low potential sensitivity for paleontological resources, based on age.

CM4 (approximately 65,000 acres of restored freshwater and brackish tidal habitat within the BDCP Restoration Opportunity Areas)

Ground-disturbing activities associated with CM4 range from relatively shallow, localized excavation to deep or extensive excavation. Two types of activities involve deeper excavation.

- Modify existing land elevations through grading and filling or subsidence reversal.
- Relocate existing roads and utilities to support construction and postconstruction activities at the restoration site or services to adjacent lands protected by levees.

Sensitive Pleistocene deposits occur at the surface or in the shallow subsurface in all the Restoration Opportunity Areas (ROAs), except the South Delta ROA (Figures 27-2 and 3-1). Shallow, localized excavation in areas where sensitive units occur at the surface could disturb paleontological resources in these units. Deeper or extensive excavation could disturb sensitive units in all of the ROAs.

CM5 (approximately 10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta)

Ground-disturbing activities associated with CM5 include clearing and grubbing, demolition of existing structures, setting back levees and removing existing levees, removal of riprap to allow for channel meander between setback levees, grading to restore drainage patterns and increase inundation frequency and duration, and establishment of riparian habitat. Most of these activities would involve shallow excavation or excavation in disturbed materials (levees), but grading to

restore drainage patterns could involve deeper excavation. This floodplain-related excavation could occur in the northern, eastern, or southern sections of the Delta, but the most promising areas for paleontological resources are expected along the San Joaquin River in Conservation Zone 7. This area includes sensitive Modesto Formation and Corral Hollow/Brushy Creek drainage units at or near the surface (Figures 27-2 and 3-1); sensitive paleontological resources could be disturbed in this area.

CM6 (20 linear miles of channel margin habitat enhancement in the Delta)

Ground-disturbing activities associated with CM6 include clearing and grubbing, demolition of existing structures, modification of levees or setting back levees, removing riprap where levees are set back, and modifying channel geometry in unconfined channel reaches or along channels where levees are set back. Most of these activities would involve shallow excavation or excavation in disturbed materials (levees), but modifying channel geometry could involve deeper excavation. Sensitive Pleistocene deposits may be encountered at shallow depths along the San Joaquin River in Conservation Zone 7 (Figures 27-2 and 3-1), should there be channel geometry modification in this area.

CM7 (approximately 5,000 acres of restored valley/foothill riparian habitat)

Ground-disturbing activities associated with CM7 include clearing and grubbing, and demolition of existing structures. Earthwork activities for development of the riparian habitat areas would be minimal and focused on removal of riprap and minor landform modifications to restore water circulation. These activities are shallow and unlikely to disturb paleontological resources.

CM8 (approximately 2,000 acres of restored grassland and 8,000 acres of protected or enhanced grassland within BDCP Conservation Zones 1, 8, and/or 11)

Ground-disturbing activities associated with CM8 entail little or no ground disturbance. Any grading for this restoration would be at shallow depths and would not be likely to affect paleontological resources.

CM3 and CM9 (approximately 67 acres of restored vernal pool complex and 600 acres of protected vernal pool complex within Conservation Zones 1, 8, and/or 11)

Ground-disturbing activities associated with CM9 entail some land disturbance, such as minor grading to improve connectivity between complexes. Any grading for this restoration would be at shallow depths and would not be likely to affect paleontological resources.

CM10 (approximately 1,200 acres of restored nontidal marsh within Conservation Zones 2 and 4 and/or 5)

Ground-disturbing activities associated with CM10 entail grading to establish an elevation gradient to support open water perennial aquatic habitat intermixed with shallower marsh habitat. The Pleistocene Riverbank and Modesto Formations are exposed throughout Conservation Zone 4 and may occur in the older alluvium of Putah Creek in Conservation Zone 2. Where sensitive Pleistocene deposits are exposed at the surface or are overlain by a shallow veneer of Holocene deposits in these two conservation zones (Figures 27-2 and 3-1), paleontological resources could be disturbed as grading is undertaken for CM10.

NEPA Effects: Although excavation associated with these conservation measures under Alternative 4 would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units

sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 4 would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 4.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 4.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 4.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 4.

