North County Corridor New State Route 108

Preliminary Paleontological Mitigation Plan

Cities of Modesto, Riverbank, and Oakdale

Stanislaus County, California

California Department of Transportation District 10

EA 10-0S800

10-STA-108

SR 108 [PM 27.5/44.5], SR 219 [PM 3.7/4.8], SR 120 [PM 6.9-11.6]

Project ID. 1000000263

February 2015

Accepted By:________________________ Date: 2.23.15

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Abstract

The California Department of Transportation (Caltrans), in cooperation with the North County Corridor Transportation Expressway Authority, proposes to construct the North County Corridor New State Route 108 in northern Stanislaus County, California. This project proposes to relocate the current alignment of SR 108 to a more southerly alignment.

The California Environmental Quality Act and Caltrans guidelines require that impacts to nonrenewable paleontological resources be considered during project implementation. Therefore, a Paleontological Evaluation Report (PER) was prepared in order to determine the potential to encounter scientifically significant paleontological resources during ground-disturbing activities associated with the proposed project. The PER determined that the project area contains sediments of the Pleistocene Modesto, Riverbank, and Turlock Lake Formation as well as areas of Artificial Fill. While Artificial Fill has no paleontological sensitivity, all three Pleistocene formations have the potential to produce scientifically significant paleontological resources and therefore, have high paleontological sensitivity. Because the project area contains deposits with high paleontological sensitivity, the PER recommended that a Paleontological Mitigation Plan (PMP) be developed for the project.

This preliminary PMP contains information necessary to mitigate impacts to paleontological resources during ground-disturbing activities associated with this project. It includes a discussion of area geology, the types of paleontological resources that may be present, locations within the project that are likely to contain paleontological resources, recommended monitoring and laboratory methods, an estimated cost breakdown for the monitoring program, and recommendations for contents of a final report. However, because this project is still in the early Project Approval and Environmental Documentation phase, this preliminary PMP will need to be revised and/or appended prior to guiding mitigation monitoring in order to incorporate additional project details, such as the final design alignment, specific locations and methods of excavation, amount of sediment to be excavated, and the construction schedule.

Please note that the paleontological portion of this report, as well as the discussion of geology, serve only to document the paleontological findings for the project area and in no way represents a geological assessment. Therefore, this report should not be used as such.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

Paleontological resources are the remains (such as bones, teeth, shells, leaves, or wood) and/or traces (such as tracks or burrows) of prehistoric animal and plant life. Fossils provide evidence of ancient organisms and can document the patterns of organic evolution and extinction. In California, impacts to paleontological resources are addressed through the environmental review process pursuant to the California Environmental Quality Act (CEQA). In order to determine whether paleontological resources will be affected by California Department of Transportation (Caltrans) projects, a Paleontological Identification Report (PIR) and, if needed, a Paleontological Evaluation Report (PER) are prepared that will determine the geology of the area, whether fossil resources are known from the geologic units that will be encountered, and the significance of those resources.

The PER prepared for this project (Smith, 2014) determined that sediments within the project area may contain scientifically significant paleontological resources. Therefore, it became necessary to prepare a Paleontological Mitigation Plan (PMP) to direct mitigation of impacts to paleontological resources. This preliminary PMP discusses the geologic units within the project area and their paleontological sensitivities, and generally outlines the measures for mitigating project impacts to paleontological resources that may be encountered during project development. This preliminary PMP was prepared following the Caltrans Standard Environmental Reference (SER), Volume I, Chapter 8, as well as guidelines developed by the Society of Vertebrate Paleontology (SVP, 1995, 2010).

1.1 Project Description

The proposed project is located in Caltrans District 10 within portions of the Oakdale, Riverbank, and Modesto communities in Stanislaus County, California (Figures 1 and 2). The North County Corridor New State Route (SR) 108 Project will connect SR 219 near Modesto, CA to SR 120 near Oakdale, CA. The proposed project consists of four Build Alternatives (1A, 1B, 2A, and 2B) and the No-Build Alternative (Figure 3).

The western terminus of all alternatives is at the SR 219 (Kiernan Avenue)/Tully Road intersection. The alternatives proceed to the vicinity of the Claus Road/Claribel Road intersection, where Segment 2 begins and the alternatives separate into two different alignments (A and B). In Segment 2, Alternatives 1A and 1B veer northeast

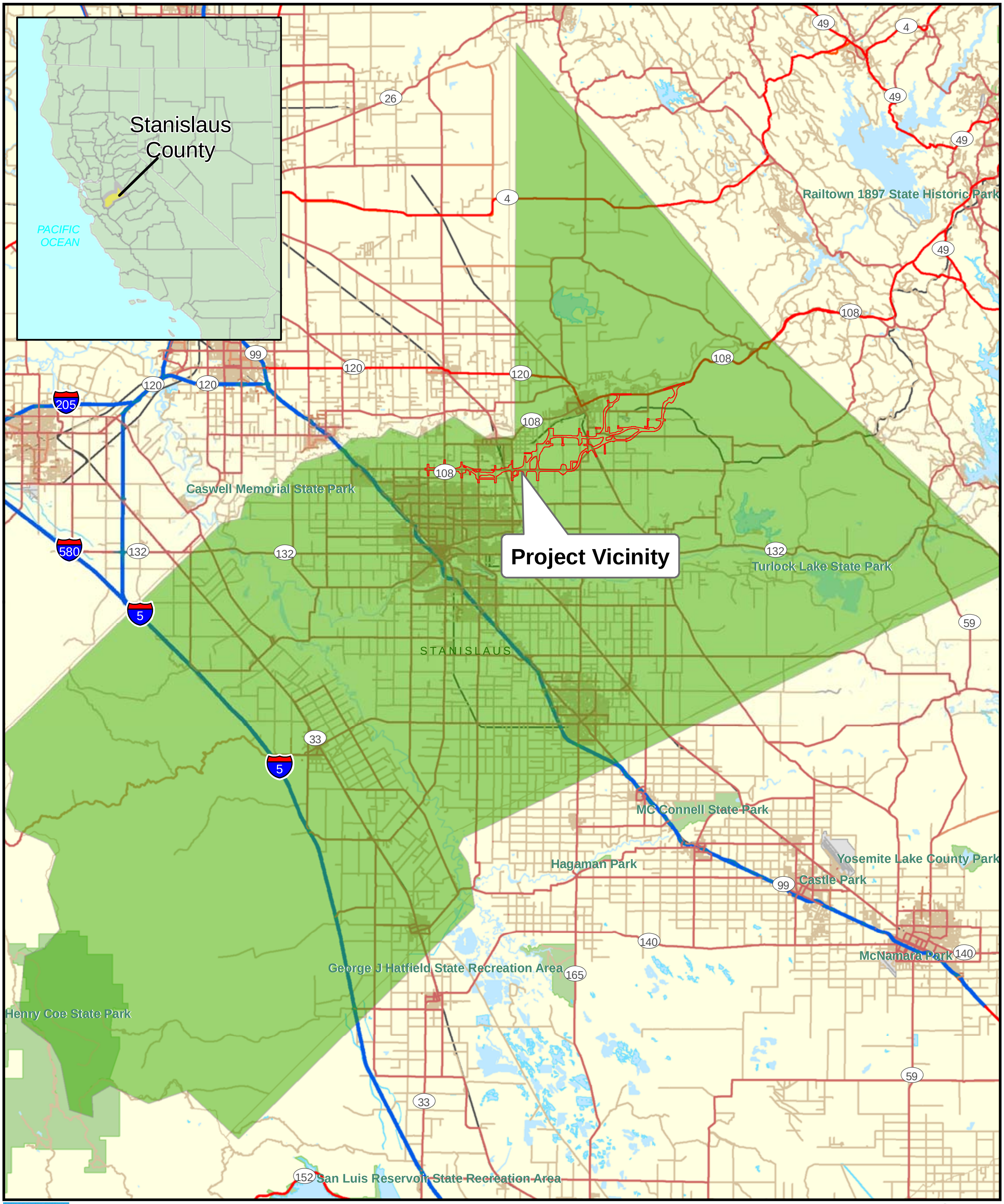

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FIGURE 1

Project Vicinity

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI 2008; Dokken Engineering 5/8/2014.
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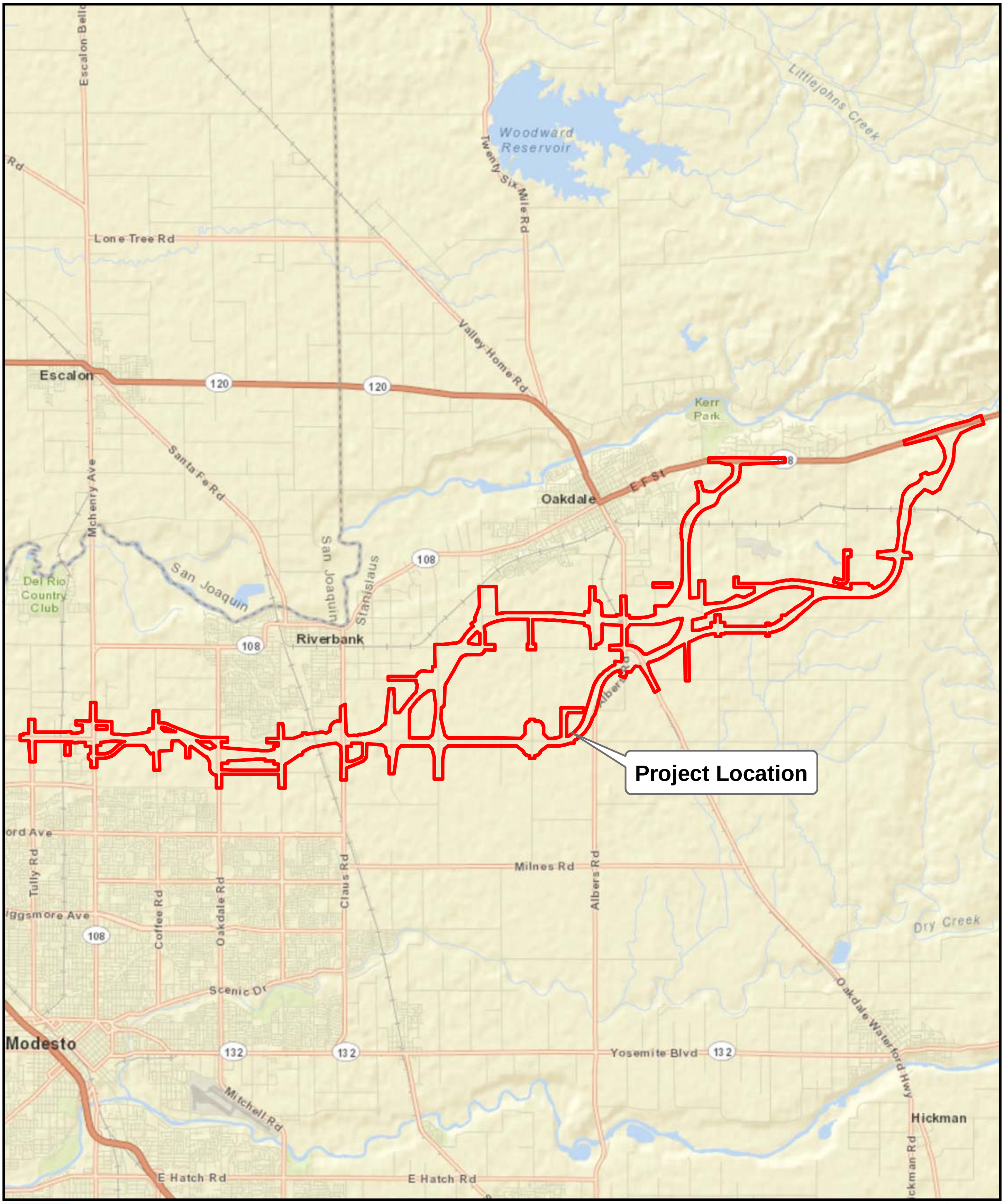

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FIGURE 2

Project Location

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: World Street Map; Dokken Engineering 5/8/2014.
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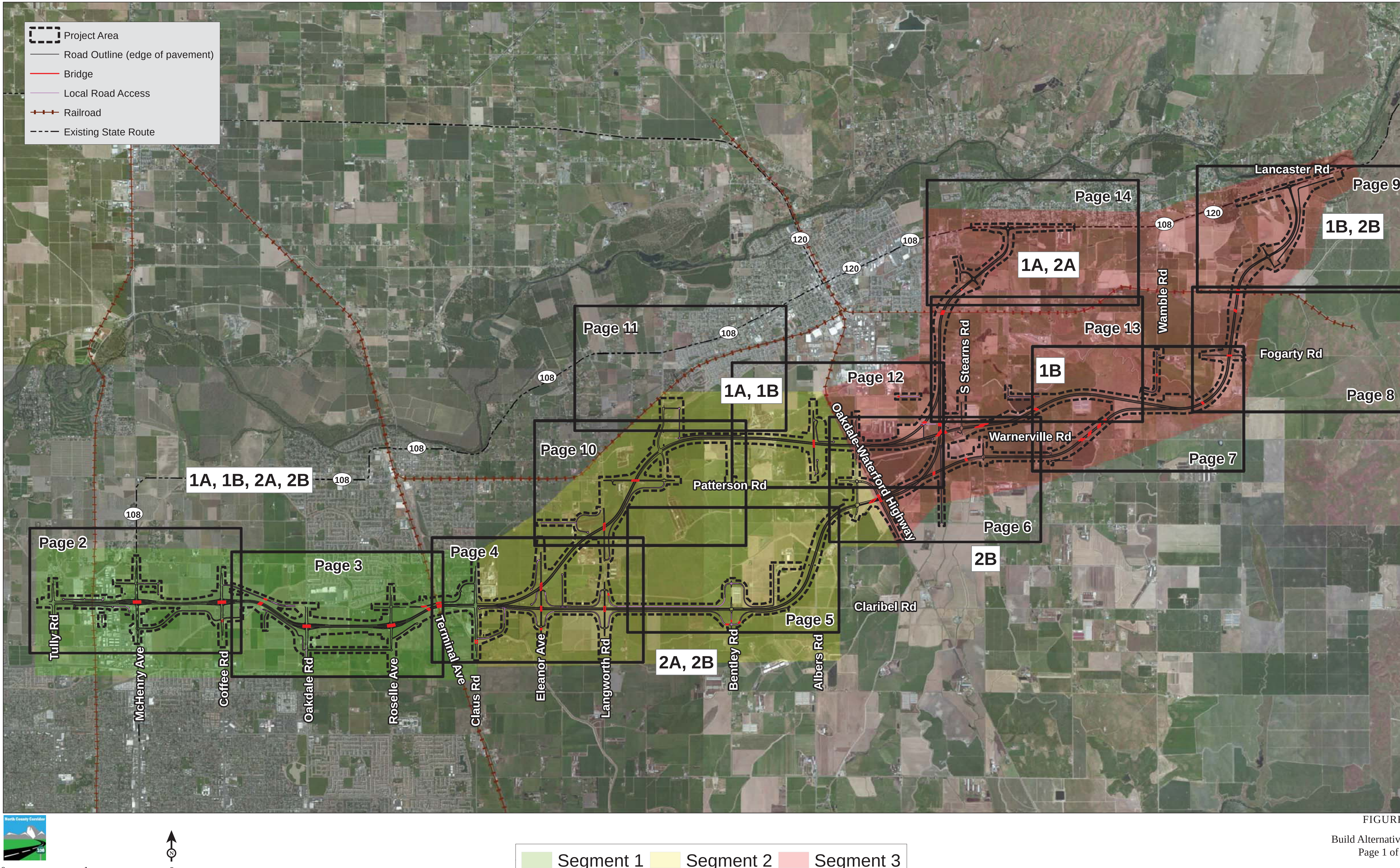

