Centennial Corridor Project

City of Bakersfield and Kern County, CA

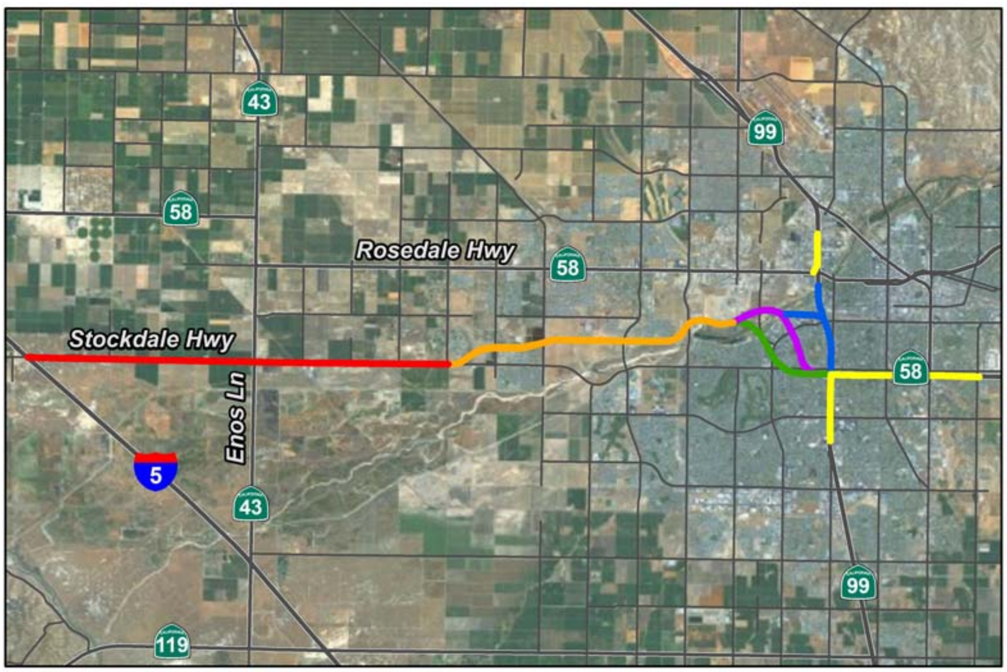
District 06 - KER – 58 - PM T31.7 to PM R55.6

District 06 - KER – 99 - PM 21.2 to PM 26.2

Project ID # 06-0000-0484

SCH #2008091102

Extended Phase I Geoarchaeological Report: Stage I Geomorphic Sensitivity Model



November 2012
(Revised March 2014)

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Extended Phase I Geoarchaeological Report: Stage I Geomorphic Sensitivity Model

State Route 99 to Interstate 5

CITY OF BAKERSFIELD AND KERN COUNTY, CALIFORNIA
District 06-KER-58–PM T31.7 to PM 55.6
District 06-KER-99–PM 21.2 to PM 26.2
Project ID # 06-0000-0484
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November 2012

STATE OF CALIFORNIA

Department of Transportation

U.S. Geological Survey Oildale, Gosford, and Lamont 7.5-minute topographic quadrangles (1:24,000 scale)

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Summary of Findings

The Centennial Corridor Project is along the Kern River in the city of Bakersfield in the southeastern corner of the San Joaquin Valley. The objectives of this stage of the Extended Phase I study were to define the spatial distribution of late Quaternary landforms within the study area from existing soil and geologic data sources and to expand the existing regional buried-site model. The study revealed the presence of four distinct late Quaternary surfaces on the Kern River alluvial fan identified as follows (from oldest to youngest):

- Qa3: Upper Modesto (latest Plesitocene) fan alluvium capped with late Holocene deposits
- Qa2: Post Modesto II (late Holocene) fan terrace
- Qa1: Post Modesto III (latest Holocene) fan terrace along the modern channel of the Kern River
- Qa0: Post Modesto IV modern channel and bar deposits of the Kern River.

The Qa3 surface is underlain by a thin cap of late Holocene alluvium dating to less than 3000 years B.P. that was deposited on top of a latest Pleistocene soil dating to 11,000 years B.P. The Qa3 surface has a high potential for buried archaeological resources within 2–3 meters of the modern surface.

The Qa2 surface is underlain by up to 10 meters of early–late Holocene alluvium, with buried soils dating to 9000–2000 years B.P. The Qa2 surface is considered to be less than 1,200 years old. Several late Holocene Qa2 channels were identified from historical aerial photographs on the Qa2 surface. These represent known prehistoric water sources. The areas adjacent to these channels have a high potential for buried intact cultural resources.

The Qa1 surface is inset (incised) into the Qa2 surface and is therefore younger. Regional radiocarbon dates indicate that this surface is underlain by alluvium less than 1,000 years in age, most likely dating to less than 500 years B.P. Because prehistoric sites on its surface have been identified on the Qa1 adjacent to the Kern River, this portion of the Qa1 surface is considered to have a very high potential for buried archaeological resources.

The Qa0 surface is underlain primarily by recent (historical-period) channel alluvium and has a low potential for containing intact buried cultural resources.

Areas of extensive historical-period disturbance mapped as urban land in the Kern County soil survey are considered to have a moderate potential for intact buried archaeological resources. The upper few meters of natural strata are likely disturbed, and any intact cultural resources will be in a secondary context.

Prehistoric sites on the modern surface across the entire study area are very likely less than 1000 years B.P. in age. Evaluation of known sites within and near the study suggests site density increases toward the modern channel for the Kern River.

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List of Abbreviated Terms

B.P.	Radiocarbon years before present, with present being the year 1950.
cal years B.P.	Calendar years before present
Caltrans	California Department of Transportation
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
I-5	Interstate 5
ka	Thousand years ago
mya	Million years ago
PQS	Professional Qualified Staff
RPA	Register of Professional Archaeologists
SRI	Statistical Research, Inc.
XPI	Extended Phase I

Section 1 Introduction

The California Department of Transportation (Caltrans) proposes to establish a new alignment for State Route 58, which would provide a continuous route along State Route 58 from Cottonwood Road (post mile R55.6) on existing State Route 58, east of State Route 99 to Interstate 5 (I-5) (post mile T31.7). Improvements to State Route 99 (post miles 21.2 to 26.2) would also be made to accommodate the connection with State Route 58.

The project is located at the southern end of the San Joaquin Valley in the City of Bakersfield in Kern County, California. The study site is bound on the east by Cottonwood Road, on the west by I-5, on the north by Gilmore Avenue, and on the south by Wilson Road. Caltrans is the lead agency for the project pursuant to the California Environmental Quality Act and the National Environmental Policy Act.

The proposed continuous route, known as the Centennial Corridor, has been divided into three segments, as shown in Figure 1-1.