27.3.3.10 Alternative 5—Dual Conveyance with Pipeline/Tunnel and Intake 1 (3,000 cfs; Operational Scenario C)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 5 in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 5 would include the same physical/structural components as Alternative 1A, but would entail only one intake and one intake pumping plant. The effects of Alternative 5 would, therefore, be the same as 1A but of a lesser magnitude. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 5. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 5 could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 5 would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 5 would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 5 would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Under Alternative 5, approximately 25,000 acres of tidal habitat restoration would take place, compared to approximately 65,000 acres of tidal habitat restoration under Alternatives 1A through 4. The type of effects would be the same, but the magnitude of potential effects associated with breaching and modifying levees would be substantially reduced under Alternative 5.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 5 would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.11 Alternative 6A—Isolated Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario D)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 6A in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 6A would include the same physical/structural components as Alternative 1A, but existing connections between the SWP and CVP south Delta export facilities would be severed. These connections would be in the same geologic units and would not substantially change the effects on paleontological resources. The effects of Alternative 6A would, therefore, be the same as those under Alternative 1A. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 6A. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 6A could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 6A would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, as a result of excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 6A would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 6A would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 6A would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or

destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.12 Alternative 6B—Isolated Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario D)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 6B in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-12.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 6B would include the same physical/structural components as Alternative 1B, but existing connections between the SWP and CVP south Delta export facilities would be severed. These connections would be in the same geologic units and would not substantially change the effects on paleontological resources. The effects of Alternative 6B would, therefore, be the same as those under 1B. See the discussion of Impact PALEO-1 under Alternative 1B.

The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would occur with construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities described above. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for the new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants necessary for construction of the tunnels would most likely destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 6B could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with construction of these facilities would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 6B would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 6B would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 6B would be fairly shallow, CM2, CM4–CM, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or

protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.13 Alternative 6C—Isolated Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario D)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 6C in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-13.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 6C would include the same physical/structural components as Alternative 1C, but existing connections between the SWP and CVP south Delta export facilities would be severed. These connections would be in the same geologic units and would not substantially change the effects on paleontological resources. The effects of Alternative 6C would, therefore, be the same as 1C. See the discussion of Impact PALEO-1 under Alternative 1C.

The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d. The effects associated with the borrow sites would be greater than under Alternative 6A but less than under Alternative 6B.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 6C. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Because the length of the dual-bore tunnel would be considerably less under Alternative 6C than under Alternatives 1A, 2A, and 6A, the severity of this effect would be reduced. However, excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert siphons, tunnel, Byron Tract Forebay and canals to Jones and Banks pumping plants, and other water facility components would most likely still destroy unique or significant paleontological resources and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 6C could cause the destruction of unique paleontological resources. Ground-disturbing activities in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, pipelines, conveyance canal and intermediate pumping plant, culvert siphons, tunnel, Byron Tract Forebay and canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 6C would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Most excavation associated with these conservation measures under Alternative 6C would be shallow. However, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 6C would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.14 Alternative 7—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Enhanced Aquatic Conservation (9,000 cfs; Operational Scenario E)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 7 in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 7 would include the same physical/structural components as Alternative 1A, but would, like Alternative 4, entail only three intakes and three intake pumping plants. The effects of Alternative 7 would, therefore, be the same as those under Alternative 4, although the intake locations would be different. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 7. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 7 would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 7 could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with construction of these facilities would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 7 would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other

stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Conservation measures would under Alternative 7 would be similar to those under 1A except that Alternative 7 would include significantly more channel margin habitat enhancement and more seasonally inundated floodplain restoration (double that under Alternative 1A). The habitat enhancement and floodplain restoration do not, however, substantially change the effects of these conservation measures because most of this additional enhancement and restoration would likely involve fairly shallow excavation along the lower San Joaquin River in the south Delta (Conservation Zone 7), which is covered in nonsensitive Holocene deposits.

Most excavation associated with these conservation measures under Alternative 7 would be shallow. However, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 7 would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.15 Alternative 8—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Increased Delta Outflow (9,000 cfs; Operational Scenario F)

The location of BDCP facilities (and the construction activities associated with those facilities) under Alternative 8 in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-10.