FIGURE 3

Build Alternatives
Page 1 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives
Page 2 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

FIGURE 3

Build Alternatives
Page 3 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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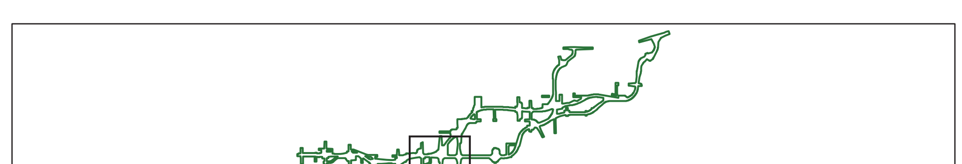

FIGURE 3

Build Alternatives
Page 4 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives
Page 5 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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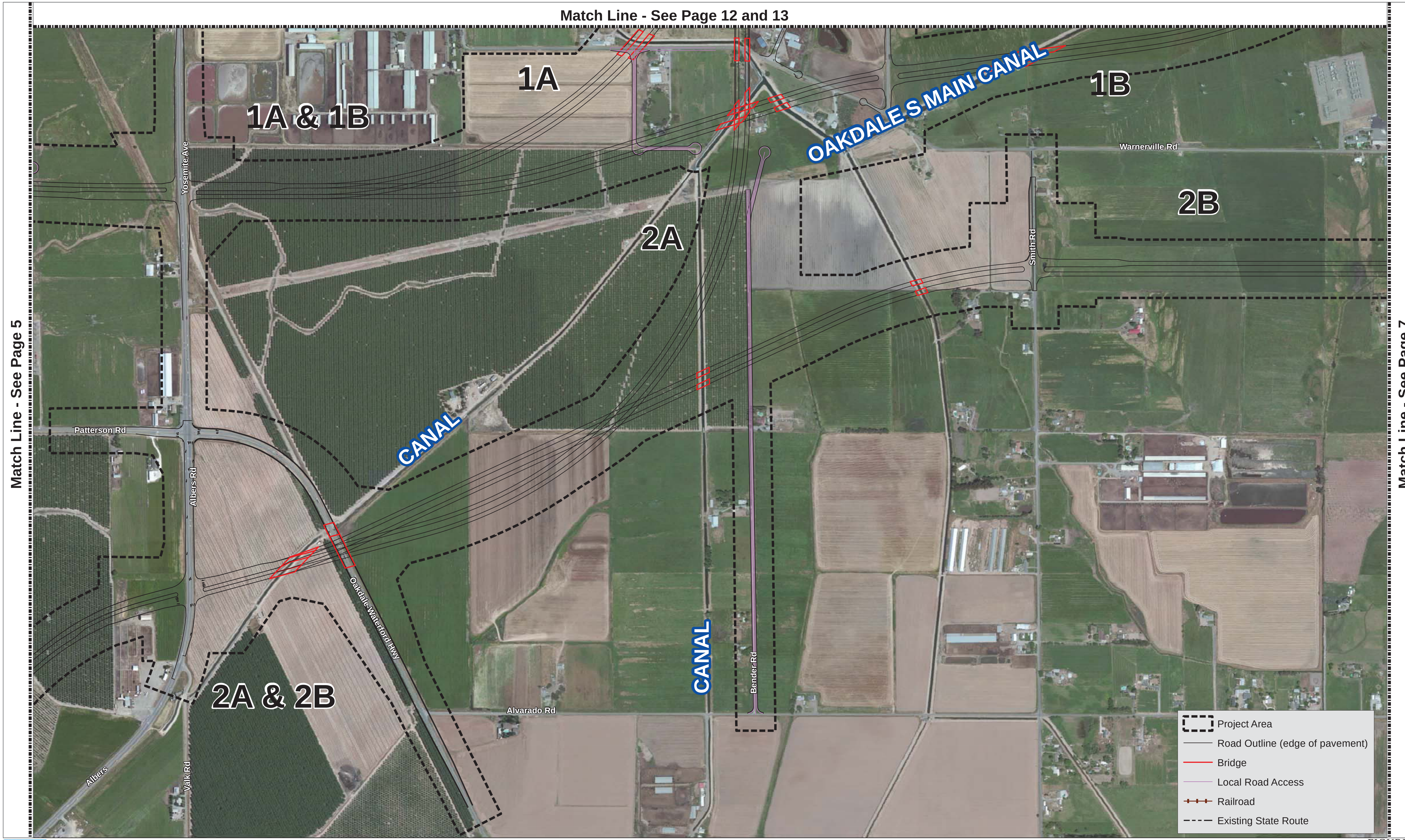

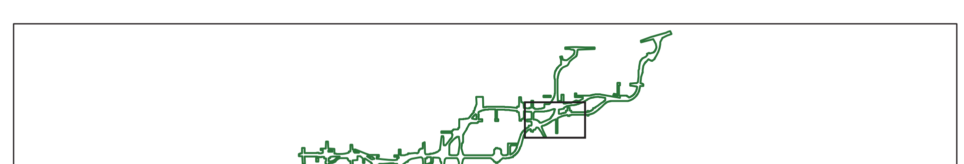

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SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives
Page 6 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

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SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives
Page 7 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

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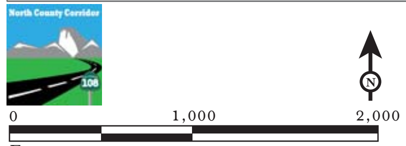

FIGURE 3
Build Alternatives
Page 8 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3
Build Alternatives
Page 9 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

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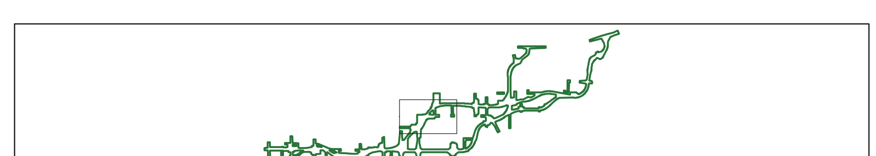

FIGURE 3

Build Alternatives
Page 10 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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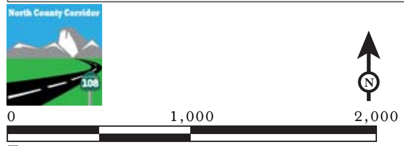

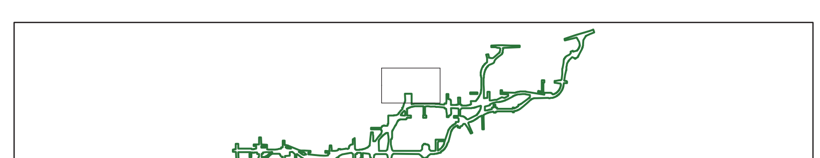

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

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SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives
Page 12 of 14

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

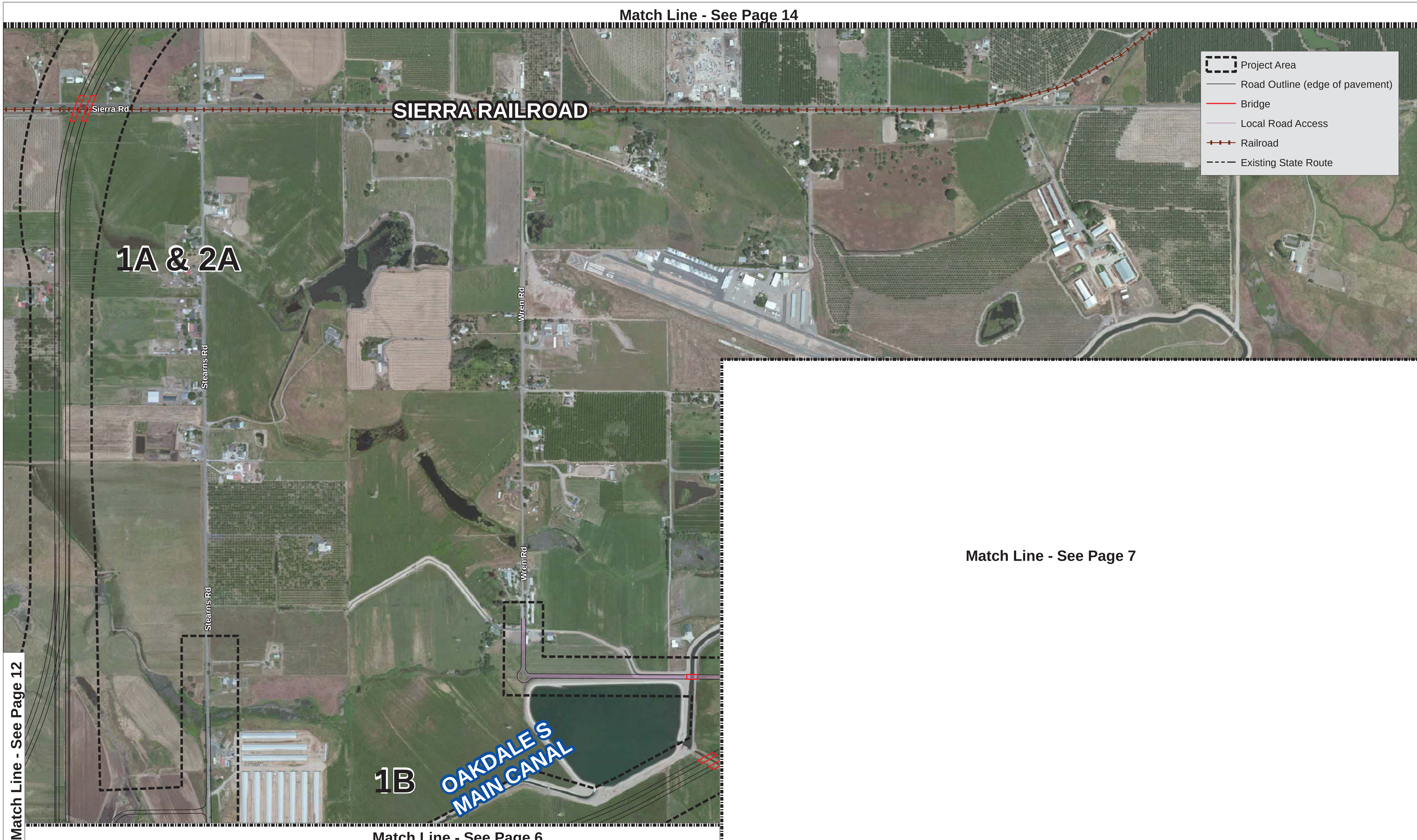

FIGURE 3

Build Alternatives

Page 13 of 14

EA: 10-0S800, Project ID # 1000000263

North County Corridor State Route 108 Project

Stanislaus County, California

SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.

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SOURCE: ESRI Maps Online March 2011; Dokken Engineering 5/8/2014.
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FIGURE 3

Build Alternatives

EA: 10-0S800, Project ID # 1000000263
North County Corridor State Route 108 Project
Stanislaus County, California

near the Claus Road/Claribel Road intersection and pass through the southern boundary of Oakdale, and Alternatives 2A and 2B continue easterly along Claribel Road and turn northeastward past the intersection of Claribel Road/Bentley Road. Each of the alternatives then breaks into two possible alignments to their eastern terminus in Segment 3, just past the Oakdale-Waterford Highway. The eastern terminus of Alternatives 1A and 2A end along SR 108/120 just east of the City of Oakdale boundary. Alternatives 1B and 2B end farther east of the Alternatives 1A and 2A terminus, along SR 108/120 in the vicinity of Lancaster Road. The purpose of the project is to reduce existing and future traffic congestion in northern Stanislaus County, enhance traffic safety on existing SR 108, support the efficient movement of goods, and improve interregional travel.

The proposed project improvements include:

- At grade intersections;
- Grade separation structures at major roadway and railway crossings;
- Structures at various waterway crossings, such Modesto Irrigation District (MID) and Oakdale Irrigation District (OID) canals;
- County and City roadway improvements at various locations; and
- New freeway/expressway controlled access travel lanes.

The four alternatives would consist of two to three 12-foot (ft) wide through lanes with 5–10 ft wide left and right shoulders in each direction. The east-bound and westbound alignments would be separated by a 46–70 ft wide median, including the 5–19 ft wide shoulders and 26–60 ft wide graded, unpaved median area. Drainage swales would be located along either side of the new roadway.

As the proposed roadway would function as a freeway/expressway with controlled access, new and realigned local access roads will be needed to provide continued access to existing properties. This would involve construction of a discontinuous local roadway system which would provide a 12 ft wide through lane and an 8 ft wide shoulder in each direction. Up to a 12 ft wide area would be provided between the right-of-way (ROW) limit and the edge of the pavement to allow for drainage ditches. Where required, turn lanes would provide connections to cross roads. Each of the four build alternatives includes these proposed local access roads, which are delineated on Figure 3.

Elevated roadways, separated grade crossings, single-point urban interchanges, signalized intersections, and roundabouts would be needed for each of the four alternatives. A Class 2 bike lane would also be constructed within the road shoulder from Claus Road to the eastern terminus at SR 108/SR 120.