Segment 1 is the easternmost segment, which would connect the Westside Parkway to the existing State Route 58 (East) freeway. Multiple alignment alternatives are being evaluated for this segment and are discussed below.

Segment 2 is composed of the Westside Parkway and extends from Truxtun Avenue to Heath Road. This roadway is a local facility that would be transferred into the State Highway System. The analysis evaluates potential impacts associated with improvements to the Westside Parkway from Truxtun Avenue to the Calloway Drive interchange which would be made to accommodate additional traffic from Centennial Corridor connecting to the Westside Parkway.

Segment 3 extends from Heath Road to I-5. This segment will need a temporary route adoption for the use of Stockdale Highway between Heath Road and I-5 as an interim alignment for State Route 58. A future new alignment (ultimate) as identified in the 2002 *Route 58 Route Adoption Project Tier I Environmental Impact Statement/Environmental Impact Report* (EIS/EIR) will be constructed when there is greater traffic demand and funding is available. Since traffic would use Stockdale Highway between Heath Road and I-5 on an interim basis, the potential impacts will also be evaluated for the interim use of Stockdale Highway. Improvements to the Stockdale Highway/State Route 43 (known locally as Enos Lane) intersection would be made to accommodate the additional traffic..

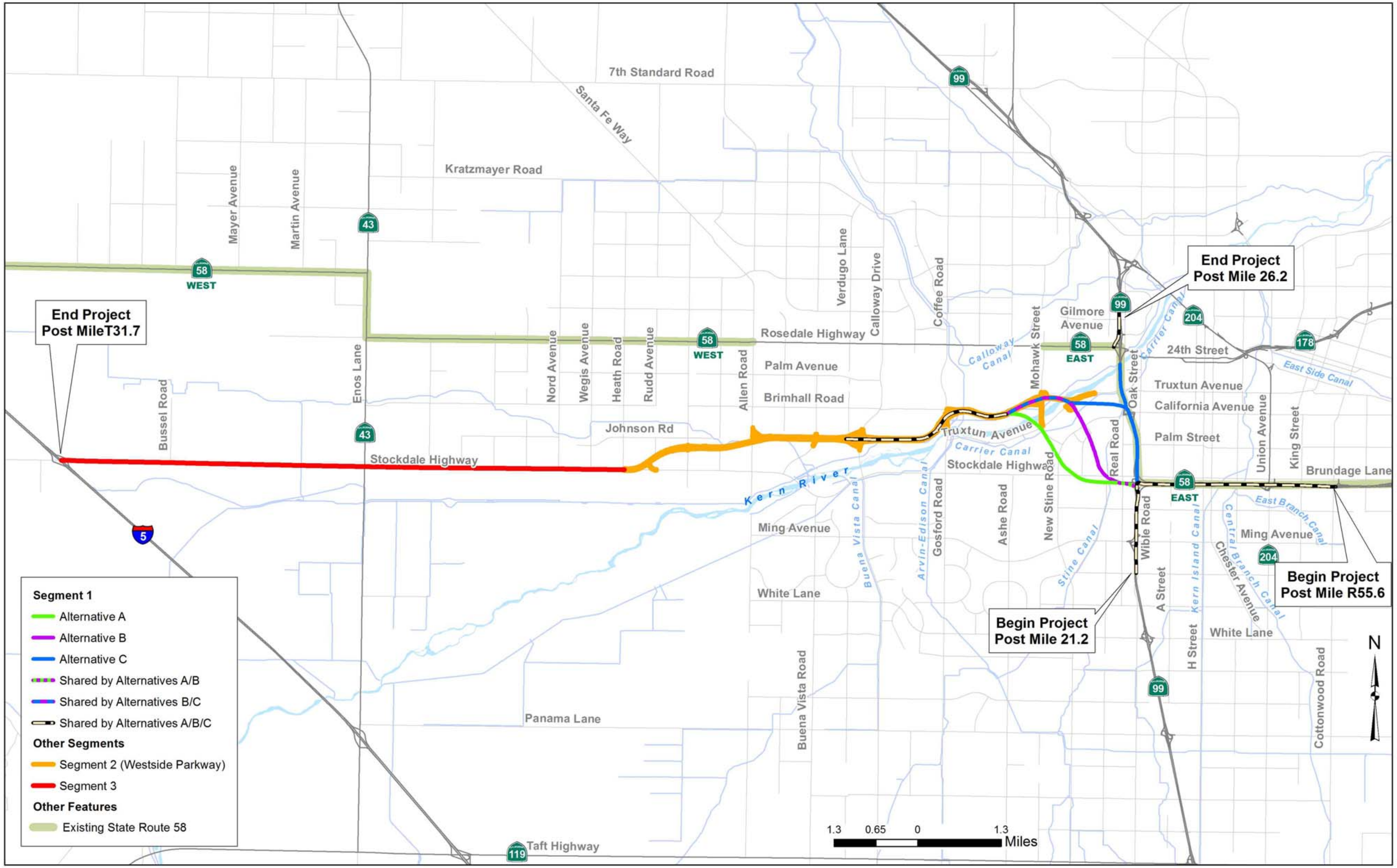

Figure 1-1 Segments of the Centennial Corridor

This technical study focuses on Segment 1. The improvements in Segment 2 are limited to improvements within the Westside Parkway right-of-way--an area previously disturbed for the construction of the Westside Parkway. The improvements in Segment 3 are limited to minor intersection improvements and the depth of construction would be limited to five feet or less.

1.1 PURPOSE AND NEED

The purpose of the Centennial Corridor project is to provide route continuity and associated traffic congestion relief along State Route 58 within Metropolitan Bakersfield and Kern County from the State Route 58 east (from Cottonwood Road) to Interstate 5.

State Route 58 is a critical link in the state transportation network that is used by interstate travelers, commuters, and a large number of trucks. Under existing conditions, State Route 58 does not meet the capacity needs of the area, and this is expected to get worse as the population grows. State Route 58 lacks continuity in central Bakersfield, which results in severe traffic congestion and reduced levels of service on adjoining highways and local streets. This route is offset by about 1 mile at State Route 43 and by about 2 miles at State Route 99. The merging of two major state routes (58 and 99) into one alignment between the eastern and western legs of State Route 58 degrades the traffic level of service on this segment of freeway. In addition, State Route 99's close spacing for its two interchanges with State Route 58 (East and West), in addition to an interchange at California Avenue, results in vehicles aggressively changing lanes, which adds to the congestion.

1.2 PROJECT DESCRIPTION

The project alternatives include three build alternatives and a No-Build Alternative.