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

NEPA Effects: Alternative 8 would include the same physical/structural components as Alternative 1A, but would entail only three intakes and three intake pumping plants. The effects of Alternative 8 would, therefore, be the same as those under Alternatives 4 and 7. Alternative 8 would entail the same three intakes as Alternative 7. See the discussion of Impact PALEO-1 under Alternative 1A.

The shallow excavation and grading in surficial Holocene deposits that would take place for the construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

Mitigation Measures PALEO-1a through PALEO-1d are available to mitigate the effects of the surface-related ground disturbance activities associated with Alternative 8. However, while these measures could be applied to the excavation of the tunnel shafts, no mitigation is available for the boring activities because they would be conducted deep underground and could not be monitored. Moreover, although boring material could be examined by monitors, such work would be subsequent to boring, and the boring area could not be accessed even if fossils were encountered.

Excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 8 would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute an adverse effect under NEPA.

***CEQA Conclusion*:** Construction of water conveyance facilities proposed under Alternative 8 could cause the destruction of unique paleontological resources. The ground-disturbing activities associated with Alternative 8 would occur in geologic units sensitive for paleontological resources and could therefore have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. While implementation of Mitigation Measures PALEO-1a through PALEO-1d would reduce the effects of surface-related ground disturbance to a less-than-significant level, excavation for new intakes, new intake pumping plants, new forebays, pipelines and tunnels, canals to Jones and Banks pumping plants, and other water facility components necessary for Alternative 8 would most likely destroy unique or significant paleontological resources in the Plan Area and would constitute a significant and unavoidable impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Conservation measures would under Alternative 8 would be similar to those under 1A. Most excavation associated with these conservation measures under Alternative 8 would be shallow. However, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface

in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-2d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-2a through PALEO-2d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 7 would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.3.16 Alternative 9—Through Delta/Separate Corridors (15,000 cfs; Operational Scenario G)

The location of BDCP construction activities under Alternative 9 in relation to geologic units is shown in Figure 27-2. The depth and extent of these activities are shown in Table 27-15. A detailed depiction of the through Delta/separate corridors alternative is provided in Figure M3-5 in the Mapbook Volume.

Table 27-15. Summary of BDCP Construction Activities and Geologic Units Sensitive for Paleontological Resources that Could be Disturbed under Alternative 9

Alternative 9	Location	Construction/Excavation	Sensitive Units Disturbed
Two new Delta intakes	Delta Cross Channel, Georgiana Slough	Excavation of 30 ac total, including plants and basins	Riverbank and Modesto Formations
Pumping plants	San Joaquin River at Head of Old River and Middle River upstream of Victoria Canal	Excavation of 8–10 ac (3 permanent)	Pleistocene units
19- by 19-ft, 23- by 23-ft, and 26- by 26-ft culvert siphons	Where alignment crosses major waterways	Same as 1B but different dimensions	

Impact PALEO-1: Destruction of Unique or Significant Paleontological Resources as a Result of Construction of Water Conveyance Facilities

Construction of water conveyance facilities under Alternative 9 could cause the destruction of unique paleontological resources as a result of excavation for new intakes and pumping plants, channel enlargement, culvert siphons, canal, and Old River and Middle River diversion pumping plants.

The construction of water conveyance facilities associated with Alternative 9 varies from the other action alternatives in two main respects: the location of the intakes is south of the intake locations in the other alternatives, and there is no new large-scale conveyance structure (i.e., tunnel or canal).

The depth, extent, and location of excavation and other ground-disturbing activities vary greatly across the Plan Area (Table 27-15). Accordingly, this discussion considers these activities on the basis of their location and the depth of excavation. The two intakes would involve deep and extensive excavation in the northern portion of the Plan Area (Table 27-15). The intakes would be located at the Delta Cross Channel and the Georgiana Slough. Ground-disturbing activities include clearing and grubbing, rough grading, excavation, pile driving, constructing foundations, and final

grading. Construction of the intakes would involve an area of approximately 30 acres. Each intake would be approximately 85 feet wide and 45 feet long.