Various utilities exist throughout the project area that would need to be relocated. These include electric, telephone, water, sewer, and irrigation lines. At the time of this report, the exact locations to which the impacted utilities would be relocated are unknown, but relocation would take place within the currently defined project area.

Permanent ROW and temporary construction easements would also be required for the proposed project.

1.2 Summary of Excavation Parameters

Inclusive of all proposed build alternatives, at this stage of project design the project will include excavation and grading to the following depths:

- Interchanges: 4–11 ft
- Railroad structures: 6–8 ft
- Bridges and wing walls: 60 ft piles
- Standard retaining walls and sound walls: 5 ft spread footings
- Minor structures: 5 ft spread footings
- Sign structures: 25–33 ft piles
- Signals: 13 ft piles
- Light poles: 10 ft piles
- Utility poles: 10–20 ft
- Standard sign posts: 6 ft
- Underground utilities: 5–10 ft
- Drainage structures: 5–15 ft
- Canal crossings: 6.5 ft
- Pavement structural section: 3 ft
- Cut slopes: 20–30 ft

These excavation depths may change during the final design phase, and this list will need to be revised and/or appended in the final PMP.

1.3 Goals

The goal of this preliminary PMP is to provide the information and guidance necessary in order to mitigate impacts to scientifically significant, nonrenewable paleontological resources and avoid the destruction of scientifically important fossils. In order to meet this goal, this preliminary PMP will:

- Identify geologic units and portions of the project area with the potential to contain scientifically important fossils;
- Provide guidance on best practices for the collection (removal) and preservation of scientifically important fossils;
- Identify a potential curation facility to allow and maintain access for scientific study of important fossils collected from this project area; and
- Provide a generalized cost estimate for the services needed to mitigate impacts to paleontological resources, including the costs of monitoring, lab work, report preparation, and curation.

Because this project is still in the early Project Approval and Environmental Documentation (PA&ED) phase, this preliminary PMP will have to be revised and/or appended prior to mitigation monitoring in order to incorporate additional project details, such as the final design alignment, specific locations and methods of excavation, amount of sediment to be excavated, and the construction schedule. These additional details will directly affect the recommendations in the final PMP and intensity of the monitoring effort.

Chapter 2 Background

2.1 Geologic Setting

The project is located in the northeastern San Joaquin Valley and lies within the Great Valley Geomorphic Province (California Geological Survey, 2002). This province is an alluvial valley approximately 50 miles (mi) wide and over 400 mi long between the Coast Ranges and the Sierra Nevada in the central portion of California (California Geological Survey, 2002: Norris and Webb, 1976). Its northern part is drained by the Sacramento River and is known as the Sacramento Valley; the southern portion is drained by the San Joaquin River and is known as the San Joaquin Valley.

The San Joaquin Valley is filled with marine and alluvial sediments that have been deposited almost continuously since the Jurassic (201.3–145.0 million years ago [Ma]) (California Geological Survey, 2002; Howard, 1979; Norris and Webb, 1976). These sediments overlie the westward-tilted block of the plutonic and metamorphic Sierra Nevada basement. The northern portion of the San Joaquin Valley was part of the Pacific Ocean and subject to submarine deposition from the Jurassic until the late Paleocene (59.2–56.0 Ma), when uplift of the Sierra Nevada put this portion of the San Joaquin Valley on or near the shore of the Pacific Ocean (Bartow, 1991; Howard, 1979). Between the Paleocene (66.0–56.0 Ma) and the Pliocene (5.333–2.588 Ma), deposition alternated between terrestrial and marine, depending on conditions, and the entire valley did not become isolated from the Pacific Ocean until the Pliocene (Bartow, 1991; Howard, 1979).

In the northern San Joaquin Valley, the marine deposits of the latest Jurassic to Cretaceous (152.1–66.0 Ma) Great Valley Sequence are unconformably overlain by various Late Paleocene to Eocene (59.2–33.9 Ma) marine units (Bartow, 1991; Bartow and Nilsen, 1990). Unconformably overlying these Eocene formations, the Valley Springs Formation, a Late Oligocene to Middle Miocene (28.1–11.62 Ma) alluvial deposit, was the first subaerial deposit in the northern San Joaquin Valley (Bartow, 1991). The Valley Springs Formation was then succeeded by the volcaniclastic Mehrten Formation (Bartow, 1991). Alluvial deposition resumed and then continued through the Miocene (23.03–5.333 Ma) and into the Pleistocene (2.588 Ma–11,700 years before present [BP]) (Bartow, 1991; Howard, 1979).

During the Late Pleistocene (126,000–11,700 years BP), changing climatic conditions resulted in the creation of a series of large alluvial fans on either side of the San Joaquin Valley (Bartow, 1991; Howard, 1979), including the project area. According to geologic mapping by Wagner et al. (1991), the project area contains Pleistocene sediments of the Modesto, Riverbank, and Turlock Lake Formations. In addition, although not mapped by Wagner et al. (1991), Artificial Fill also may be present within the project area where it was placed for previously developed roadways and structures (Smith, 2014). Although the PER also indicates that Unnamed Holocene Deposits are likely present at the surface within the project area and may extend up to 5 ft below the surface (Smith, 2014), the preliminary geotechnical report prepared for this project (Blackburn Consulting, 2012) supports the mapping by Wagner et al. (1991) and indicates that Pleistocene deposits are present at the surface. Therefore, the Unnamed Holocene Deposits discussed in the PER are not included in this preliminary PMP. Figure 4 shows the geology of the project area and its surroundings as mapped by Wagner et al. (1991). The paleontology of these units is described in more detail below. All the dates for the geologic periods and epochs follow the International Commission on Stratigraphy ([ICS], 2013).

2.2 Paleontology

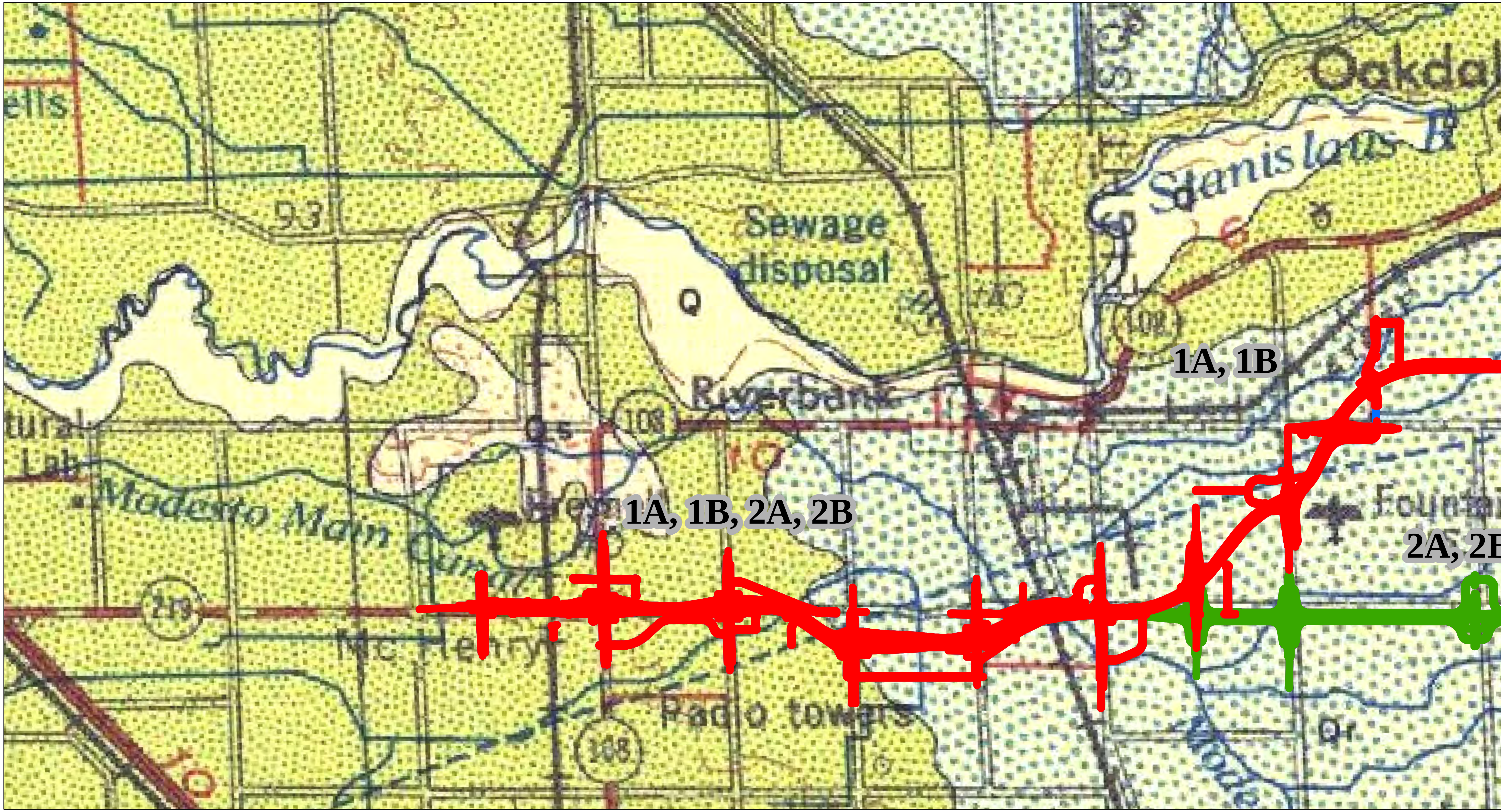
The results of the locality search and literature review conducted during preparation of the PER indicate that no paleontological resources have been found within the project area (Smith, 2014). However, paleontological resources have been recovered near the project area and elsewhere in Stanislaus County and central California from sediments similar to those in the project area. The following discussion contains information on the paleontological resources that may be encountered within each of the geologic units in the project area.

2.2.1 Artificial Fill

Artificial Fill can contain fossils, but these fossils have been removed from their original location and are thus out of context. As such, they are not considered to be important for scientific study.

2.2.2 Modesto Formation

The Modesto Formation was deposited approximately 9,000 to 75,000 years BP during the Rancholabrean North American Land Mammal Age (NALMA) (11,000–240,000 years BP). As such, there is a potential for it to contain Rancholabrean fossils



LEGEND

Project Area

- Alternative 1A
- Alternative 1B
- Alternative 2A
- Alternative 2B

Geologic Formations

- Q - Alluvium
- Qs - Dune Sand
- Qm - Modesto Formation
- Qr - Riverbank Formation
- Qtl - Turlock Lake Formation
- QTnm - North Merced Gravel
- Pl - Laguna Formation
- Tm - Mehrten Formation

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Map Index

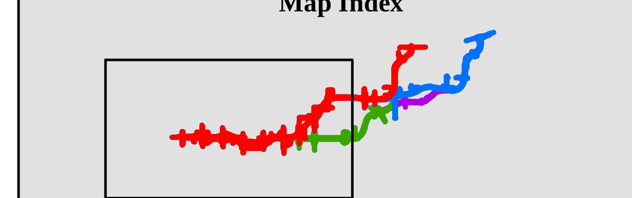

FIGURE 4a

Geologic Map of the Project Area and Vicinity

EA: 10-0S800, Project ID # 1000000263
North County Corridor New State Route 108 Project
Stanislaus County, California

SOURCE: Wagner, D.L., Bortugno, E.J., and McJunkin, R.D., Geological Map of the San Fransisco-San Jose Quadrangle, California, 1:250,000, CDMG Regional Geographic Map Series, Map No. 5A, Geology, Sheet 1 of 5.

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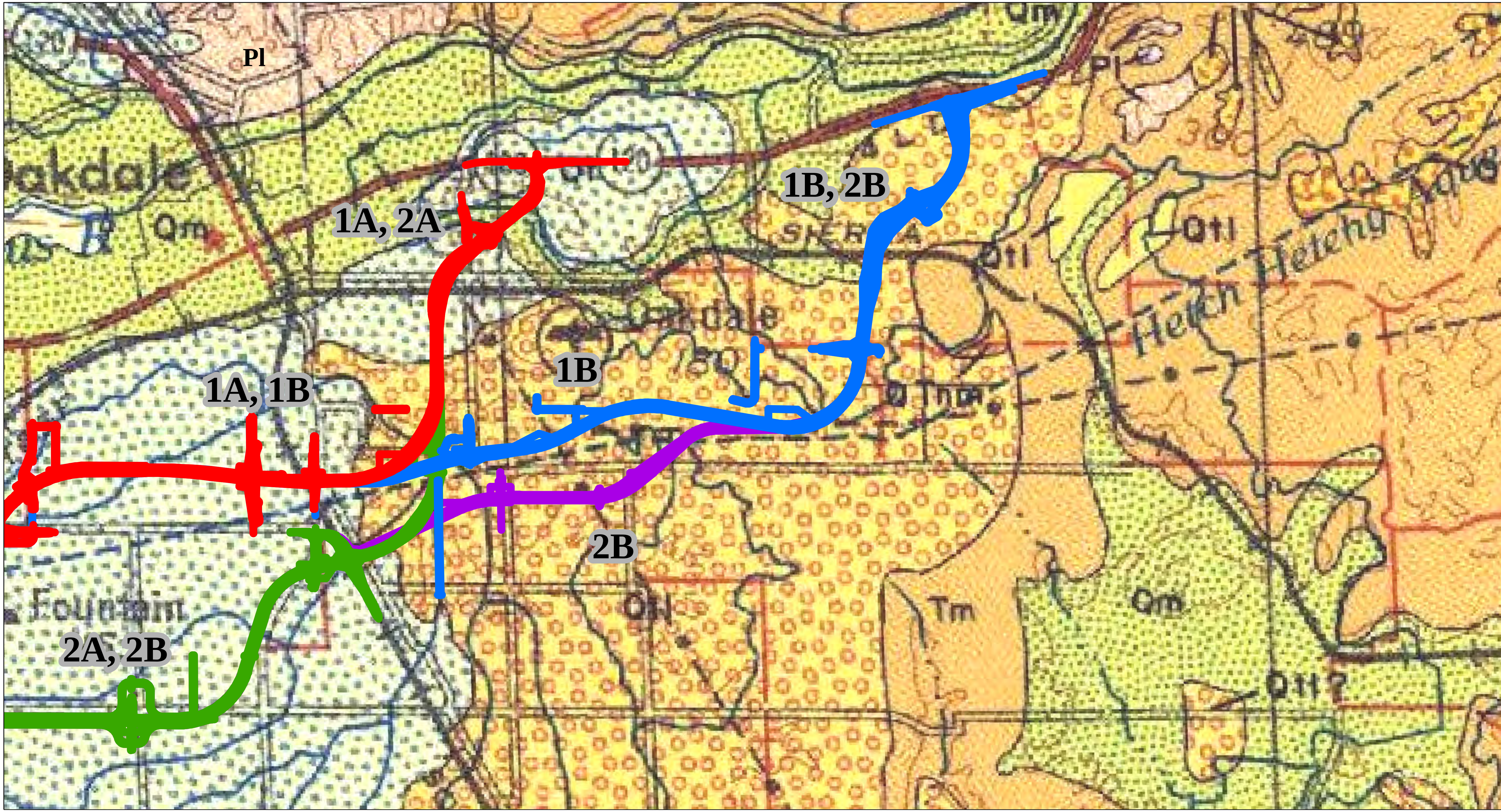

LEGEND

Project Area

- Alternative 1A
- Alternative 1B
- Alternative 2A
- Alternative 2B

Geologic Formations

- Q - Alluvium
- Qs - Dune Sand
- Qm - Modesto Formation
- Qr - Riverbank Formation
- Qtl - Turlock Lake Formation
- QTnm - North Merced Gravel
- Pl - Laguna Formation
- Tm - Mehrten Formation

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FIGURE 4b

Geologic Map of the Project Area and Vicinity

EA: 10-0S800, Project ID # 1000000263

North County Corridor New State Route 108 Project

Stanislaus County, California

SOURCE: Wagner, D.L., Bortugno, E.J., and McJunkin, R.D., Geological Map of the San Fransisco-San Jose Quadrangle, California, 1:250,000, CDMG Regional Geographic Map Series, Map No. 5A, Geology, Sheet 1 of 5.