1.2.1 No-Build Alternative

No construction of Segment 1 would occur under the No-Build Alternative. In addition no improvements to the Westside Parkway from Truxtun Avenue to the Calloway Drive interchange would be required. There would also be no improvements made to the Stockdale Highway/State Route 43 intersection. The No-Build Alternative would involve the following actions: (1) the Westside Parkway would be route adopted into the State Highway System; (2) the portion of Mohawk Street from the Westside Parkway to Rosedale Highway would be designated as part of State Route 58, which would provide a connection to State Route 99; (3) Stockdale Highway between Heath Road and Interstate 5 would serve as an interim alignment for State Route 58 until ultimate improvements are constructed; and (4) the portion of State Route 58 (West) from Allen Road to Interstate 5 would be relinquished) to the local jurisdictions as a local facility.

1.2.2 Build Alternatives

As shown in Figure 1-2, the three build alternatives (Alternatives A, B, and C) within Segment 1 propose new alignments that would extend from Cottonwood Road on the existing State Route 58 (East) and connect to I-5 via the Westside Parkway. Alternatives A and B would be west of State Route 99, and Alternative C would parallel State Route 99 to the west. Under Alternative A, the eastern end of the Westside Parkway mainline would be realigned to conform to the Alternative A alignment, and ramp connections would be provided to the Mohawk Street interchange. Under Alternatives B and C, the alignments would connect to the Westside Parkway by extending the mainline lanes built as part of the Westside Parkway project. Detailed descriptions of the alternatives are provided on the following subsections.

1.2.2.1 Common Design Features of the Build Alternatives

The build alternatives would connect State Route 58 (East) to the east end of Westside Parkway by means of a six-lane freeway. All the build alternatives would involve a route adoption to include the selected Segment 1 alignment and the Westside Parkway into the State Highway System as State Route 58. In Segment 3, there would be a temporary route adoption of Stockdale Highway as the interim State Route 58 connection to Interstate 5 until the ultimate alignment (the Cross Valley Canal alignment addressed in the 2001 EIS/EIR) is constructed, which would occur at a later date. Though the alignment and design characteristics vary by alternative, the three build alternatives have the following common design features:

Segment 1

All the alternatives would provide the following connections between State Route 58 and State Route 99 using high speed connection ramps:

- Northbound State Route 99 to westbound Centennial Corridor
- Northbound State Route 99 to eastbound State Route 58 (East)
- Southbound State Route 99 to eastbound State Route 58 (East)
- Eastbound Centennial Corridor to southbound State Route 99
- Westbound State Route 58 (East) to southbound and northbound State Route 99.

Direct connector ramps from southbound State Route 99 to westbound State Route 58 are not being provided as part of this project. However, to accommodate this movement, the southbound State Route 99/Rosedale Highway off-ramp would have two lanes off the freeway and widen to four lanes at the intersection with Rosedale Highway. Additionally, an auxiliary lane would be provided on State Route 99 from south of Gilmore Avenue to the State Route 58 (Rosedale Highway) off-ramp. Direct connector ramps from eastbound State Route 58 to northbound State Route 99 are not being provided as part of this project.

The project would require the widening of the South P Street Undercrossing and the westbound State Route 58 Grade Separation over State Route 99. In addition, the Stockdale Highway off-ramp from southbound State Route 99 and the Wible Road on- and off-ramps on State Route 99, located just south of the existing State Route 58/State Route 99 interchange, would be removed.

Segment 2

The Westside Parkway would be incorporated into the State Highway System with each of the Build Alternatives. Improvements to connect Centennial Corridor to the Westside Parkway would extend from where each build alternative connects at the eastern end of the Westside Parkway towards the west, ending at the Calloway Drive interchange. The proposed improvements would widen the Westside Parkway by constructing one additional lane in the median to provide auxiliary lanes. In the westbound direction, the median widening would extend from east of the Friant-Kern Canal through the Calloway Drive interchange. The limits of the added lane in the eastbound direction would differ between each alternative, as described in the Unique Design Features of the Build Alternatives section below. With each build alternative, modifications to the westbound diamond off-ramp to Calloway Drive and the eastbound loop on-ramp from Coffee Drive would be required.

Though the improvements described above are physically located in Segment 2, construction would be undertaken as part of Segment 1 construction to facilitate traffic operations between the Westside Parkway and the Centennial Corridor.

Segment 3

With each build alternative, improvements would be required at the Stockdale Highway and State Route 43 intersection. The proposed improvements would widen the intersection and add signals to control the traffic movements. State Route 43 would be widened to add a dedicated left-turn lane in both directions. Stockdale Highway would be widened to add a dedicated left-turn lane and a shared through/right-turn lane in both directions. Though physically located in Segment 3, these improvements would be built as part of Segment 1 to ensure adequate traffic operations at this intersection.