Excavation for the intakes would occur in both sensitive and nonsensitive units (Figure 27-2). Although most of the surficial geologic units in the area affected by excavation for the intakes are of Holocene age and not sensitive for paleontological resources, the Riverbank Formation, which is of Pleistocene age and sensitive for paleontological resources, is exposed at the surface nearby or underlies the Holocene units in the shallow subsurface (Figure 27-3). The Modesto Formation, another Pleistocene age unit that is sensitive for paleontological resources, also occurs in the area and is likely exposed at the surface and in the shallow subsurface. These Pleistocene units likely occur at a depth of 5–15 feet and would therefore be disturbed during excavation of the intakes.

New canals would be excavated in the southernmost part of the Plan Area at Victoria Canal. The amount of material that would be excavated, which is the least of all alternatives, is shown in Table 27-11. These canals would be similar to those under Alternative 1B but only 1.5 miles long. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons (discussed below), eventually reaching Clifton Court Forebay. A new intertie canal would be constructed to connect the forebay to CVP facilities.

Construction of the two new canal segments would involve excavating with a bottom width of up to 65 feet. In this alignment, Pleistocene deposits may occur at shallow depth (Figure 27-3). These deposits would therefore be disturbed during excavation of the canal. In addition, canal construction requires that the organic-rich peaty soils, which may be up to 25 feet thick, be removed, thereby increasing the likelihood that Pleistocene deposits would be encountered. As with Alternative 1B, the Holocene or Upper Pleistocene alluvium of creeks from the Corral Hollow Drainage to Brushy Creek (Qch), which is sensitive for paleontological resources, is exposed at the surface (Figures 27-2 and 27-3). Excavation of the canal would therefore likely disturb Pleistocene units sensitive for paleontological resources.

Culvert siphons would be constructed where the alignment crosses major waterways. As under Alternative 1B, culvert siphons would be constructed using cut-and-cover methods, but the dimensions would differ: a 19- by 19-foot, 23- by 23-foot, and 26-foot by 26-foot concrete structure. The depth of trenches for these culvert siphons would vary by location, but the roof of the structures would be installed 47 feet below the existing slough invert. In most cases, peat soil would be excavated so that the culvert foundation would be founded on alluvial sand (Pleistocene). Given the depth of the culverts and the need to remove peat soil in some locations, excavation of the culvert siphons would likely disturb Pleistocene units sensitive for paleontological resources.

Construction of the diversion pumping plants would take place on the San Joaquin River at the Head of Old River and on Middle River upstream of Victoria Canal. The area of the pumping plants would be excavated to a depth of 25–30 feet below ground surface. At these locations, Holocene deposits form a veneer over the Pleistocene deposits (Figures 27-2 and 27-3). The Modesto Formation, which is sensitive for paleontological resources, occurs in the shallow subsurface, likely at a depth of 10–20 feet, and would therefore be disturbed during excavation of the pumping plants.

Channel enlargement would take place in four locations along Middle River: between Mildred Island and Railroad Cut (enlarged area 4,777 square feet), between Railroad Cut and Woodward Canal (enlarged area 4,319 square feet), between Woodward Canal and Victoria Canal (enlarged area 3,201 square feet), and Victoria Canal (enlarged area 8,145 square feet). Hydraulic or mechanical

dredgers would be used to dredge in already disturbed and young deposits and therefore would not affect units sensitive for paleontological resources.

The effects of construction of the access roads would be similar to those under Alternative 1A, but of lesser magnitude because fewer roads would be needed. The shallow excavation and grading in surficial Holocene deposits that would occur with construction of roads could be addressed through implementation of Mitigation Measures PALEO-1b and 1d.

The effects of excavation of borrow material would be much less than under all other alternatives (Table 27-11). Impacts, however, would be mitigated with the same mitigation measures described under Alternative 1A.

NEPA Effects: The ground-disturbing activities that occur in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would represent an adverse effect because conveyance facility construction could directly or indirectly destroy unknown paleontological resources in geologic units known to be sensitive for these resources. However, Mitigation Measures PALEO-1a through PALEO-1d would be available to mitigate the effects of the activities described above. No adverse effects would be expected.