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that have been found in alluvial deposits of the same age. Common examples of Rancholabrean vertebrate fossils include ground sloth, dire wolf, saber-toothed cat, camel, bison, mammoth, horse, rodent, bird, reptile, and amphibian fossils (Bell et al., 2004; Jefferson, 1991a, b). Rancholabrean fossils reported from Stanislaus County include mammoths (*Mammuthus columbi*); giant ground sloths (*Paramylodon harlani* and *Megalonyx jeffersoni*), horse (*Equus*), camel (*Camelops hesternus*), bison (*Bison antiquus*), and pocket gopher (*Thomomys*) (Jefferson, 1991b).

Within the Modesto Formation, Dundas et al. (2009) report the occurrence of bison (*Bison*) from a locality near the City of Fresno, approximately 100 mi to the southeast. Cehrs et al. (1979) noted specimens of mammoth (*Mammuthus*) from two gravel pits within the Modesto Formation just to the north of the City of Clovis, a little over 100 mi to the southeast.

Closer to the project area, Gust et al. (2012) report a very significant vertebrate collection from the upper and lower Modesto Formation recovered during grading for the SR 99 Arboleda Drive Project in Merced County, approximately 45 mi to the southeast. During monitoring, a total of 1,667 fossils were collected from 39 localities at depths ranging from 1.75–26.9 ft below the surface. Fossil specimens included large mammals like Columbian mammoth (*Mammuthus columbi*), giant ground sloth (*Paramylodom harlani*), western camel (*Camelops hesternus*), American llama (*Hemiauchena*), ancient bison (*Bison antiquus*), two types of horse (*Equus occidentalis* and *E. conversidens*), and deer (*Odocoileus hemionius*), dire wolf (*Canis dirus*), coyote (*Canis latrans*), and cougar (*Felis concolor*). Small mammals included jackrabbit (*Lepus californicus*) Auduobon and Bachman's rabbits (*Sylvilagus auduboni* and *S. bachmani*), ground squirrel (*Spermophilus*), kangaroo rat (*Dipodomys*), pack rat (*Neotoma*), pocket gopher (*Thomomys bottae*), vole (*Microtus*), pocket mouse (*Perognathus*), deer mouse (*Peromyscus*), and harvest mouse (*Reithrodontomys*). Birds included Canada goose (*Branta canadensis*), California quail (*Calipepla californica*), western scrub jay (*Aphelocoma californica*), northern mocking bird (*Mimus polyglottos*), American robin (*Turdus migratorius*), western meadowlark (*Sturnella neglecta*), and sparrow (*Zonotrichia*). Fish included minnows (Cyprinidae) and three-spine stickleback (*Gasterosteus aculeatus*). The Western pond turtle (*Emys marmorata*) was the only turtle identified. Snakes of the gopher snake family (Colubridae) and rattlesnake (*Crotalus*) were also found. In addition, several specimens of frog and toad were present but could not be identified more precisely.

2.2.3 Riverbank Formation

The Riverbank Formation spans two NALMAs: the Rancholabrean (11,000–240,000 years ago), named for the Rancho La Brea fossil site in central Los Angeles, and the Irvingtonian (240,000–1.8 Ma), named for an assemblage of fossils from the Irvington gravels near Fremont (Alroy, 2000; Bell et al., 2004).

Fossils have been recovered from the Riverbank Formation in the City of Sacramento during construction of the Sleep Train Arena (previously known as the ARCO Arena), approximately 85 mi north of the project area (Hilton et al., 2000). These fossils include Harlan's ground sloth (*Paramylodon harlani*), ancient bison (*Bison antiquus*), coyote (*Canis* cf. *latrans*), horse (*Equus*), camel (*Camelops hesternus*), squirrel (*Sciurus*), antelope (Antilocapridae) or deer (Cervidae), mammoth (*Mammuthus*), and a few plants.

In Stanislaus County, the Riverbank Formation has produced a specimen of Harlan's ground sloth (*Paramylodon harlani*) while other Rancholabrean fossils from the County include mammoths (*Mammuthus columbi*), Jefferson's ground sloths (*Megalonyx jeffersoni*), horse (*Equus*), camel (*Camelops hesternus*), bison (*Bison antiquus*), and pocket gopher (*Thomomys*) (Jefferson, 1991b).

2.2.4 Turlock Lake Formation

The Fairmead Landfill Fossil locality contains some of the best examples of fossils from the Turlock Lake Formation (Dundas et al., 1996; McDonald et al., 2013). These fossils were found during paleontological mitigation monitoring associated with grading within the Fairmead Landfill located in Madera County. This mid-Irvingtonian (0.55–0.78 Ma) locality has produced specimens of birds (Anatidae), Western pond turtle (*Emys marmorata*), Harlan's ground sloth (*Paramylodon harlani*), Jefferson's ground sloth (*Megalonyx jeffersoni*), Shasta ground sloth (*Nothrotheriops shastensis*); coyote (*Canis* cf. *latrans*); Armbruster's wolf (*Canis armbrusteri*), saber-toothed cat (*Smilodon*), scimitar-toothed cat (*Homotherium*), pocket gopher (*Thomomys*), kangaroo rat (*Dipodomys*), jackrabbit (*Lepus*), Columbian mammoth (*Mammuthus columbi*),horse (*Equus*), two species of camel (*Camelops* and *Hemiauchenia*), two species of antelope (*Capromeryx* and *Tetrameryx irvingtonensis*), and deer (*Odocoileus*) (Dundas, et al., 1996; McDonald et al., 2013). A variety of plant fossils have also been recovered from several localities in the Turlock Lake Formation in Fresno County according to the online collections database at the University of California Museum of Paleontology in Berkeley, California. Fossils from the Irvingtonian NALMA (240,000–1.8 Ma) are less common than the younger Rancholabrean (11,700–240,000 years BP); therefore, they are scientifically very significant.

Chapter 3 Description of the Resource

As discussed in the Background Section, Wagner et al. (1991) mapped the Modesto, Riverbank, and Turlock Lake Formations within the project area. In addition, although not mapped by Wagner et al. (1991), Artificial Fill also is likely present in the project area (Smith, 2014). Table A summarizes the ages of the geologic units within the project area, and each geologic units is described in more detail below.

Table A: Ages of Geologic Units within the North County Corridor New State Route 108 Project Area

Geologic Unit	Geologic Epoch	Age (years BP)[1]
Artificial Fill	Holocene	Less than 100
Modesto Formation	Late Pleistocene	9,000–75,000
Riverbank Formation	Middle Pleistocene	130,000–450,000
Turlock Lake Formation	Early Pleistocene	540,000–1 million

[1] Source for ages of formations (not Artificial Fill): Marchand and Allwardt (1981)

BP = before present

3.1 Artificial Fill

Artificial Fill consists of sediments that have been removed from one location and transported to another by humans. The transportation distance can be a few feet to dozens of miles, and composition is dependent on the source. When it is compacted and dense, it is known as “engineered fill,” but it can be loosely compacted. Artificial Fill will sometimes contain modern debris such as asphalt, wood, bricks, concrete, metal, glass, plastic, and even plant material.

This unit is not mapped by Wagner et al. (1991) but likely exists in many portions of the project area where it was used for previous development, such as for existing roads or structures (Smith, 2014). Depending on the area, the thickness of fill can be less than 1 ft to several tens of feet.

3.2 Modesto Formation

The Modesto Formation is mapped mainly in the western portion of the project area, but also in a small area on the eastern end of Alternatives 1A and 2A (Figure 4).

The Modesto Formation is exposed for over 400 mi extending from the Sacramento River near Redding in the north to the Kern River near Bakersfield in the south (Marchand and Allwardt, 1981). The type section is located along the south bluff of the Tuolumne River south of the City of Modesto (Marchand and Allwardt, 1981). This formation is essentially an alluvial fan deposit composed of interbeds of gravel, sand, and silt deposited by streams carrying glacial outwash from the western side of the Sierra Nevada throughout the Central Valley (Marchand and Allwardt, 1981). Marchand and Allwardt (1981) indicate a maximum thickness for the Modesto Formation of up to approximately 131 ft and divide the formation into an upper and lower member based on topographic position and soil development. The upper member was deposited between approximately 9,000 and 14,000 years BP and is composed of unconsolidated, unweathered gravel, sand, silt, and clay (Marchand and Allwardt, 1981). The lower member of the Modesto was deposited between approximately 27,000 and 75,000 years BP and is composed of consolidated, slightly weathered, well-sorted silt and fine sand, with occasional interbeds that contain gravels (Frye et al., 1968; Marchand and Allwardt, 1981). Marchand and Allwardt (1981) state that there is a discernable soil horizon between the upper and lower members in several areas indicating a period of erosion and non-deposition. This period likely represents a time of glaciation with few to no active streams carrying sediment out of the Sierra Nevada (Bartow, 1991). Geologic mapping by Wagner, et al. (1991) is not at a sufficient detail to specify which member is present within the project area.

3.3 Riverbank Formation

The Riverbank Formation is mapped at the surface in the central portion of the project area (Figure 4). This formation is primarily composed of arkosic sand with some scattered pebbles, gravel lenses, as well as some interbedded fine sand and silt, all of which was derived from the Sierra Nevada to the east (Marchand and Allwardt, 1981). Some of the finer grained deposits are well-stratified and may have been deposited in ponds or small lakes, while some of the well-sorted sandy deposits may represent sand dune deposits (Marchand and Allwardt, 1981).

Marchand and Allwardt (1981) have divided the Riverbank Formation into three informal units (upper, middle, and lower) based on superposition, paleosols, and geomorphic evidence. All three units have similar composition and appear to coarsen upward. Marchand and Allwardt (1981) state that the Riverbank Formation has variable thickness, ranging from 66–262 ft, depending on the proximity to major rivers and how many of units are present.

The Riverbank Formation was deposited between 130,000 and 450,000 years BP and forms terraces and fans that cut into the underlying Turlock Lake Formation or fill post-Turlock Lake Formation gullies and ravines (Marchand and Allwardt, 1981). In addition, the Riverbank Formation itself contains gullies on its surface that have been filled in by the overlying lower member of the Modesto Formation (Marchand and Allwardt, 1981).

3.4 Turlock Lake Formation

The Turlock Lake Formation is mapped on the eastern portion of the project area (Figure 4). This formation consists mainly of fine sand and silt, with local clay layers at the base and occasional coarse pebbly sand or gravel beds (Marchand and Allwardt, 1981). The coarser-grained gravel and sand beds are usually massive or cross-bedded, lenticular, and not laterally extensive, while the finer-grained deposits are commonly well-sorted, well-bedded, and often contain nearly unweathered grains of mica, feldspar, and mafic minerals (Marchand and Allwardt, 1981). In addition, Marchand and Allwardt (1981) note that some of these beds accumulated in lakes and contain impressions of plants.

Marchand and Allwardt (1981) subdivided the Turlock Lake Formation into two informally named units (lower unit and upper unit) that are separated by a well-developed soil horizon marking a disconformity (Marchand and Allwardt, 1981). In addition, both the upper contact with the Riverbank Formation and lower contact with the Mehrten Formation are unconformable (Marchand and Allwardt, 1981), suggesting periods of nondeposition. In fact, the upper surface of this formation has been modified by erosion to the point that little of the original depositional surface or fan morphology remains (Marchand and Allwardt, 1981).

This formation has a thickness of between 295 and 1,033 ft and commonly stands topographically above the younger fans and terraces throughout the northeastern San Joaquin Valley (Marchand and Allwardt, 1981). It has a minimum age of 540,000 years BP and a maximum age of between 730,000 and 1 million years BP (Marchand and Allwardt, 1981).

Chapter 4 Proposed Research

The paleontological sensitivities for each of the geologic units within the project area are summarized in Table B, and an explanation of the sensitivity assignment for each unit is provided below.

Table B: Paleontological Sensitivities of the Geologic Units within the North County Corridor New State Route 108 Project Area

Formation/Unit	Paleontological Sensitivity
Artificial Fill	No
Modesto Formation	High
Riverbank Formation	High
Turlock Lake Formation	High

4.1 Artificial Fill

Artificial Fill can contain fossils, but because it has been moved from one area to another, any fossils that may be in the fill are out of context and would not be scientifically important. Thus, Artificial Fill has no paleontological sensitivity.

4.2 Modesto Formation

As noted in the Background section, the Late Pleistocene Modesto Formation has produced scientifically important Rancholabrean vertebrate fossils from around the Central Valley (Bell et al., 2004; Cehrs et al., 1979; Dundas et al. 2009; Jefferson, 1991a, b). Of particular importance is the collection from the SR 99 Arboleda Drive Project in Merced County (Gust et al., 2012), which yielded a large assemblage of vertebrates, including specimens of birds, reptiles, amphibians, and large and small mammals.