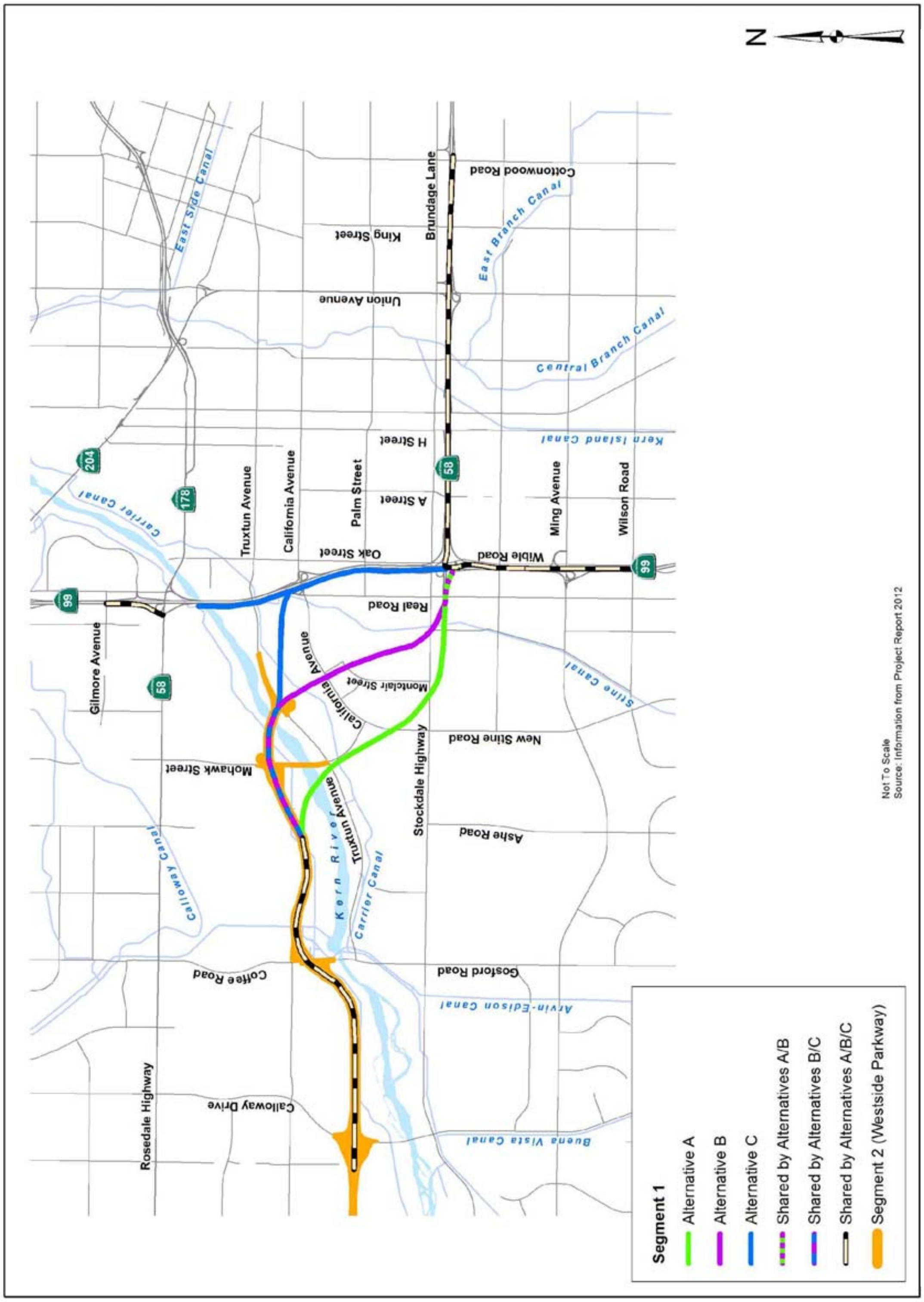

Figure 1-2 Segment 1 of Centennial Corridor

1.2.2.2 Unique Design Features of the Build Alternatives

Alternative A

Alternative A would travel westerly from the existing State Route 58/State Route 99 interchange for about 1 mile, south of Stockdale Highway, where it would turn northwesterly and span Stockdale Highway/Montclair Street, California Avenue/Lennox Avenue, Truxtun Avenue, and the Kern River before joining the eastern end of the Westside Parkway near the Mohawk Street interchange.

A link would be provided from northbound State Route 99 to westbound State Route 58 and from eastbound State Route 58 to southbound State Route 99 via high-speed connectors. No direct connector ramps would be built from southbound State Route 99 to westbound State Route 58 or from eastbound State Route 58 to northbound State Route 99. Southbound State Route 99 would be widened to accommodate the additional traffic from eastbound State Route 58 to the southbound State Route 99 connector. The existing westbound State Route 58 to southbound State Route 99 loop-ramp connector would be realigned and would connect to the proposed eastbound State Route 58 to southbound State Route 99 connector before merging onto southbound State Route 99. The existing southbound State Route 99 to eastbound State Route 58 connector and northbound State Route 99 to eastbound State Route 58 would be preserved with some changes.

The limits of widening on State Route 99 would extend to the Wilson Road overcrossing. On northbound State Route 99, a three-lane exit would be provided just north of Wilson Road to carry the northbound State Route 99 to westbound State Route 58 traffic on two lanes and the Ming Avenue on- and off-ramp traffic on the third lane. All ramps in this area would have to be realigned to provide for the additional lanes. The Wible Road on- and off-ramps just south of the existing State Route 58/State Route 99 interchange, which is in conflict with the Caltrans standards of interchange spacing, would have to be removed to accommodate this design. The Stockdale Avenue off-ramp on the southbound State Route 99 to eastbound State Route 58 connector would be removed as well. Under this concept, the State Route 58 would also lose its link with Real Road. Also, Alternative A would provide an auxiliary lane on State Route 99 from south of Gilmore Avenue to the Rosedale Highway off-ramp.

The median widening to provide an auxiliary lane along the Westside Parkway would extend in the eastbound direction from the Coffee Road off-ramp to the connection with Centennial Corridor between Coffee Road and Mohawk Street.

Other features with this alternative include 1) the construction of 19 soundwalls; 2) the construction of a park and ride facility off Mohawk Street, between California Avenue and

Truxtun Avenue, to replace the facility that would be displaced by the project; 3) 7 infiltration basins, which would be placed throughout the study area to retain stormwater runoff for water quality improvement purposes; and 4) 48 retaining walls of varying sizes located throughout the study area.

Excavation and grading would be required as part of the project construction. The maximum depth of excavation for Alternative A would be between 25 and 40 feet. Alternative A would disturb about 1,125 acres of soil from grading activities. A total of about 944,000 cubic yards of existing soils would be graded. In addition, about 1,700,000 cubic yards of soil would be imported as fill for the roadway.

Alternative B

Alternative B would run westerly from the existing State Route 58/State Route 99 interchange for about 1,000 feet, south of Stockdale Highway, where it would turn northwesterly and go over Stockdale Highway/Stine Road, California Avenue, Commerce Drive, Truxtun Avenue, and the Kern River before joining the east end of Westside Parkway between the Mohawk Street and Coffee Road interchanges. This alignment would depress State Route 58 between California Avenue and Ford Avenue, minimizing visual impacts to the neighborhood. Overcrossings are proposed at Marella Way and La Mirada Drive to ease traffic circulation.

Alternative B proposes the same connections to State Route 99 that Alternative A does and would require similar improvements on State Route 99 and existing State Route 58.

The median widening to provide an auxiliary lane along the Westside Parkway would extend in the eastbound direction from the Coffee Road off-ramp to the connection with Centennial Corridor at Truxtun Avenue. Modifications would be required to the eastbound Mohawk Street off-ramp, westbound Truxtun Avenue on-ramp, and the eastbound Mohawk Street loop on-ramp. In addition, construction of the proposed westbound Mohawk Street off-ramp and realignment of the Cross Valley Canal maintenance access road from Mohawk Street would be required.

Other features with this alternative include 1) the construction of 24 soundwalls; 2) the construction of a park and ride facility north of California Avenue, next to the Centennial Corridor, to replace the facility that would be displaced by the project; 3) 8 infiltration basins that would be placed throughout the study area to retain stormwater runoff for water quality improvement purposes; and 4) 42 retaining walls of varying sizes located throughout the study area.

The maximum depth of excavation for Alternative B would be between 25 and 40 feet. Alternative B would disturb about 1,020 acres of soil from grading activities. A total of about 942,000 cubic yards of existing soils would be graded. In addition, about 1,078,000 cubic yards of soil would be imported to fill in the roadway.