CEQA Conclusion: Construction of water conveyance facilities proposed under Alternative 9 could cause the destruction of unique paleontological resources as a result of excavation for new intakes and pumping plants, channel enlargement, culvert siphons, canal segments, and Old River and Middle River diversion pumping plants. Ground-disturbing activities in geologic units sensitive for paleontological resources have the potential to damage or destroy those resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact under CEQA. Implementation of Mitigation Measures PALEO 1a through PALEO-1d would reduce these effects to a less-than-significant level because they would ensure that unique or significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

Impact PALEO-2: Destruction of Unique or Significant Paleontological Resources Associated with the Implementation of Other Conservation Measures

NEPA Effects: Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) have the potential to affect paleontological resources. These activities are addressed in detail in the discussion of Alternative 1A. Conservation measures to address reduction of other stressors (CM11–CM22) would have no effect on paleontological resources because they would not entail ground-disturbing activities.

Although excavation associated with these conservation measures under Alternative 1B would be shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. Units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation for these conservation measures. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of vertebrate or otherwise scientifically significant paleontological resources as defined by the SVP (2010) would be an adverse effect.

Mitigation Measures PALEO-1b and PALEO-1d are available to mitigate all shallow ground-disturbing conservation measures. Mitigation Measures PALEO-1a through PALEO-1d would address all deeper ground-disturbing conservation measures.

***CEQA Conclusion*:** Ground-disturbing activities associated with other conservation measures (CM2 and CM4–CM10) could affect paleontological resources. Although most excavation associated with these conservation measures under Alternative 1B would be fairly shallow, CM2, CM4–CM6, and CM10 require deeper or more extensive excavation. In addition, units sensitive for paleontological resources, such as the Riverbank and Modesto Formations, occur at the surface in several conservation zones and occur at shallow depth in other zones. If fossils are present in the Plan Area, they could be damaged during excavation associated with these conservation measures. The greater the extent of excavation, the greater the potential impact, although even localized excavation could damage or destroy paleontological resources. Direct or indirect destruction of significant paleontological resources as defined by the SVP (2010) would constitute a significant impact.

Implementation of Mitigation Measures PALEO-1b and PALEO-1d for all shallow ground-disturbing conservation measures and Mitigation Measures PALEO-1a through PALEO-1d for all deeper ground-disturbing conservation measures would ensure that scientifically significant paleontological resources in the alternative footprint are systematically identified, documented, avoided or protected from damage where feasible, or recovered and curated so they remain available for scientific study and would reduce these impacts to a less-than-significant level.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

27.3.4 Cumulative Analysis

The cumulative analysis for paleontological resources considers the effects of BDCP implementation in combination with the potential effects of other past, present, and reasonably foreseeable projects and programs. The analysis focuses on projects and programs within the Plan Area and the broader Delta region that involve substantial ground-disturbing activities in geologic units with a high potential for containing significant paleontological resources (the Modesto, Tulare, Tehama, Montezuma, Riverbank, Neroly, and Markley Formations). The principal programs and projects considered in the analysis are listed in Table 27-16. This list has been drawn from a more substantial compilation of past, present, and reasonably foreseeable programs and projects included in Appendix 3D, *Defining Existing Conditions, the No Action/No Project Alternative, and Cumulative Impact Conditions*.

Table 27-16. Programs and Projects Considered in Paleontological Resources Cumulative Analysis