The sediments of the Modesto Formation in the project area are similar to those that produced the aforementioned fossils. Therefore, they have the potential to yield similar paleontological resources, which would be useful for taxonomic, evolutionary, and paleoecological studies, particularly if a large assemblage similar to the one collected from the SR 99 Arboleda Drive Project was recovered. Moreover, because these rocks record depositional changes that occurred in the Central Valley through the Late Pleistocene, fossils recovered from this area could be beneficial for biostratigraphic studies and correlating geologic units. As such, the Modesto Formation is considered to have high paleontological sensitivity.

4.3 Riverbank Formation

Sediments of the Middle Pleistocene Riverbank Formation have yielded a wide variety of large and small mammals, as well as plants (Hilton 2000; Jefferson, 1991b), and there is a potential to encounter these types of fossils in the Riverbank Formation in the project area. Any vertebrate, invertebrate, and plant fossils recovered from these deposits would be considered scientifically significant because they would add to our understanding of the environment of this area during the Middle Pleistocene and the evolution of the animals and plants that lived here. Moreover, because this formation ranges into the Irvingtonian NALMA, which is not as well represented in the fossil record, any fossils recovered from the older sediments in this formation may help fill in gaps in our understanding of the evolution, distribution, and paleoecology of life during the this interval. In addition, because this formation spans two NALMAs, the Rancholabrean and Irvingtonian, and records depositional changes in the Central Valley through the Middle Pleistocene, fossils recovered from this area could be beneficial for biostratigraphic and correlation purposes. As a result, the Riverbank Formation is considered to have high paleontological sensitivity.

4.4 Turlock Lake Formation

Several localities in the Turlock Lake Formation from across the Central Valley have produced a substantial fossil collection of birds, reptiles, large and small mammals, and plants (Dundas et al., 1996; Marchand and Allwardt, 1981; McDonald, 2013). By producing both vertebrate and plant fossils, these deposits provide information for studies on biological evolution, biostratigraphy, and paleoecology of this region. Moreover, fossils from the Irvingtonian NALMA are less common than the younger Rancholabrean, and fossils collected from this formation could help fill in gaps in our understanding of the evolution, distribution, and paleoecology of life during the this interval. In addition, fossils recovered from this formation could be beneficial for biostratigraphic studies and correlating geologic units across the Central Valley. Because fossils from the Turlock Lake Formation are considered scientifically important, this formation is given a high paleontological sensitivity rating.

Chapter 5 Scope of Work

5.1 Personnel

The mitigation and monitoring program should be implemented and directed by a qualified Principal Paleontologist. Unlike some other disciplines, neither the federal nor State government has mandated educational and/or experience requirements for paleontologists. Caltrans, however, uses the following suggested guidelines derived from a combination of professional society, federal, State, and local agency guidance for defining the attributes of a qualified Principal Paleontologist.

- A graduate degree in paleontology, geology, or related field, with demonstrated experience in the vertebrate, invertebrate, or botanical paleontology of California or related topical or geographic areas; and
- At least 1 year of full-time professional experience, or equivalent specialized training in paleontological research (i.e., the identification of fossil deposits, application of paleontological field and laboratory procedures and techniques, and curation of fossil specimens), administration, or management; and
- At least 4 months of supervised field and analytic experience in general North American paleontology; and
- Demonstrated ability to carry research to completion.

An advanced degree is less important than demonstrated competence in fieldwork, reporting, and curation. References should be checked and examples of past work should be examined.

In addition, Caltrans has definitions for the qualifications of paleontological monitors who will be performing the monitoring during grading. According to Caltrans SER Environmental Handbook, Volume 1, Chapter 8, a qualified paleontological monitor is an individual who has demonstrated experience in the collection and salvage of fossil materials. An undergraduate degree in geology, paleontology, or related field is preferable, but is less important than documented experience performing paleontological monitoring and mitigation. In addition, the paleontological monitor must work under the direction of a qualified Principal Paleontologist.

5.2 Pre-Construction Salvage

Pre-construction salvage is often undertaken in order to collect fossils from known localities or identify new localities prior to the beginning of construction to reduce or eliminate delays to grading when construction actually begins. However, because the project area consists of previously developed roadways and agricultural land, a pre-construction survey and salvage is not required for this project.

5.3 Monitoring Effort

Geologic deposits with high paleontological sensitivity will be monitored specific to the types and methods of qualifying excavation activities. The location and extent of monitoring will be determined from the project's final design plans. Based upon this information, a final Paleontological Mitigation Plan will be prepared.

The recommended monitoring effort during project development depends on the paleontological sensitivity of the deposits, as well as on the depth and methods of excavation and whether the sediments have been previously disturbed. The initial recommended monitoring effort based on the paleontological sensitivity of each geologic unit in the project area is summarized in Table C.

Table C: Recommended Monitoring Effort for Geologic Units within the North County Corridor New State Route 108 Project Area

Formation/Unit	Paleontological Sensitivity	Monitoring Effort
Artificial Fill	No	None
Modesto Formation	High	Full-time
Riverbank Formation	High	Full-time
Turlock Lake Formation	High	Full-time

Excavations that remain in Artificial Fill, which has no paleontological sensitivity, do not require monitoring. However, before the final monitoring plan can be developed, the thickness and distribution of Artificial Fill throughout the project area must be determined. Generally, excavations into high sensitivity deposits, such as the Modesto, Riverbank, and Turlock Lake Formations, would require full-time monitoring. However, this recommendation may be modified depending on the excavation methods, presence of Artificial Fill, and level of previous ground disturbance. Taking these factors into account, the expected minimum and maximum monitoring efforts for each element of the project is summarized in Table D.

Table D: Recommended Range of Monitoring Effort for Elements within the North County Corridor New State Route 108 Project Area

Project Element	Excavation Depth	Minimum Monitoring Effort	Maximum Monitoring Effort[1]
Interchanges	4–11 ft	None	Full-time
Railroad Structures	6–8 ft	None	Full-time
Bridges and Wing Walls (piles)	60 ft	None	None
Standard Retaining and Sound Walls (spread footings)	5 ft	None	Full-time
Minor Structures	5 ft	None	Full-time
Sign Structures (piles)	25–33 ft	None	None
Signals (piles)	13 ft	None	None
Light Poles (piles)	10 ft	None	None
Utility Poles (piles)	10–20 ft	None	None
Standard sign posts (piles)	6 ft	None	None
Underground Utilities	5–10 ft	None	Full-time
Drainage Structures	5–15 ft	None	Full-time
Canal Crossings	6.5 ft	None	Full-time
Pavement Structural Section	3 ft	None	Full-time
Cut Slopes	20–30 ft	None	Full-time

ft = feet

Drilling for piles for the bridges and wing walls, sign structures, signals, light poles, utility poles, and standard sign posts does not require monitoring because this excavation method grinds the deposits into tiny pieces and precludes the collection of paleontological resources. However, the excavations for the interchanges, railroad structures, retaining and sound walls, underground utilities, drainage structures, canal crossing, pavement structural section,and cut slopes, are likely to cover a larger area and allow for the collection of paleontological resources. Therefore, excavations for these elements would require full-time monitoring.

[1] Indicates the maximum preliminary monitoring recommendation based on the sensitivity of the geologic units and the current level of project design. The final monitoring recommendations will be adjusted based the results of additional design details, presence of Artificial Fill, and evidence of ground disturbance.

Because this project is still in the PA&ED phase, the exact locations and methods of excavation are not known, and the anticipated excavation depths listed above are not confirmed at this time. Therefore, the recommendations for monitoring efforts outlined in this preliminary PMP will need to be revised and/or appended based on more detailed information in the final design plans, evidence of manmade or other ground disturbance, and field observations from spot checking. For example, if the final design plans and evidence of ground disturbance indicate that excavation for the pavement structural section will remain in disturbed sediments, then no monitoring would be required. However, if the final design plans and field observations indicate that excavation for the pavement section would be deeper than predicted or would occur in areas that have not been disturbed, then full-time monitoring would be required.

5.4 Monitoring Methods

The number of monitors needed will depend on the number of spreads, or active work areas, being excavated, the sensitivity of the sediments in each spread, and the distance between spreads. Generally, one monitor is needed for each spread located in sensitive sediments separated from another such spread by more than approximately 500 ft. Distances of more than approximately 500 ft make effective monitoring of two areas by one individual difficult. However, the number (and spacing) of monitors needed during excavation will depend on the excavation schedule, locations, and methods, and may be adjusted throughout the course of excavation based on these factors.

Monitors should observe all excavation in sediments identified as having high sensitivity as it occurs, examining the in situ sediments and the resulting backdirt for paleontological remains. Due to historical and modern day ground disturbance form human activity, as well as plant and animal bioturbation, increased oxygen content, and chemical weathering processes that decrease conditions suitable for preservation, Caltrans generally recommends that monitoring begin at depths greater than three to five ft below the ground surface. However, the specific locations and depths for monitoring will need to be determined based on the excavation depths in the final design plans, evidence of manmade or other ground disturbance, and field observations from spot checking. In deposits that have been previously disturbed, monitoring would not be recommended, even if the area is mapped as having high sensitivity.

In addition to visually examining the sediments, the monitors should spot-screen some matrix through $^{1}/_{16}$-inch mesh screens for fossil materials. This allows remains to be observed that might otherwise be missed due to their small size. If small fossils are observed during screening or during the course of regular monitoring, the monitors should have the authority to collect a standard sample of up to 6,000 pounds of matrix that can be screened in another location away from active grading operations (see the section on Bulk Samples, below).

During construction excavation, a qualified paleontological monitor shall initially be present on a full-time basis whenever excavation will occur within the sediments that have a high sensitivity rating. Monitoring may be reduced to part-time if no resources are being discovered in sediments with a high sensitivity rating. Monitoring reductions and when they occur will be determined by the qualified Principal Paleontologist in consultation with the Resident Engineer (RE).

If fossils are observed and collected, their localities must be assigned field locality numbers. There are several ways of assigning field locality numbers. One easy way consists of using the monitor's initials, the date of the find, and a number indicating whether the find is the first, second, third, etc., locality for that monitor on that day. For example, JAD-20170822-02 would represent the second locality found by John A. Doe on August 22, 2017. This method allows any notes the monitor recorded in field books to be accessed quickly and easily. It also allows easy sorting of data within spreadsheets. To a lesser extent, it can also be used to see what period during the excavation produced the majority of the fossils.

To ensure the least amount of delay to grading activities, all monitors shall be equipped, either on their persons or in their vehicles, to quickly stabilize and collect fossil material. This shall include equipment like a pick, shovel, rock hammer, dental picks, brushes, glue, hardeners, trowels, putty knives, and plaster medical bandages. When resources are located in situ, monitors shall be prepared and shall have the authority to halt or redirect the excavation work in the area of discovery until the find can be assessed for significance and, if necessary, documented and collected from the field. Procedures for rerouting equipment will need to be established with the Principal Paleontologist, the Resident Engineer, and the construction foreman. If the find is deemed scientifically significant, the monitors will need to note the location with a global positioning system (GPS) unit. A simple handheld GPS unit is usually adequate. The use of GPS units allows localities to be recorded quickly and accurately for use in spreadsheets or fossil catalogs, or to be entered in geographic information system (GIS) programs for plotting on a map. Monitors must also be instructed to fill out a fossil locality sheet for each find. Fossil locality sheets contain important information, such as a field number of the locality, tentative identification of the find, description of the sediments, formation name, location of the find within the project (project station number and distance from centerline, or roadway shoulder), GPS information, and elevation. Once the find is recorded, the monitor can then collect it from the field, and grading activities can continue.

When an area is identified where the grading equipment must be temporarily rerouted, the monitors will set up an exclusion zone. Often this is accomplished with wooden lath and a uniquely colored flagging tape so that the construction crews know to keep away. It is important to use a unique color, or combination of colors, so as not to cause confusion with other tape colors used on construction sites that may have other meanings. Another option is to use easily recognizable yellow caution tape. Construction crews will need to be informed that they cannot enter the exclusion zone until the monitors have completed the analysis and/or collection of the resource, or unless instructed to enter the area by the Principal Paleontologist to assist with the collection.

When large specimens, or large concentrations of specimens, are encountered, a salvage team may need to be deployed to recover the specimens rapidly in order to avoid construction delays. Salvaging often involves excavation around the fossil and wrapping the fossils and surrounding matrix in a “cast” or “jacket” made from plaster and burlap or plaster medical bandages. In this manner, the fossils can be removed from the field quickly and safely. The jacket can then be transported to a laboratory environment, where the sediment surrounding the bone can be removed in a more controlled setting. If large fossils or large concentrations of fossils are encountered, the grading contractor shall consider using heavy equipment on site to assist in the removal and collection of the specimen. This may entail assisting with the removal of sediment from around the fossil and the lifting of heavy specimens onto a truck for removal from the project. This will ensure the timely salvage of the fossil material so that normal grading activities can proceed as soon as possible.

In some instances, construction equipment may have to operate at night. Nighttime monitoring is usually not productive for the collection of fossils, as the paleontological remains are not as visible as they are during daylight hours, even under artificial light. Therefore, it is recommended that no monitoring occur at night. If grading must occur at night, it is recommended that all work be limited to those areas identified as having low sensitivity for paleontological resources, or within areas that although identified as having high sensitivity, have been approved by the Principal Paleontologist to have reduced monitoring levels because the units are not producing scientifically significant paleontological remains. If needed, the areas that receive approval from the Principal Paleontologist to be graded at night can be surveyed by the monitors the following morning.

Monitors should also record their monitoring activities in a field book and/or on a daily monitoring form. The notes should record things such as the area where excavation is occurring, sediment type being excavated, number and types of equipment working, times and methods of monitoring, notes on any recovered fossils, and any other pertinent information on the project.

5.5 Safety Measures

All monitors, as well as any crew members required to assist with the salvage of large fossils or bulk samples, should follow the current Caltrans Safety Manual. This document covers all aspects of safety for workers on Caltrans projects and is too detailed to be fully repeated here. However, Chapter 12, Personal Protective Equipment (PPE), contains important information that should be included here on what protective equipment should be worn by all monitors. PPE that should be worn at all times while on the project includes work boots, long pants, an orange or bright yellow-green vest, or an orange or bright yellow-green shirt, and a hard hat. Eye and hearing protection as well as work gloves should be readily available for use if the need arises.