Alternative C

Near the existing State Route 58/State Route 99 interchange, Alternative C would turn north and run parallel to the west of State Route 99 for about 1 mile. The freeway would turn west and span the BNSF Railway rail yard, Truxtun Avenue, and the Kern River. This alternative proposes undercrossings at Brundage Lane, Oak Street, State Route 99, Palm Avenue, and California Avenue.

Connections would be provided from eastbound State Route 58 to southbound State Route 99 and from northbound State Route 99 to westbound State Route 58. The existing westbound State Route 58 to southbound State Route 99 loop-ramp connector would connect to the proposed eastbound State Route 58 to southbound State Route 99 connector before merging onto southbound State Route 99. The southbound State Route 99 Ming Avenue off-ramp would be relocated north of the eastbound State Route 58 to southbound State Route 99 connector to facilitate weaving between the Ming Avenue off-ramp and the eastbound State Route 58 to southbound State Route 99 connector traffic. A connector would be provided east of northbound State Route 99 from Brundage Lane to south of California Avenue to facilitate weaving between westbound State Route 58 to northbound State Route 99 traffic with northbound State Route 99 to westbound State Route 58 traffic.

Improvements on State Route 99 would extend from the Wilson Road overcrossing (south of the State Route 58/State Route 99 interchange) to the Gilmore Avenue overcrossing (north of the State Route 58/State Route 99 interchange). A collector-distributor (C-D) road system would provide access from westbound State Route 58 to northbound State Route 99 as well as from northbound State Route 99 to westbound State Route 58. The Wible Road on- and off-ramps just south of the existing State Route 58/State Route 99 interchange would have to be removed to accommodate the northbound State Route 99 auxiliary lane. The Stockdale Avenue off-ramp on the southbound State Route 99 to eastbound State Route 58 connector would be removed as well. Under this concept, southbound State Route 99 would also lose its link with Real Road.

The median widening to provide an auxiliary lane along Westside Parkway would extend in the eastbound direction from the Coffee Road off-ramp to the connection with Centennial Corridor at Truxtun Avenue. Modifications would be required to the eastbound Mohawk

Street off-ramp, westbound Truxtun Avenue on-ramp, and the eastbound Mohawk Street loop on-ramp. In addition, construction of the proposed westbound Mohawk Street off-ramp and realignment of the Cross Valley Canal maintenance access road from Mohawk Street would be required.

Other features with this alternative include (1) the construction of 17 soundwalls; (2) the construction of a park and ride facility Real Road and Chester Lane to replace the facility that would be displaced by the project; (3) 11 infiltration basins that would be placed throughout the study area to retain stormwater runoff for water quality improvement purposes; and (4) 42 retaining walls of varying sizes located throughout the study area.

The maximum depth of excavation for Alternative C is between 25 and 40 feet. Alternative C would disturb about 1,124 acres of soil from grading activities. A total of about 1,150,000 cubic yards of existing soils would be graded. In addition, about 750,000 cubic yards of soil would be imported to fill in the roadway.

1.3 Geomorphic Sensitivity Model

This report presents the findings of a geoarchaeological assessment conducted for the Centennial Corridor Project in Bakersfield, Kern County, California, under contract with BonTerra Consulting. This study was completed in accordance with requirements specified in Chapter 5 (Subsections 5.5.1–5.5.6) of the Caltrans Environmental Handbook on Cultural Resources. Section 5.5 notes that the Extended Phase I (XPI) study is an extension of the identification phase, meeting the requirements of Title 36, Section 800.4(b), of the Code of Federal Regulations; Stipulation VIII B of the Section 106 Programmatic Agreement that governs Caltrans's cultural resource actions on federally assisted state and local projects; and similar requirements under the California Environmental Quality Act.

The Caltrans handbook lists five reasons to conduct an Extended Phase I study. Number five says a geoarchaeological study is designed "to search for archaeological deposits (as an extension of the survey effort) in areas of high sensitivity where such deposits may be buried, or obscured by sediment deposition, vegetation, or landscaping or other modern development." The primary objectives of this Extended Phase I study are (1) to help the project proponent select a preferred alternative route by developing an archaeological sensitivity model for buried cultural resources; (2) conduct a limited search for buried archaeological sites in areas deemed to be of high sensitivity; and (3) evaluate the potential for buried cultural deposits in areas of high archaeological sensitivity.

The development of the geomorphic sensitivity model is divided into two stages. Stage I (the focus of this report) involves assessing the vertical area of potential effects by conducting a geomorphic evaluation of specific areas along the planned and alternate routes, which entails the review of existing geologic maps, the regional District 6/9 geoarchaeological overview, soil-survey reports, records-search results, and other relevant data sources. This approach enables us to identify areas within the study area that possess low, moderate, high, and very high archaeological sensitivity.

Stage II will begin once a preferred alternative route has been selected and will focus on subsurface testing, as necessary, to refine and field check the preliminary buried-site sensitivity model and to further assess the archaeological sensitivity model. Statistical Research, Inc. will submit a second Extended Phase I proposal for the anticipated future Stage II work after the preferred alternative is selected.

1.4 Key Personnel

The key personnel involved in the project include Kenneth M. Becker, Jeffrey A. Homburg, and Jason D. Windingstad. All three participants meet the Secretary of the Interior's Professional Qualifications Standards for the relevant field of study. Mr. Becker and Dr. Homburg meet Caltrans Professional Qualified Staff (PQS) standards for Principal Investigator for Prehistoric Archaeology, and Mr. Windingstad meets Caltrans PQS standards for Co-Principal Investigator for Prehistoric Archaeology.

1.4.1 Kenneth M. Becker, M.A., RPA, Project Manager and Principal Investigator

Mr. Becker is a principal investigator and regional marketing director at Statistical Research, Inc.'s Redlands, California, office. In that capacity, he oversees projects in southern and central California and the Great Basin and frequently serves as project manager for a variety of projects. He earned his B.A. degree in anthropology from California State University, Los Angeles, in 1988 and his M.A. degree from that same institution in 2000. Mr. Becker has more than 20 years of experience throughout California, the Great Basin, and the Southwest and has conducted survey, evaluation, and data recovery excavation throughout these regions. Mr. Becker has a strong interest in cultural landscape archaeology as it pertains to prehistoric trade and trails and is the senior author of "Path Finding: The Archaeology of Trails and Trail Systems" (Becker 2008). His other research interests include lithic analysis, invertebrate-faunal analysis, coastal and island archaeology, and historical archaeology. In 2003, he directed data recovery excavation at Dove Cemetery (CA-SLO-1892H), a pioneer cemetery in Atascadero, California. From 2001 to 2003, Mr. Becker served as project director for Extended Phase I and Phase II excavations at CA-MER-381/H and CA-MER-383 for the Caltrans

Merced Freeway Conversion project in District 10. He currently serves as project manager for an inventory of nearly 1,000 miles of conventional rural highways for Caltrans District 8 in San Bernardino and Riverside counties. Mr. Becker is a Registered Professional Archaeologist (No. 15559) and has served two terms as a nominating-committee member of that organization. He is an active member of the Society for American Archaeology, the Society for California Archaeology, and the Society for Industrial Archaeology.