Agency	Program/Project	Status	Description of Program/Project	Effect on Paleontological Resources
California Department of Water Resources and Solano County Water Agency	North Bay Aqueduct Alternative Intake Project	Draft EIR is ongoing	This project will construct an alternative intake on the Sacramento River and a new segment of pipeline to connect it to the North Bay Aqueduct system.	The pipeline segment of the project could have adverse impacts on paleontological resources. Ground-disturbing activities associated with construction of the intake and pipeline could disturb units sensitive for paleontological resources, such as the Modesto and Riverbank Formations.
California High Speed Rail Authority and Federal Railroad Administration	California High-Speed Rail System, Sacramento to Merced Section	Briefing on Initial Alternatives completed. Sacramento to Merced section is part of Phase 2.	Development of new high-speed rail service. Near-term improvements could include right-of-way preservation, interim operation on existing tracks, and passing sidings. Future improvements would construct a new rail line.	No paleontological resources are expected to be disturbed within this corridor, based on the sedimentary units occurring between Sacramento and Stockton
Bureau of Reclamation	Delta-Mendota Canal/California Aqueduct Intertie	Completed in 2012	The purpose of the intertie is to better coordinate water delivery operations between the California Aqueduct (state) and the Delta-Mendota Canal (federal) and to provide better pumping capacity for the Jones Pumping Plant. New project facilities include a pipeline and pumping plant.	No impacts to paleontological resources are expected.
City of Stockton	Delta Water Supply Project (Phase 1)	Currently under construction	This project consists of a new intake structure and pumping station adjacent to the San Joaquin River; a water treatment plant along Lower Sacramento Road; and water pipelines along Eight Mile, Davis, and Lower Sacramento Roads.	This project could disturb units sensitive for paleontological resources, such as the Riverbank Formation.

Agency	Program/Project	Status	Description of Program/Project	Effect on Paleontological Resources
Zone 7 Water Agency and California Department of Water Resources	South Bay Aqueduct Improvement and Enlargement Project	Completed	The South Bay Aqueduct Improvement and Enlargement Project will improve and expand the existing South Bay Aqueduct. The project will increase the existing capacity of the water conveyance system up to its design capacity of 300 cfs, and expand capacity in a portion of the project to add 130 cfs (total of 430 cfs).	This project could disturb units sensitive for paleontological resources, such as the Panoche and Neroly Formations.
Yolo County	Yolo County General Plan Update	Continuing actions	County of Yolo's 2030 Countywide General Plan allows for additional growth in unincorporated areas of the county of just under 31,000 people, up to 10,462 homes, and 1.5% growth in average annual employment.	Buildout contemplated under the updated general plan will result in ground-disturbing construction that could affect geologic units sensitive for paleontological resources, such as the Modesto and Tehama Formations.
CALFED Levee Stability Program	Existing project levees in the Delta	Continuing actions	Protection of resources in the Delta through maintenance and improvement of existing levees	This program will result in the repair of project and non-project levees in the Delta. Ground-disturbing construction and borrow activity necessary to complete typical improvements could disturb geologic units sensitive for paleontological resources, such as the Modesto and Riverbank Formations.

No Action Alternative

The ongoing projects and programs in the Delta under the No Action Alternative in addition to the cumulative projects would require ground-disturbing construction to either construct new facilities or implement restoration and habitat enhancement goals. SWP/CVP operations would require repair, maintenance, or protection of infrastructure such as levees, and may also include actions for water quality management, habitat and species protection, and flood management. These continuing actions could occur throughout the Plan Area and could result in effects on paleontological resources, depending on the type of construction needed for repairs or adjustments to potential irrigation water and drainage needed for water quality and flood management. In addition, many planning documents that govern portions of the Delta include buildout footprints that allow development of undisturbed land that is likely to contain paleontological resources. Because of the ground-disturbing activities associated with the cumulative set of plans and projects, the suite of all

ongoing projects and programs in the Delta could both singly and collectively result in adverse effects on paleontological resources.

The Delta and vicinity is within a highly active seismic area, with a generally high potential for major future earthquake events along nearby and/or regional faults, and with the probability for such events increasing over time. Based on the location, extent and non-engineered nature of many existing levee structures in the Delta area, the potential for significant damage to, or failure of, these structures during a major local seismic event is generally moderate to high. In the instance of a large seismic event, levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region. (See Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies* for more detailed discussion). Reclaiming land or rebuilding levees after a catastrophic event due to climate change or a seismic event could result in the destruction of unique paleontological resources. While similar risks would occur under implementation of the action alternatives, these risks may be reduced by BDCP-related levee improvements along with those projects identified in Table 27-16.