A Code of Safe Practices should be prepared to outline safe practices for the monitoring team and document that the monitoring team members have been trained in these practices. The monitoring team members also should attend site- or project-specific training if required by the construction firm or if there are site- or project-specific safety issues of which the monitoring team needs to be aware.

Prior to the beginning of construction, the Principal Paleontologist, or his or her representative, shall lead a pre-grade/pre-construction meeting to inform all workers and agencies involved of the monitoring plan. This will also help to inform the construction workers of the monitoring methods and serve to alert the workers that monitors will be present on site, and the operators will need to be aware of them.

As mentioned above, in some instances, construction equipment may have to operate at night. In addition to nighttime monitoring not being conducive for the collection of fossils, the monitors on the ground themselves are not as visible to the heavy equipment operators. This situation presents a significant safety hazard even when lights are set up. Therefore, it is recommended that monitoring not occur at night.

Monitors should have a minimum of at least 1 year of experience in working around heavy equipment. Communication procedures must be established among the monitors and the equipment operators so that all are aware of the others' actions.

Tailgate meetings are also an important aspect of any safety meeting and are usually conducted by the grading contractor on a weekly basis. All monitors should attend these meetings, especially to remind the operators that monitors will be on the ground. In addition, monitors will be able to determine where construction excavation is planned for the week ahead and if there are any changes to the movement of equipment patterns within the project.

5.6 Bulk Samples

If sediments containing concentrations of small bones and teeth are encountered during monitoring, a salvage team should be sent to the area to collect a standard sample of up to 6,000 pounds. Depending on the location of the find, such as a limited exposure of fossil-bearing strata, less material may be collected. The matrix should then be transported to a designated wash area, preferably within the project area, and stockpiled either in trashcans or on the ground on heavy-duty plastic tarps. All collected matrix must be clearly labeled with its locality number to keep track of where the sediment sample originated. The wash area that is chosen should be accessible throughout the duration of construction but also be away from any proposed cut-or-fill areas. The wash area and screen washing must meet Stormwater Pollution Prevention Plan (SWPPP) requirements. Processing is usually completed concurrently with construction, with the intent to have all processing completed before, or just after, project completion. A small corner of a staging or equipment parking area is an ideal location. If water is not available, the location should be accessible by a water truck to occasionally fill containers with water.

Once the matrix containing the concentrations of fossil material has been safely stockpiled, the following techniques can be employed to separate the fossils from the matrix:

- The matrix sample should be allowed to dry completely in the sun.
- The matrix and blocks of matrix can then be placed in buckets of water until the matrix disaggregates. Soaking time will vary depending on how indurated the matrix is and can range from as short as 1 hour to as long as overnight.
- The matrix can then be placed in 20-mesh screens ($^1/_{20}$ inch) and agitated by hand in tubs of water to wash away the matrix that was smaller than 20-mesh. If there are abundant large clasts in the matrix, it may be necessary to prescreen the matrix through ⅛ inch or ¼ inch screens in order to separate out the larger clasts.
- Some material passing through the 20-mesh screen should be further washed through 30-mesh screens to determine whether smaller fossils are present. If determined to be present, all material should be screened through both the 20- and 30-mesh screens.
- When no further matrix passes through the screens, the residual matrix should be set aside to dry. Depending on the nature of the sediment being washed, the washing/drying process may need to be repeated four to five times until the matrix is reduced to only fossil material and resistant sediment clasts that cannot be further broken down.
- When fully dry after the final wash, the samples can be placed in bags, labeled with the locality number and the screen size, and transported to the lab, where they can be examined under a magnifying scope to separate the fossil material from the residual matrix.
- When samples from different localities are washed on the same day, care must be taken to ensure that all the screens, buckets, and other equipment are thoroughly cleaned between wash cycles to prevent contamination and that the samples from different localities are not mixed up and washed at the same time.

5.7 Preparation of Stratigraphic Columns

A stratigraphic column is a graphical interpretive sketch, in vertical view, of the on-site sediments. Geologic stratigraphic columns usually include detailed descriptions of each unique layer such as color, grain size, texture, and sorting along with information on the contact between the layers, such as angular, sharp, or gradational. In addition, the location of any collected fossil remains can be placed in the proper context so that interrelationships between fossils can be assessed. The description of the differing sediment layers along with the fossils that are found within each layer can be used to better understand or reconstruct the different environments that existed in the area in the past. Therefore, by interpreting the sequence of events that produced the strata and structures displayed in a stratigraphic column, it is possible to gain an insight into the geologic history of a region.

If possible, attempts should be made to create a stratigraphic column, especially in areas where fossil localities are recorded. However, it is often difficult to make geologic stratigraphic columns on road widening and interchange improvement projects because they generally have limited continuous sediment exposures. In these cases, very detailed sedimentary descriptions should be made for each locality to help with paleoenvironmental reconstructions.

5.8 Preparation of Collected Resources

Specimens should be prepared using standard paleontological techniques to a point of reasonable identification. Broken fossils can be repaired using cyanoacrylate glue (super glue) or white glue. Fragile fossils can be hardened using white glue thinned with water or polyvinyl buteral (butvar B-72) thinned with acetone or ethyl alcohol in a ratio of 10:1 or 8:1 (solvent: B-72). Excess matrix should be removed to better expose the fossil and reduce the storage volume. When the matrix is extremely hard and cemented, air chisels in various sizes can be used to remove matrix from around the fossil more easily. Wood chisels, awls, and dental picks can be used on the fossils encased in softer matrix.

Sometimes it is advantageous to save some sediment from around larger fossil specimens while they are being prepared and send it out for microfossil and microvertebrate analysis. This is done in an attempt to collect smaller fossils such as pollen, ostracods, foraminifera, and small vertebrate fossils, all of which can often be used to obtain clues to environmental factors such as what plants may have been growing nearby, and water salinity. Microvertebrates can also help to narrow down age ranges for the deposit and are indicative if conditions were arid or marshy.

If any wash samples are processed, the residual matrix concentrate from the wash is best examined for microvertebrates with the use of a magnifying scope in the lab. Any observed fossil remains can be sorted out and set aside for later identification. Each microvertebrate should be placed in its own secure small capsule or vial, along with its catalog number and taxonomic identification, if known. If the fossil ID is not yet known, this information can be filled in after it has been sent out for identification by an expert. If the microvertebrate is too fragmented to be identified and contains no diagnostic features, it can be combined with other fragmented bones and teeth from the same taxon, and when cataloguing is done, simply labeled as X number of unidentifiable mammal/reptile/bird/fish bone/tooth fragments.

Taxonomic classification of fossil specimens should be based on external macromorphological attributes. Specimen identification can be accomplished through comparisons with known paleontological samples, as well as modern counterparts. However, identification is best performed by individuals with experience in the fossils needing identification. This often entails enlisting the assistance of individuals at museums or universities for the identifications. Each fossil specimen should be classified to the lowest identifiable taxon possible and given a catalog number. Fossils that cannot be identified by any species-specific attributes should be assigned the most conservative taxonomic categories. Aggregates of unsorted matrix, where time prohibits complete sorting and identification, should be assigned a single catalog number to represent the mass sample.

5.9 Report Documentation

At the completion of the project, the Principal Paleontologist must prepare a Paleontological Mitigation Report (PMR). The PMR is generally completed by the Project Paleontologist who provided the paleontological monitoring. Briefly, the purpose of the PMR is to document the results of the monitoring effort and should contain:

- A discussion of the monitoring and laboratory methods;
- A list and qualifications of the individuals involved in the monitoring, fossil preparation, identification and curation;
- Results of the monitoring, including numbers of localities, numbers of specimens, and a list of specimens with both common and scientific names;
- Maps depicting where each locality was found;
- Graphics, such as geologic cross-sections;
- Illustrations and/or pictures of selected specimens, with pictures of selected localities in the field so that they can be easily identified if needed during future excavations;
- A discussion of the resources collected, how they fit into the overall geologic and paleontologic context, and how the specimens will add to the scientific knowledge of the area, including discussions on whether there are any specimens that are rare or unique and if they are the first occurrence for the particular specimen for the age of the rock of the formation itself; and

- An itemized fossil catalog, usually included as an appendix.

A Paleontological Stewardship Summary (PSS) is also required if any long-term commitments are necessary. The purpose of the PSS is to provide the various divisions within Caltrans, such as the Maintenance and Operations staff (including the Encroachment Permits Office), a summary of the locations where resources were collected during the monitoring (including county, route, Post Mile limits, and side of highway), and a description of the resource. The PSS should also provide the types of use restrictions (such as areas that must be monitored for resources during any new ground-disturbing activities), and the duration of those restrictions in order to ensure that resources will continue to be protected even during routine future maintenance. Generally, the PSS is completed in-house by Caltrans. Procedures for preparing both the PMR and PSS can be found in Caltrans SER Environmental Handbook, Volume 1, Chapter 8.

5.10 Curation of Fossils into a Permanent Repository

Although all fossils collected during mitigation remain the property of the landowner (usually the City, County, or Caltrans in the case of roadway projects, especially when the fossils are collected within Caltrans ROW), the collection should be properly curated at an approved facility, such as a museum or university (preferably local to the project location) and preserved for future scientific studies above and beyond what is covered in the PMR. A copy of the final report and a searchable master catalog database in a format such as Microsoft Excel or Access should be curated with the fossils.

The curation facility is usually identified by the Principal Paleontologist prior to the beginning of construction and, at a minimum, a draft curation agreement between the landowner and the curation facility is in place prior to the beginning of construction. The curation agreement will spell out how the fossils should be curated, such as preparation methods, identification methods, assignment of catalog numbers, labeling and tagging methods, methods of packing, and estimated costs associated with storage at the facility (storage is usually based on a one-time fee and is based on the volume in cubic feet that the fossils occupy). The curation agreement will also guarantee that the paleontological specimens that are collected will have a permanent storage location upon completion of the project.

As the project is within Stanislaus County, the University of California Museum of Paleontology (UCMP) located at the University of California, Berkeley is a reasonable choice as a permanent repository for fossils collected from this project. The policy of the UCMP is to not enter into a curation agreement until the volume of material being curated is known. Therefore, at this stage of the project, a curation agreement cannot be established with the UCMP. However, the UCMP has agreed to accept first right of refusal for the curation of any fossils recovered from the project. A copy of the email communication with Dr. Mark Goodwin, Assistant Director of the UCMP regarding the UCMP policy and agreement is included in Appendix B.

It should be noted that processing fossils for curation into a facility generally requires work after the completion of grading, so it will be necessary for the Principal Paleontologist to work closely with the project proponent to ensure that appropriate funding remains active until the fossils are properly curated.

Chapter 6 Decision Thresholds

6.1 Discarding of Specimens

Initially, all observed fossil specimens, especially vertebrate fossils, should be collected and brought to the lab. If it is readily apparent in the field that there are hundreds of the same species of invertebrate shell, for example, the decision can be made by the monitor to only collect a representative sample of the invertebrate fossils. This decision will help reduce the storage volume and prevent unneeded duplication. All vertebrate fossils should be collected, as all are considered scientifically significant. However, if a large fossil specimen, even a vertebrate specimen, is partially exposed but extends outside the project area or deeper into the ground than proposed excavation will occur, the decision can be made to record as much information about the specimen as possible, including measurements, sketches, and photographs, and then leave the balance of the specimen in situ.

Once in the lab, and at the completion of the project, the decision can be made to discard invertebrate specimens that have enough representatives in the collection. In addition, if numerous vertebrate fossils are not diagnostic because of their fragmentary nature, some of them may also be discarded. This is usually done to reduce the storage volume for the curation facility. Discarding does not necessarily entail the placing of the specimens into the trash. Often, the specimens can be used in fossil education programs at schools or museums, allowing children and adults to handle real fossils with no fear of a one-of-a-kind fossil being broken or damaged.

6.2 Reduction of Monitoring

Initially, monitoring would occur on a full-time basis in areas that have been identified as having a high paleontological sensitivity, have not been previously disturbed by development or other activities that could result in distrubed sediments, and where the excavation methods allow for the recovery of fossils. Areas identified as having Artificial Fill have no paleontological sensitivity and would not require monitoring until excavation extends beneath the depth of the fill. At that point, the monitoring level would be dependent on the sensitivity of the sediments that are exposed beneath the fill.

If, during the course of the project, a particular sediment identified as having high paleontological sensitivity has not produced any fossil remains, the Principal

Paleontologist, in consultation with the RE, may decide that monitoring levels can be reduced to a part-time basis in that geologic formation or unit. There is no universally accepted criterion for deciding when monitoring levels need to be reduced, or by how much; however, it is usually done in a graduated process. However, if any remains are discovered in a geologic formation, or unit, after monitoring levels have been reduced, the Principal Paleontologist, in consultation with the RE, may decide to increase monitoring back to a full-time basis.

Chapter 7 Permits

Permits are often required to collect paleontological resources on Federal land and within land under the jurisdiction of the California Department of Parks and Recreation (i.e., State Parks). As the project is not within lands administered by the United States Department of Agriculture Forest Service, United States Department of Interior, Bureau of Land Management, or the State Parks, permits issued by these agencies to collect paleontological resources will not be required on this project.

Chapter 8 Schedule

Because this project is still in the PA&ED phase, a schedule for construction is not available at this time. However, a few general statements may be made regarding monitoring efforts and associated tasks.

All ground-disturbing activities, such as grading, excavating, and trenching, in paleontologically sensitive and undisturbed deposits would require monitoring. Activities that do not involve ground disturbance, such as demolition of existing buildings, concrete pouring and paving, installation of new and/or relocated utilities, trench backfill, construction of retaining walls and sound walls, and placement of fill, would not require monitoring. Ground disturbance in deposits with no paleontological sensitivity, such as Artificial Fill, or that have been previously disturbed, also would not require monitoring. However, the thickness of deposits such as Artificial Fill, the schedule and methods of excavation, and evidence of previous ground disturbance must be taken into account when developing the monitoring schedule. The initial monitoring effort recommended in Section 5.3 will need to be revised based on this information during the final design phase.

If any paleontological resources are discovered during construction, they will need to be processed in a laboratory setting to clean, stabilize, and identify them. In addition, if sediment samples are collected for screening, they will need to be washed and picked for fossils. It is generally a good idea to prepare fossils for curation concurrently with construction activities so that not much time passes between the collection and the preparation to ensure that all collected fossils can be identified, catalogued, and discussed in the Paleontological Mitigation Report. Laboratory work and screen washing can occur concurrently with construction unless the finds are found during the final days or weeks of the project, in which case they can be processed soon after the project has been completed.