1.4.2 Jeffrey A. Homburg, Ph.D., RPA, Geoarchaeology Principal Investigator

Dr. Homburg has over 30 years of experience in cultural resource management and geoarchaeology. He will serve as principal investigator for the project and will oversee the work of the project director. Since 1978 Dr. Homburg has worked on more than 130 cultural resource management projects (59 data recovery projects, 50 survey projects, and 21 other archaeological and soil science projects) in the U.S. West, Southwest, Southeast, Great Basin, and Northeast. He has worked for Statistical Research, Inc. since 1988 and has performed dozens of geoarchaeological studies in California, the U.S. Southwest, Great Basin, Northwest Mexico, East and West Africa, and Mongolia. Dr. Homburg earned a Ph.D. in soil science from Iowa State University in 2000, specializing in pedology; an M.A. in anthropology from Louisiana State University in 1991, specializing in geoarchaeology; and a B.A. in anthropology from the University of Oklahoma in 1979, specializing in archaeology and cultural anthropology.

His areas of interest and expertise are in geoarchaeology, soil geomorphology, landscape reconstruction, and ancient and traditional agriculture, focusing on coastal and arid environments of North America and Africa. Dr. Homburg has authored or coauthored 20 refereed journal articles and peer-reviewed book chapters, 10 archaeological monographs, and over 100 peer-reviewed reports and other papers. He has made over 90 presentations at professional meetings, such as those of the Society for American Archaeology, Soil Science Society of America, European Association of Archaeologists, and Society of Africanist Archaeologists. He has served as the director of SRI’s Paleoenvironmental and Geosciences Department since 2000. In addition to his role at SRI, Dr. Homburg is an adjunct professor in the Department of Anthropology at the University of Arizona. He is a Registered Professional Archaeologist (No. 10586) and is a member of the Society for American Archaeology, the Society for Archaeological Sciences, the Soil Science Society of America, the Association for the Advancement of Science, and various state and regional organizations.

1.4.3 Jason D. Windingstad, M.S., Geoarchaeology Project Director

Mr. Windingstad earned a B.S. degree in geology and environmental science from Southwest Minnesota State in 2002 and an M.S. in pedology, with an emphasis in geoarchaeology, from the University of Tennessee in 2005. Mr. Windingstad's primary research interests are soil geomorphology, soil genesis, late Quaternary paleoenvironments, and anthropogenic influences on soil properties. Since 2005, he has conducted geoarchaeological and archaeological research in cultural resource management and academic settings across the U.S. West, Southwest, Northeast, Midwest, and Southwest and in Eastern Europe. Since beginning work at SRI in August of 2008, he has worked on over a dozen projects in Arizona, California, New Mexico, and Texas. These studies focused on producing buried-site predictive models, modeling landscape evolution, and interpreting site-specific formation processes on the archaeological record.

He is particularly skilled in field interpretation and laboratory analysis of soil and sediment in archaeological contexts. His research has recently been published in the *Journal of Archaeological Science* and *American Antiquity*. Mr. Windingstad has recently completed geoarchaeological assessments and landscape reconstructions for large data recovery projects, including the Joint Courts Complex in Tucson, Arizona (for Pima County); Christiansen Border Village, between Douglas and Naco, Arizona (for the U.S. Army Corps of Engineers); U.S. 60 from Florence Junction to Superior, Arizona (for the Arizona Department of Transportation); and on Fort Bliss in Texas and New Mexico. He has also constructed geomorphic predictive models based on subsurface testing and laboratory analysis of soil/sediment samples for the Lake Success Dam Seismic Remediation Project near Porterville, California (for the U.S. Army Corps of Engineers), and the Kuebler Ranch prehistoric site east of San Diego, California.

Section 2 Environmental Context

2.1 Physiography

The city of Bakersfield is in the far-southeastern corner of the Great Valley of California, a 700-kilometer-long (435-mile-long) and up-to-100-kilometer-wide (62-mile-wide) plain between the Sierra Nevada on the east and the coast ranges to the west (Bartow 1991). The Stockton Arch and associated fault near the city of Stockton divides the Great Valley into two major subbasins: the Sacramento Valley, drained by the south-flowing Sacramento River, to the north and the San Joaquin Basin, drained by the north-flowing San Joaquin River, to the south (Figure 2-1). These drainages merge near Stockton to form the Sacramento–San Joaquin Delta that drains west into San Francisco Bay. The San Joaquin Valley is further subdivided into four subbasins, the internally drained Tulare, Buena Vista, and Kern Lake basins and the externally drained northern San Joaquin Basin north of the Kings River fan. In the far-southern extent of the San Joaquin Valley, the Bakersfield Arch forms a small basin, the Maricopa-Tejon subbasin. Here, the Kern River, the only major south-flowing river to drain the Sierra Nevada, drained into Buena Vista, Tulare, and Kern lakes in prehistory. Those lake beds are now dry, but they formed extensive lakes during the late Pleistocene and periodically over the Holocene (Culleton 2006; Negrini 2006).

The Kern River heads in Sequoia National Park and drains approximately 5,698 square kilometers (2,200 square miles) in the southern quarter of the Sierra Nevada range (Webb 1946). The upper Kern River watershed is on the western slopes of Mount Whitney and flows south 97 kilometers (60 miles) to the confluence with its main tributary, the South Fork. Downstream from Isabella Reservoir, the Kern River turns to the southwest and flows another 95 kilometers (59 miles) to Bakersfield and the Maricopa-Tejon subbasin of the San Joaquin Valley. Elevations in the watershed upstream of Bakersfield range from 137 meters (450 feet) to 4,570 meters (14,995 feet) above mean sea level at the summit of Mount Whitney. Isabella Reservoir now controls approximately 85 percent of the watershed above Bakersfield (Dean 1971). During the Tioga Glaciation (beginning about 26 thousand years ago [ka]) the upper Kern River basin was extensively glaciated; the Kern Glacier extended to within 1.6 kilometers (1 mile) of Golden Trout Creek, or about 130 kilometers (80 miles) upstream of Bakersfield (Fryxell 1965).