Impact PALEO-3: Cumulative Effect on Paleontological Resources from Construction Activities in the Plan Area and Delta Region

NEPA Effects: Implementation of the BDCP and other local and regional projects as presented in Table 27-16, could contribute to regional impacts on paleontological resources. Construction of the BDCP alternatives would take place in geologic units sensitive for paleontological resources, such as the Riverbank and Modesto Formations. The greater the extent of excavation, the greater the potential effect, although even localized excavation could damage or destroy important paleontological resources. Other past, present, and probable future projects and programs in the region that are identified in Table 27-16 and Appendix 3D, *Defining Existing Conditions, the No Action/No Project Alternative, and Cumulative Impact Conditions* have the potential to destroy unique or significant paleontological resources.

Alternatives 1A-9 involve surface excavation for both water conveyance construction and restoration implementation. Additionally, Alternatives 1A-8 would entail subsurface tunneling in geologic units sensitive for paleontological resources. Excavation into sensitive geologic units—extensive grading, trenching, structure foundation excavation, levee construction, and dredging—in combination with other projects listed in Table 27-16 that require similar surface excavation in sensitive geologic units, in addition to tunneling, which would disturb a large volume of sensitive Pleistocene deposits that may contain sensitive resources would create an adverse cumulative effect on paleontological resources.

Because none of the projects listed in Table 27-16 involve tunneling, and no other tunneling projects that could have unavoidable and unmitigable effects are known to be permitted, under construction, recently completed, or reasonably foreseeable in the Plan Area or surrounding Delta region, BDCP's incremental contribution to the adverse cumulative effect on paleontological resources is significant.

The subsurface effect caused by BDCP cannot be mitigated because the technology used to bore the tunnels does not allow access for monitoring or recovery, even if fossils are present in the boring cuttings. Mitigation Measures PALEO-1a through PALEO-1d, which include monitoring, identification, and recovery of paleontological resources during ground-disturbing activities, are available to address the effect resulting from surface excavation.

Consequently, Alternatives 1A-8 would contribute to a cumulatively considerable adverse effect on sensitive paleontological resources.

Alternative 9 does not involve any tunneling. The surface impacts of Alternative 9 would be cumulatively significant when taken in conjunction with the effects of the projects listed in Table 27-16. However, with Mitigation Measures PALEO-1a through PALEO-1d, the incremental effect of Alternative 9 is not considered cumulatively considerable.

***CEQA Conclusion*:** All BDCP alternatives involve surface excavation for both water conveyance construction and restoration implementation. Excavation into sensitive geologic units in combination with other past, present and probable future projects and programs that require similar surface excavation in the Plan Area (identified in Table 27-16) could result in a substantial cumulatively significant impact on paleontological resources.

Alternatives 1A-8 involve both surface excavation and tunneling. While surface excavation has been shown to have a less-than-significant impact with implementation of Mitigation Measures PALEO-1a through PALEO-1d, tunneling has been shown to have a significant and unavoidable impact on sensitive paleontological resources. Alternatives 1A-8 would entail subsurface tunneling in geologic units sensitive for paleontological resources. Combined with other past, present and probable future projects and programs in the Plan Area, the impacts of Alternatives 1A-8 would be cumulatively significant. Since none of the projects identified in Table 27-16 involves tunneling, the incremental impact from Alternatives 1A-8 is cumulatively considerable and cannot be mitigated.

Alternative 9 would not involve tunneling and because Mitigation Measures PALEO-1a through PALEO-1d for surface excavation in sensitive geologic units associated with this alternative reduce the level of impact, it would not be a considerable contribution to a cumulatively significant impact.

Mitigation Measure PALEO-1a: Prepare a Monitoring and Mitigation Plan for Paleontological Resources

Please see Mitigation Measure PALEO-1a under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1b: Review 90% Design Submittal and Develop Specific Language Identifying How the Mitigation Measures Will Be Implemented along the Alignment

Please see Mitigation Measure PALEO-1b under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1c: Educate Construction Personnel in Recognizing Fossil Material

Please see Mitigation Measure PALEO-1c under Impact PALEO-1 in the discussion of Alternative 1A.

Mitigation Measure PALEO-1d: Collect and Preserve Substantial Potentially Unique or Significant Fossil Remains When Encountered

Please see Mitigation Measure PALEO-1d under Impact PALEO-1 in the discussion of Alternative 1A.

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