The Paleontological Mitigation Report also should be prepared soon after the completion of the project. Although there is no set time, an attempt should be made to have this completed within 6 months or less following project completion.

Chapter 9 Justification of Cost Estimate

As with the schedule, because this project is still in the PA&ED phase, a cost estimate for construction is not available at this time. However, a few general statements may be made regarding the costs of monitoring efforts and associated tasks.

Paleontological monitoring will be conducted when excavation for the project encounters sediments that have the potential to contain nonrenewable fossil resources. Monitors will be supervised by a field coordinator, and all paleontological monitoring will be conducted under the direction of the Principal Paleontologist. At the conclusion of monitoring, fossils that are discovered will be stabilized and prepared to a reasonable point of identification, identified, cataloged, and placed in a curation facility. Additional monitors may be needed if a salvage crew needs to be sent to the project to collect a large concentration of fossil remains or to collect and process bulk samples of sediment for microfossils and microvertebrates. If additional monitors and a salvage crew are required, a budget augment will be required to cover the additional cost. Table E includes estimated costs for monitoring, as well as costs incurred if paleontological resources are discovered and need to be processed.

Table E: North County Corridor New SR 108 Project Preliminary PMP Estimated Cost Breakdown

Task	Cost
Construction Paleontology Monitoring (assumes 1 monitor for 8 hours per day/40 hours per week monitoring and 1 hour per day commuting to project/5 hours per week)	$4,050/week
Field Coordinator Supervision (4 hours per week)	$560/week
Principal Paleontologist (2 hours per week)	$320/week
Laboratory processing of fossils (40 hours per week)	$3,600/week
Preparation of the PMR	$10,000
Curation Fees (at UCMP)	$1,000/cubic foot

SR 108 = State Route 108
PMP = Paleontological Mitigation Plan
PMR = Paleontological Mitigation Report
UCMP = University of California Museum of Paleontology

It should be noted that this is an estimate and monitoring costs could be lower if, over the course of the project, the Principal Paleontologist reduces monitoring levels from full-time to part-time. However, if the design plans call for additional areas of excavation or if excavation schedules change, additional monitoring may be necessary. In addition, if resources are discovered, additional time and effort will be required to salvage the fossils with additional paleontological crew members, and that cost is not included above. If resources or sensitive sediments are discovered after monitoring has been reduced, it is likely the Principal Paleontologist will reinstate full-time monitoring.

Prior to the beginning of grading, a curation agreement will need to be initiated with a curation facility so that fossils will be prepared to the standards of that facility and ultimate storage fees can be ascertained. The cost to curate the specimens into a museum repository will vary from institution to institution, but an average cost is a one-time charge of $1,000 per cubic foot (about the size of a banker's box).

At the conclusion of grading, a PMR will be required to discuss the results of the monitoring, and the identification and significance of any collected specimens. The PMR is generally completed several months after all grading activities have ceased. Finally, the collected and prepared specimens will need to be placed within a curation facility.

It should be noted that these costs may increase at 3 to 5 percent per year for each year that the project does not begin. In addition, if a large number of specimens or a particularly large specimen, such as a mammoth, is encountered, a budget augment will likely be required for additional activities, such as salvage, lab work, and curation fees. Conversely, if fossil specimens are not collected during paleontological monitoring, the costs associated with laboratory preparation and curation fees will not apply, and the cost to prepare the PMR will be lower.

Chapter 10 Summary

According to the PER prepared for the project (Smith, 2014), there are sediments within the project area that have a high sensitivity rating for paleontological resources.In order to mitigate potential adverse impacts to scientifically significant, nonrenewable paleontological resources, the mitigation plan included in this preliminary PMP should be implemented and followed. Briefly, the mitigation measures include:

- Attendance at the pregrade meeting by a qualified paleontologist or his/her representative. At this meeting, the paleontologist shall explain the likelihood for encountering paleontological resources, where these resources may occur, what resources may be discovered, and the methods that will be employed if anything is discovered.
- The recommended monitoring effort during project development will depend on the paleontological sensitivity of the deposits, as well as on the depth and methods of excavation and whether the sediments have been previously disturbed. Generally, during construction excavation, a qualified paleontological monitor shall initially be present on a full-time basis for excavation activities in sediments that have a high-sensitivity rating. However, for some portions of this project, this recommendation may be reduced in the final PMP to spot-check monitoring or no monitoring based on the excavation depth and methods, presence of Artificial Fill, and evidence of previous ground disturbance. Monitoring is not required for excavations that remain in Artificial Fill or for drilling in high sensitivity deposits. Full-time monitoring may be reduced if no resources are being discovered in sediments with a high-sensitivity rating (monitoring reductions and when they occur, will be determined by the qualified Principal Paleontologist in consultation with the Resident Engineer). For the final PMP, these monitoring recommendations must be revisited based on additional information from the final geotechnical report, excavation details for the final design plan, presence of Artificial Fill, and evidence of previous ground disturbance.
- The monitor shall inspect fresh cuts and/or backdirt to recover paleontological resources. The monitor shall be empowered to temporarily divert construction equipment away from the immediate area of the discovery. The monitor shall be equipped to rapidly stabilize and remove fossils to avoid prolonged delays to construction schedules. If large mammal fossils or large concentrations of fossils

are encountered, the grading contractor shall consider using heavy equipment on site to assist in the removal and collection of large materials.

- Localized concentrations of small (or micro-) vertebrates may be found in all native sediments. Therefore, it is recommended that these native sediments occasionally be spot-screened through ⅛ inch to $^{1}/_{20}$ inch mesh screens to determine whether microvertebrates are present. If microvertebrates are encountered, additional sediment samples (up to 3 cubic yards or 6,000 pounds) shall be collected and processed through $^{1}/_{20}$ inch mesh, and sometimes $^{1}/_{30}$inch mesh screens, to recover additional fossils. The processing of large bulk samples is best accomplished at a designated location within the project limits that will be accessible throughout the duration of construction but will also be away from any proposed cut or fill areas. Processing is usually completed concurrently with construction, with the intent to have all processing completed before, or just after, project completion. A small corner of a staging or equipment parking area is an ideal location. If water is not available, the location should be accessible for a water truck to occasionally fill containers with water.
- Any recovered specimens shall be prepared to the point of identification and permanent preservation. Preparation includes the picking of any washed mass samples to recover small invertebrate and vertebrate fossils, the removal of surplus sediment from around larger specimens to reduce the volume of storage for the repository and the storage cost, and the addition of approved chemical hardeners/stabilizers to fragile specimens. This process is best accomplished at a designated laboratory, usually off site, with access to fossil preparation tools, magnifying equipment, storage boxes and vials, and chemical hardeners. Processing of fossils through the lab is best accomplished concurrently with construction, especially if numerous fossils are being collected.
- Specimens shall be identified to the lowest taxonomic level possible and curated into an accredited institutional repository with retrievable storage. As the project is within Stanislaus County, the UCMP located at the University of California, Berkeley is a reasonable choice as a permanent repository for fossils collected from this project. The policy of the UCMP is to not enter into a curation agreement until the volume of material being curated is known. Therefore, at this stage of the project, a curation agreement cannot be established with the UCMP. However, the UCMP has agreed to accept first right of refusal for the curation of any fossils recovered from the project.
- A report of findings will be prepared at the conclusion of the project discussing what was found and the significance of the finds. This report should follow the

guidelines of Caltrans as contained in Caltrans SER Environmental Handbook, Volume 1, Chapter 8.

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Appendix A Cost Estimate

North County Corridor - LSA Cost Estimate for the Preliminary Paleontological Mitigation Plan

Task	Cultural / Paleontological Resources Group				Graphics / GIS	Word Processing	Production	Direct Costs	TOTAL COSTS
	LSA Principal	*Principal Paleontologist*	*Field Coordinator*	*Monitor*					
Task 1 - Monitoring									
Paleontological Monitoring (weekly)				45					$4,050
Monitoring Oversight (weekly)		2	4						$880
Mileage (weekly)								$56	$56
Per diem (weekly)								$675	$675
Task 2 - Laboratory									
Prepare Fossils (weekly)		8		40					$4,880
Task 3 - Paleontological Mitigation Report									
Prepare Report		48			8		2	$100	$8,780
Internal QA/QC Review	2					8			$1,160
Response to Caltrans Comments (Round 1)	1	4			4	2	2	$100	$1,620
Response to Caltrans Comments (Round 2)	1	2				1	2	$100	$700
Task 4 - Curation									
Curation fees at UCMP (per cubic foot)								$1,000	$1,000
Hours	4	64	4	85	12	11	6		
Fees	$720	$10,240	$560	$7,650	$1,500	$1,100	$480		**$23,801**
Billing Rates	$180	$160	$140	$90	$125	$100	$80		

Notes:
The cost estimate for Task 1 is based on a weekly rate; the final total cost dependent on the construction schedule.
The cost estimate for Task 2 is based on a weekly rate; the final total cost dependent on the amount of material recovered.
The cost estimate for Task 3 is based on a positive report with 1 cubic foot of prepared fossil material or less. Additional costs will be incurred to document the any additional material collected.
The cost estimate for Task 4 is a rate for 1 cubic foot of material; the final total cost dependent on the amount of material recovered.

Appendix B Agreement on First Right of Refusal with the University of California Museum of Paleontology

From: Mark B. GOODWIN <mark@berkeley.edu>
Sent: Wednesday, September 10, 2014 10:52 AM
To: Sarah Rieboldt
Cc: Patricia HOLROYD
Subject: Re: Curation Agreement request for the North County Corridor Project in Stanislaus County

Hi, Sarah,

Pat forwarded me your request. Is this a Caltrans project? We just finished a contract with Caltrans and your project may be of interest for future agreements.

UCMP requirements for accessioned collections are listed here:
http://www.ucmp.berkeley.edu/science/collectionspolicies.php

UCMP generally does not agree to serve as a repository without a reasonable approximation of the volume of material that might be donated. Our storage space is minimal for these types of collections. And of course all material must be prepared and identified to at least the family level prior to donation. Understandably you're required to have a repository agreement for your contracts. UCMP may accept first right of refusal, but cannot commit ahead of time for most projects. If this is a Caltrans project, I would consider it since we have an ongoing "state agency to state agency" relationship with them.

Please say hi to Jim!

Best,

--Mark

Accessioning collections

A minimum $400 fee for accessioning a mitigated collection is required. If it is determined by the Assistant Director for Research and Collections that specimen cabinets and drawers are required to house this collection, they will be purchased by the contractor and delivered to UCMP by prior arrangement with the Museum Scientist responsible for this collection.

On Mon, Sep 8, 2014 at 2:12 PM, Patricia HOLROYD <pholroyd@berkeley.edu> wrote:

---------- Forwarded message ----------
From: **Sarah Rieboldt** <Sarah.Rieboldt@lsa-assoc.com>
Date: Mon, Sep 8, 2014 at 11:57 AM
Subject: Curation Agreement request for the North County Corridor Project in Stanislaus County
To: pholroyd@berkeley.edu

Dear Dr. Holroyd,

I'm writing to ask you whether the University of California Museum of Paleontology (UCMP) would serve as the curation facility for fossil material recovered from the North County Corridor Project (project) in the Cities of Modesto, Riverbank, and Oakdale, Stanislaus County. This project proposes to construct the North County Corridor, a new State Route (SR-108), which will relocate the current SR-108 to a more southerly alignment. The project involves construction of a new roadway with two or three 12-foot wide through lanes and 5-10-foot shoulders in each direction, as well as intersection improvements, grade separations at major roadway and railroad intersections, and structures at various waterway crossings. This project is currently in the preliminary design phase and excavation would not be expected to begin for several years.

From west to east, the project area begins at the SR-219 (Kiernan Avenue)/Tully Road intersection north of Modesto, runs south of Riverbank and Oakdale, and ends near the intersection of SR-108 (SR-120)/Lancaster Road. The project area is underlain by deposits of the Modesto, Riverbank, and Turlock Lake Formations.

Please let me know if the UCMP is interested in serving as the curation facility for fossils recovered during excavation for this project and if there are additional procedures required by the museum to establish a curation agreement. Also, please let me know what the UCMP curation fees are (e.g., charge per cubic foot/drawer/cabinet), so we have some estimate of costs for curation.

Thank you very much.
Sincerely,
Sarah

Sarah Rieboldt, Ph.D.
LSA Associates, Inc.
20 Executive Park, Ste. 200
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www.ucmp.berkeley.edu/museum/profiles/goodwin/goodwin_profile.html

Appendix C Resume

SARAH RIEBOLDT, PH.D.
PALEONTOLOGIST

EXPERTISE

Paleontological Mitigation Reports

Paleontological Resource Monitoring

Fossil Collection, Salvage, Identification, and Curation

Federal, State, and Local Laws, Ordinances, Regulations, and Standards (LORS) Regarding Paleontological Resources

EDUCATION

University of California, Berkeley, Ph.D., Paleontology, 2005.

University of Colorado, Boulder, *Magna cum Laude* B.A., Biology, Minor in Geology, 1999.

TEACHING

Science Specialist, San Roque School, Santa Barbara, California, January 2006–June 2008.

Graduate Student Instructor, Department of Integrative Biology, University of California, Berkeley, August 2000–December 2000, January 2001–May 2001, and January 2003–May 2003.

PROFESSIONAL RESPONSIBILITIES

Dr. Rieboldt is a paleontologist at LSA with 13 years of experience in the geology and paleontology fields. Dr. Rieboldt's field and laboratory experience includes working on research projects throughout California, Nevada, Utah, Colorado, Wyoming, Texas, and Alabama. She has 5 years of experience working with natural history collections in museums in California, Colorado, and Illinois and 5 years of experience as a paleontological consultant in California and Utah, monitoring for paleontological resources, and writing paleontological resource assessment reports and mitigation plans. She also has experience in monitoring the excavation and construction process on multiple subdivision developments and a natural gas pipeline, as well as monitoring drilling and coring operations.

Dr. Rieboldt prepares paleontological assessment reports, mitigation plans, and monitoring reports following the completion of paleontological mitigation monitoring. She provides guidance on the various federal, State, and local regulations and guidelines regarding paleontological resources as they apply to project around Southern California. She also is responsible for scheduling paleontological monitors on both large- and small-scale projects.