Where the Kern River enters the San Joaquin Valley in the vicinity of Bakersfield, it exits from its deeply incised canyon to form the Kern River alluvial fan. The current apex of the Kern River alluvial fan is between Oildale and Bakersfield where it forms a 110° arc extending to the west-southwest for approximately 32 kilometers (20 miles) (Dale 1966). The fan is bound to the north by the Poso Creek fan and to the south-southeast by the Caliente Creek fan. The Kern River fan maintains a constant gradient of 0.13 percent (about 1.3 meters per kilometer [7 feet per mile])

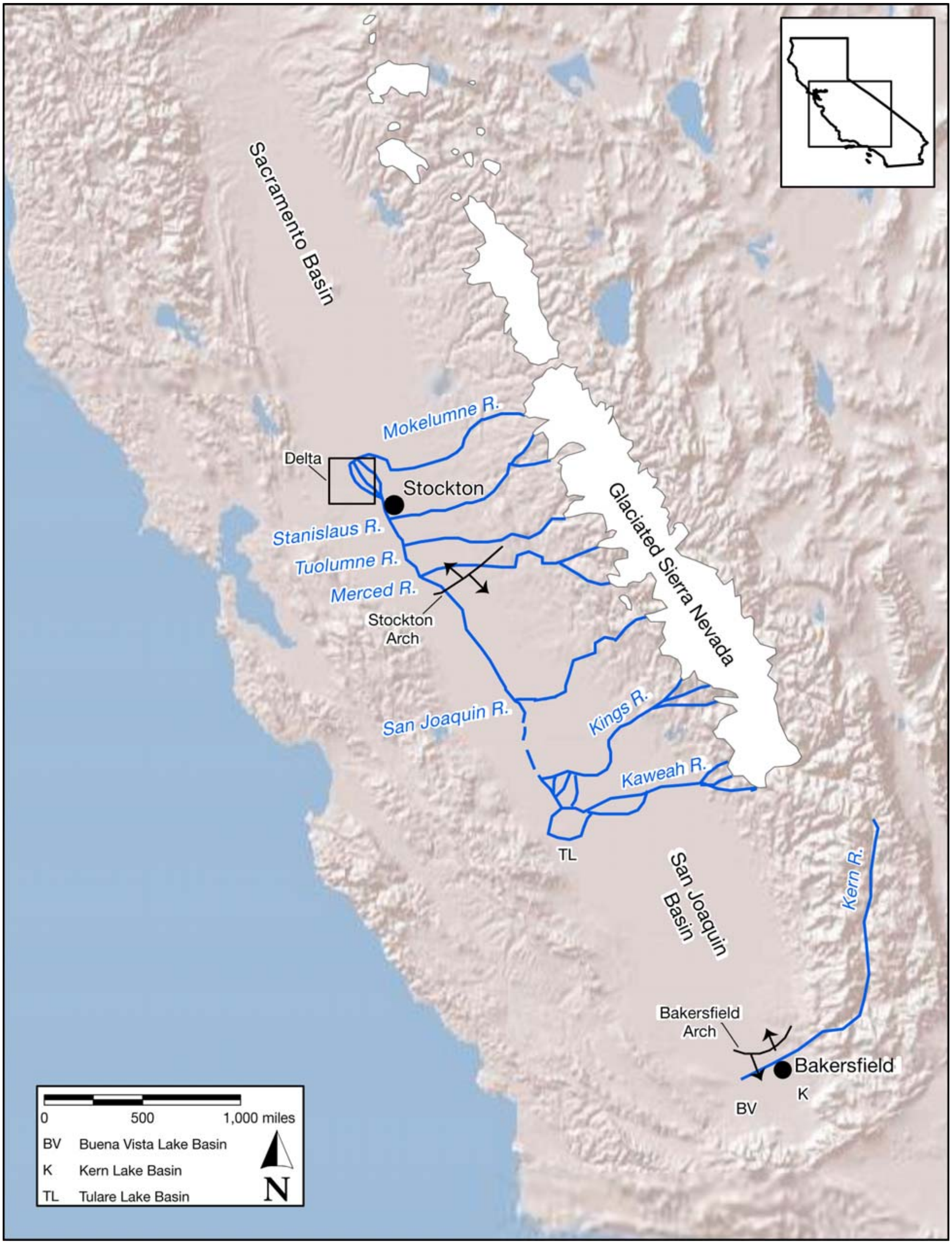

Figure 2-1 Map of the San Joaquin Valley

from the fan apex to the toe at Buena Vista and Kern Lakes. The geomorphic history of the Kern River fan will be reviewed in detail in the Results section of this report.

2.2 Soil-Landform Correlations and Soil Age

The region surrounding Bakersfield includes three main geologic provinces. From east to west, these provinces are (1) the granitic bedrock of the Sierra Nevada Batholith, (2) the marine and nonmarine sedimentary rock of the Dissected Uplands between the Sierra Nevada Mountain Range and the San Joaquin Valley, and (3) the unconsolidated Quaternary alluvial deposits of the Kern River fan (Figure 2-2). Because the potential for buried sites is tied to landform age, the following section correlates geologic mapping data with the Kern County soil survey in order to better constrain the age of landforms in the study area based on soil development. Radiocarbon dates from individual soil series provided by the Geoarchaeological Overview of Districts 6 and 9 are used to refine soil age relationships when possible (Meyer 2010) (Table 2-1).

Unfortunately, significant ambiguity exists concerning soil age relationships in the region, particularly between Modesto and Post Modesto fan deposits. As stated by Meyer (2010:53) in the District 6 and 9 geoarchaeological overview, the inappropriate use of soil age relationships in many previous studies has blurred our understanding of late Pleistocene (Modesto) and Holocene deposits/landforms. This is related both to the widespread assumption that major depositional events on central valley alluvial fans were contemporaneous with major glacial outwash cycles and that Post Modesto soils are always poorly developed in comparison to Modesto soils (Meyer 2010).

Recent work across California, however, has shown that many alluvial and colluvial deposits are contemporaneous across both glaciated and nonglaciated drainages/landforms and generally not “in phase” with glacial outwash cycles (Lettis 1982; Meyer 2008; Meyer 2010). Furthermore, many landforms previously mapped as Modesto in age are actually mantled with relatively thick Post Modesto deposits that indicate widespread sediment transport and deposition was not solely a Pleistocene phenomenon associated with glacial erosion.

Soil formation as a relative age indicator is a widely used technique for dating landforms and reconstructing the evolution of Quaternary landscapes (Birkeland 1999). While a correlation between soil development and landform age often does exist, a lack of absolute dates to provide temporal control within correlated soil stratigraphic sequences, combined with local variability in soil formation processes, often results in inaccurate age assessments. This is particularly true when dealing with soils that are not separated by a significant period of time such as upper Modesto and early Post Modesto soils.