PROJECT EXPERIENCE

Central Region Landfills – Frank R. Bowerman Landfill Wetlands Basin, Phase VIIIC, and East Flank Landslide Projects
Orange County, California
Dr. Rieboldt is currently preparing the Final Mitigation Monitoring Report for the Wetlands Basin, Phase VIIIC, and East Flank Landslide Projects. To date, LSA has collected over 100 fossil specimens from these combined projects, and the recovery of these specimens was completed without delay to the project schedule. The most notable specimens collected during the projects so far are several early Miocene (18-20 million years before present) whale fossils and leaves and mollusks from the Cretaceous (72-83 million before present). As part of the mitigation monitoring report, Dr. Rieboldt is documenting project compliance with the applicable State and County requirements for paleontological resources. She is also identifying and describing the scientific significance of the fossils recovered.

State Route 710 Project
Los Angeles County, California
LSA is leading an environmental team to prepare an Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the State Route 710 (SR-710) Project, which spans 23 cities and communities in Los Angeles County. This project, under the direction of the California Department of Transportation (Caltrans) in cooperation with the Los Angeles Metropolitan Transportation Authority (Metro), proposes to

PROFESSIONAL EXPERIENCE

Project Manager, Department of Geological Sciences, California State University, Fullerton, and John D. Cooper Archaeological and Paleontological Center, Santa Ana, California, April 2012–April 2013.

Geologist, Geological Survey of Alabama, Tuscaloosa, Alabama, April 2010–February 2012.

Collections Assistant, Field Museum of Natural History, Chicago, Illinois, February 2009–February 2010.

Science Writer, University of California Museum of Paleontology, Berkeley, California, April 2009–November 2009.

Collections Assistant, Chicago Academy of Sciences, Chicago, Illinois, October 2008–February 2009.

Postdoctoral Research Associate, Center for Integrative Planetary Science, University of California, Berkeley, May 2005–December 2005.

Paleontological Consultant, Ric Windmiller Consulting, Auburn, California, June 2000–June 2005.

Graduate Student Researcher, Department of Integrative Biology, University of California, Berkeley, January 2004–December 2004.

Science Writer, University of California Museum of Paleontology, Berkeley, California, June 2003–December 2003.

Paleontological Consultant, California Department of Parks and Recreation, San Francisco, California, and University of California Museum of Paleontology, Berkeley, California, June 2001–December 2002.

Graduate Student Researcher, University of California Museum of Paleontology, Berkeley, California, August 2002–December 2002.

Paleontological Consultant, ECORP Consulting, Inc., Roseville, California, June 2002.

PROJECT EXPERIENCE (CONTINUED)

improve mobility and relieve congestion between SR-2 and Interstates 5, 10, 210, and 605 in east/northeast Los Angeles and the San Gabriel Valley. Development of this project involves four alternatives: Freeway Tunnel, Light Rail, Bus Rapid Transit, and Transportation System Management/Transportation Demand Management. Dr. Rieboldt wrote the Paleontological Resources Identification Report and Paleontological Resources Evaluation Report (PIR/PER) for this project.

Sesi Property Landfill Closure Project
San Diego, California
Dr. Rieboldt prepared the Paleontological Mitigation Monitoring Report (PMMR) for the Sesi Property Landfill Closure Project. This project involved constructing a monolithic landfill cover with surface drainage facilities and other improvements for closure of landfilled auto-shredder waste on the Sesi property in the City of San Diego, San Diego County. Development of this project involved excavation into the paleontologically sensitive Otay and Lindavista Formations and therefore, required full-time monitoring during ground-disturbing activities in native deposits.

Morse Street Townhomes Project
Oceanside, California
Dr. Rieboldt prepared the Paleontological Assessment for the Morse Street Townhomes Project. This project involved the development of 38 townhomes on a 2.3-acre parcel of land near the intersection of Morse Street and the Pacific Coast Highway in the City of Oceanside, San Diego County. Development of this project included clearing and grading to prepare the project area, construction of the various buildings, and installation of utilities.

34202 Del Obispo Street Project
Dana Point, California
LSA conducted environmental technical studies for the 34202 Del Obispo Street Project in the City of Dana Point, Orange County. This mixed-use project involves the development of a residential community, commercial space, and a small amount of parkland/open space. Dr. Rieboldt prepared the Paleontological Resources Assessment for this project.

Spieker Continuing Care Retirement Community Project
San Juan Capistrano, California
Dr. Rieboldt prepared the Paleontological Resources Assessment as one of several environmental technical studies LSA conducted for the Spieker Continuing Care Retirement Community Project in the City of San Juan Capistrano, Orange County. This project involves the development of a Continuing Care Retirement Community designed for

PROFESSIONAL EXPERIENCE (CONTINUED)

Paleontological Consultant, Jones & Stokes Associates, Sacramento, California, August 2001–January 2002.

Collections Assistant, University of California Museum of Paleontology, Berkeley, California, August 1999–December 1999.

Collections Assistant, University of Colorado Museum of Natural History, Boulder, Colorado, September 1997–May 1999.

PRESENTATIONS

RECS (Research Experience in Carbon Sequestration) Workshop, (Birmingham, Alabama). June 6, 2011.

Geological Society of America Annual Meeting, (Denver, Colorado), "Taphonomy of Jupiter's Icy Moon Europa." November 7–10, 2004.

Bioastronomy Meeting: Habitable Worlds, (Reykjavik, Iceland), "Life, Past and Present, on Jupiter's Icy Moon, Europa." July 12–16, 2004.

35th Lunar and Planetary Science Conference (Houston, Texas), "Geosciences at Jupiter's Icy Moons: The Midas Touch." March 16, 2004.

Seventh Field Conference of the International Subcommision on Cambrian Stratigraphy: The Cambrian System of South China, (Guiyang, China), "Cambrian Inarticulate Brachiopods from Nevada and Texas." August 2001.

Fourth International Brachiopod Congress (London, England), "Can Oxygen Isotopes from Inarticulate Brachiopods Resolve the Causes of Faunal Turnovers in the Cambrian?" July 10–14, 2000.

PROJECT EXPERIENCE (CONTINUED)

residents over the age of 60 years. Development of this project includes the construction of independent living residences, community buildings, and a health care center.

SR-120/McKinley Avenue Interchange Project
Manteca, California
LSA is conducting environmental technical studies for the State Route 120 (SR-120)/McKinley Avenue Interchange Project in Manteca, San Joaquin County. The proposed project involves the construction of a new interchange at SR-120 and McKinley Avenue in order to reduce congestion, improve traffic flow, and accommodate forecasted traffic demands in and around the City of Manteca. Dr. Rieboldt assisted in the preparation of the Paleontological Identification Report/Paleontological Evaluation Report (PIR/PER) and prepared the Paleontological Mitigation Plan (PMP) for this project.

Vancouver Street Sewer Extension Project
Carlsbad, California
Dr. Rieboldt prepared the Paleontological Resources Mitigation and Monitoring Plan (PRMMP) for the Vancouver Street Sewer Extension Project. This project involved the extension of an existing sewer line from Vancouver Street to Via de Canto through Hidden Canyon Community Park in the City of Carlsbad, San Diego County. Development of this project included traditional excavation, as well as horizontal directional drilling, for the installation of the sewer line segments.

Durfee Avenue Grade Separation Project
Pico Rivera, California
LSA conducted environmental technical studies for the Durfee Avenue Grade Separation Project in the City of Pico Rivera, Los Angeles County. The project proposes to lower Durfee Avenue below the Union Pacific Railroad (UPRR) tracks to improve safety for vehicular, rail, and pedestrian traffic along Durfee Avenue and nearby streets and the railroad right-of-way. Project development includes lowering Durfee Avenue, Walnut Avenue, and Stephens Street; raising the UPRR tracks;and relocating various wet and dry utilities. Dr. Rieboldt prepared the PIR/PER for this project.

SR-60/Theodore Street Interchange Project
Riverside County, California
LSA is conducting environmental technical studies for air quality and biological, cultural, and paleontological resources for the State Route 60 (SR-60)/Theodore Street Interchange Project in Moreno Valley, Riverside County. The proposed project involves reconstruction of the local interchange at SR-60 and Theodore Street in order to reduce

PRESENTATIONS (CONTINUED)

Geological Society of America Cordilleran Section Meeting, (Berkeley, California), "Inarticulate Brachiopods from the Pioche Formation (Lower and Middle Cambrian), Nevada and their Relation to the Extinction of the Olenellida." June 2–4, 1999.

PROJECT EXPERIENCE (CONTINUED)

congestion, improve traffic flow, and accommodate forecasted traffic demands in and around the City of Moreno Valley. Project development includes removal and replacement of the Theodore Street bridge over SR-60, auxiliary lanes along SR-60, and new entrance and exit ramps from SR-60 to Theodore Street. Dr. Rieboldt is preparing the PIR/PER for this project.

SR-94/SR-125 Interchange Branch Connector Project
San Diego County, California
LSA is conducting cultural and paleontological resources assessments for the State Route 94/State Route 125 (SR-94/SR-125) Interchange Branch Connector Project in San Diego County. The proposed project involves the construction of a freeway-to-freeway connector to allow direct south-to-east movement for the SR-94/SR-125 interchange in order to improve regional circulation and reduce traffic on local streets in the Cities of La Mesa and Lemon Grove, and in the unincorporated community of Spring Valley. Project development includes construction of a freeway connector between southbound SR-125 and eastbound SR-94, auxiliary lanes on those freeways, and new noise barriers and retaining walls, as well as modifications to existing structures. Dr. Rieboldt is preparing the PIR/PER for this project.

Surfside Inn Pedestrian Overcrossing Project
Dana Point, California
LSA conducted cultural and paleontological resources assessments for the Surfside Inn Pedestrian Overcrossing Project in the City of Dana Point, Orange County. The proposed project involves replacement and rehabilitation of the pedestrian overcrossing across the Pacific Coast Highway and Metrolink right-of-way from the Capistrano Surfside Inn to Doheny State Beach. Dr. Rieboldt prepared the paleontological resources assessment.

Adelanto Solar Project
San Bernardino County, California
Dr. Rieboldt prepared a paleontological resources analysis report for the Adelanto Solar Project in San Bernardino County. This report included a summary of the geology and potential paleontological resources of the project area, results from a paleontological locality search through the San Bernardino County Museum, and recommendations for mitigating potential impacts to paleontological resources.

Digital 395 Project
San Bernardino, Kern, Inyo, and Mono Counties, California; Douglas and Washoe Counties and Carson City, Nevada
Dr. Rieboldt prepared the Paleontological Resources Mitigation and Monitoring Plan for the Digital 395 Project, which involved

PROJECT EXPERIENCE (CONTINUED)

the installation of over 590 miles of fiber-optic line along United States (U.S.) Highway 395 (US-395) on the east side of the Sierra Nevada. Running from Barstow, California, to Reno, Nevada, the project route passed through lands managed by the U.S. Department of the Interior, Bureau of Land Management; U.S. Department of Agriculture, Forest Service; U.S. Department of Defense; the States of California and Nevada; and the lands of several Native American tribes. As such, this project was subject to multiple federal, State, and local regulations and policies regarding paleontological resources.

Stratford Ranch Residential Project
Perris, California
LSA conducted an archaeological and paleontological resources assessment for the Stratford Ranch Residential Project in the City of Perris, Riverside County. The proposed project includes a new residential community with 400 lots and a 15-acre Stockpile Plan on approximately 80 acres in northeastern Perris. Project development involves clearing and grading to prepare the project area, construction of a new road within the area, and installation of on-site storm drains, new water service, new sewer lines, new electric service, new natural gas lines, and a new telecommunication infrastructure system to serve the proposed residential uses. Dr. Rieboldt prepared the paleontological resources section of this assessment.

Kaiser Bellflower East Center Demolition Project
Los Angeles County, California
The proposed project involves demolition of the existing Administration Building and East Center Wing of the Kaiser Bellflower Medical Center and remodeling of the exterior and lobby of the West Wing of the Medical Center. Excavation activities associated with this project are anticipated to reach 15–20 feet below ground surface. Dr. Rieboldt wrote the Paleontological Resources Memorandum for this project.

North Star Solar Project
Fresno, California
LSA conducted a paleontological resources assessment for the proposed North Star Solar Switching Station and Generation Tie Line (Gen Tie) Project in Fresno County. The purpose of this project is to generate and transmit renewable solar electricity from proven technology, at a competitive cost, with low environmental impact, and deliver it to market as soon as possible. The project consists of an approximately 1.5-mile long Gen Tie Line that will tie into a new 115-kilovolt (kV) Switching Station, which is an expansion of the existing Pacific Gas and Electric (PG&E) Mendota substation. Project construction work will involve location preparation, foundation installation, power pole placement, generation line installation, and erection and connection of the Gen Tie Line and Switching Station equipment. Dr. Rieboldt prepared the Paleontological Resources Assessment for this project.

PUBLICATIONS

Elrick, M., S. Rieboldt, M. Saltzman, and R.M. McKay
2011. Oxygen-isotope trends and seawater temperature changes across the Late Cambrian Steptoean positive isotope excursion (SPICE event). Geology 39(10): 987-990.

Lipps, J.H., and S.E. Rieboldt
2005. Habitats and taphonomy of life on Europa. Icarus 177:515-527.

Parham, J.F., and S.E. Rieboldt
2005. *Contia tenuis* (Sharp-tailed snake): Reproduction. Natural History Note. Herpetological Review 36(4):456.

SELECTED REPORTS

Mount Diablo State Park Paleontological Resources Inventory and Management Recommendations. Prepared for the State of California Department of Parks and Recreation, Bay Area District. December 2002.

Paleontological Resources Assessment for Bayside Covenant Church, Sierra College Boulevard and Cavitt-Stallman Road, City of Roseville, Placer County, California. Prepared for Bayside Covenant Church. June 2002.

Paleontological Resources Assessment for the Riverbend Park Project, Lompoc, California. Prepared for the City of Lompoc. January 2002.

Recommendations for Compliance with Regulatory Requirements and Mitigation Measures for Paleontological Resources for the Mountain Park Community Development Project. Prepared for the Irvine Company. November 2001.

Paleontological Resources Assessment and Mitigation Measures for the Sacramento Regional County Sanitation District 17-Mile Interceptor Project, Sacramento and Yolo Counties, California. (Co-authored with Jere Lipps, Ph.D.) Prepared for the Sacramento Regional County Sanitation District on behalf of Jones & Stokes Associates, Inc. October 2001.

Scope of Work for Paleontological Investigation Report/Paleontological Evaluation Report for I-680 Northbound Sunol Grade Project. Prepared for Caltrans and Alameda County Congestion Management Agency. August 2001.