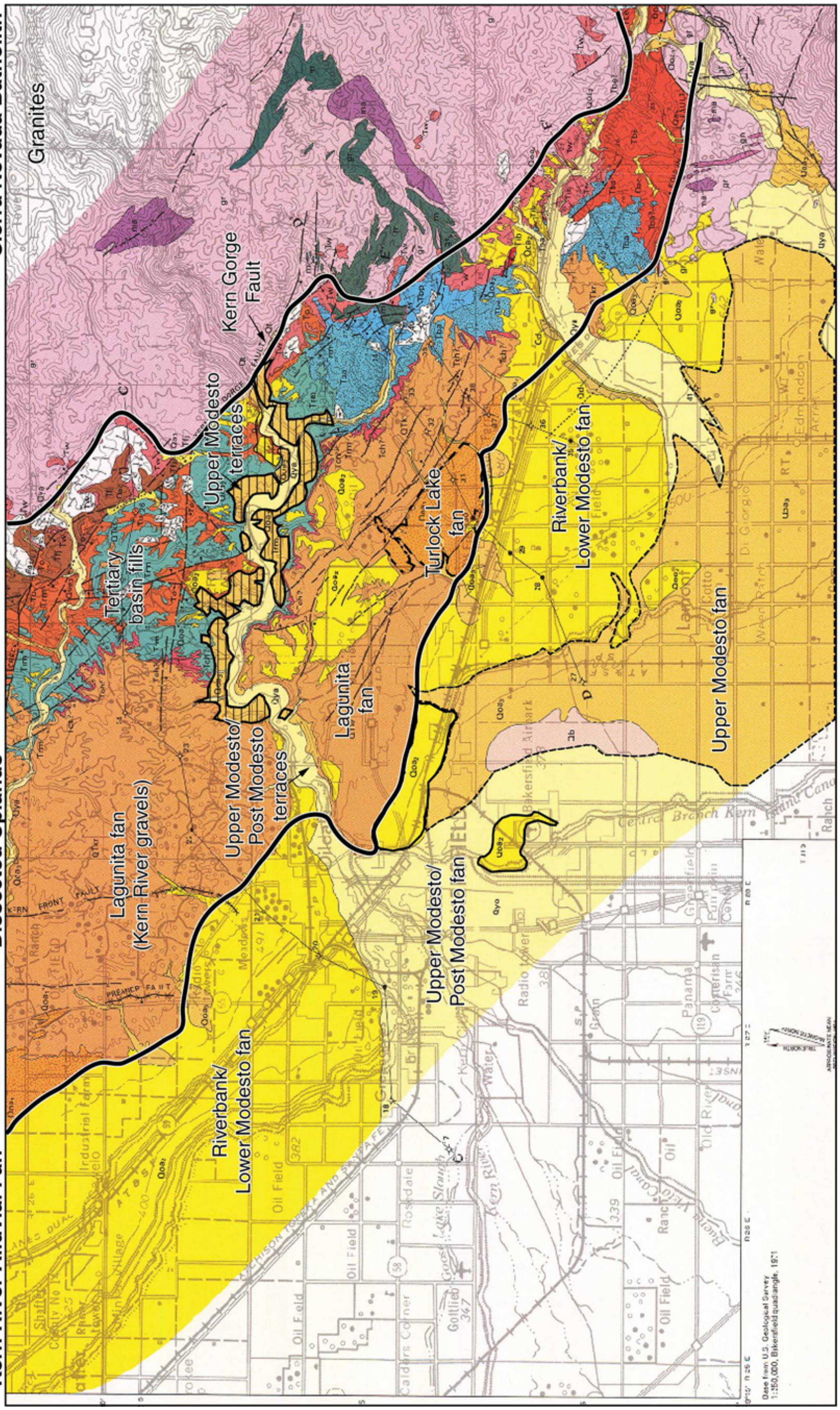

Figure 2-2 Surficial Geology of the Bakersfield Area

Table 2-1 Allostratigraphic Units of the Eastern San Joaquin Valley

Stratigraphic Unit	Approximate Age (years B.P.)	Soils Originally Associated with Unit (bold soil series are located in or near study area)	Revised Soil-Age Associations in Study Area (Meyer 2010)
Post Modesto IV	Modern	Riverwash (Entisol)	
Post Modesto III	1000–150	Tujunga, Hanford, Honcut (Entisols)	Cajon (surface) Panoche (surface)
Post Modesto II	3500–1000	Tujunga, Hanford, Honcut, Arizo (Entisols) **Panoche** (Aridisol)	Cajon (buried) Panoche (buried) Hesperia (surface)
Post Modesto I	8000–3500	Merced, Foster (Mollisols) Tujunga (Entisol)	Hesperia (buried)
upper Modesto	26,000–8000	**Cajon,** Hanford, **Hesperia** (Entisols)	
lower Modesto	40,000	Fresno (Alfisol)	
Riverbank	330,000–130,000	Snelling (Alfisol)	
Turlock Lake	600,000+	Montpellier (Alfisol)	

2.2.1 Sierra Nevada Batholith

East of Bakersfield, the Sierra Nevada consists of a west-tilted granitic batholiths—a massive body of igneous rock that slowly cooled deep below the earth’s surface—with a steep, normal-faulted eastern escarpment that forms the western boundary of Owens Valley and a relatively uniform western slope that grades into the San Joaquin Valley. The modern appearance of the Sierra Nevada is a result of the alteration of early Mesozoic volcanic and sedimentary deposits during the Cretaceous (65–144 million years ago [mya]) as granitic plutons began to form and coalesce into the massive Sierra Nevada Batholith that forms the core of the range today.

During the Eocene (38–54 mya), the batholith was tilted to the west, thereby causing accelerated erosion and rapid infilling of the San Joaquin Valley with alluvial clays and silts (Hill 1975, 2000). During the Oligocene and Miocene epochs (5–38 mya), volcanic eruptions buried much of the northern Sierra Nevada under volcanic mud flows, lava flows, and tuff. Uplift of the Sierra Nevada Batholith to its present elevation began in the Miocene and continues today.

Studies done by Huber (1981) and Wakabayashi (2001) have indicated 1.5–2.5 kilometers of uplift over the past 10 million years, with most of that uplift having occurred during the last 3–5 million years. Uplift occurred as the root beneath the crest of the batholith delaminated—split into thin layers—inciting uplift (Stock 2004) that increased the stream gradients of west-flowing rivers and rapid stream incision from 5 to 2 million years ago, deepened preexisting canyons, and increased local relief in the western foothills of the southern Sierra Nevada (Stock 2004).

The granitic landforms of the Sierra Nevada are mantled with a residual (weathered in place) or colluvial (slope deposits) layer derived from weathered granitic bedrock often referred to as regolith, decomposed granite, or grus. Granitic rock is low in porosity and permeability but is highly susceptible to weathering via orthogonal and sheet fractures (Frazier 2000).

Moisture entering these fractures causes physical and chemical weathering of the rock and the formation of regolith that, if stabilized, forms a residual or colluvial soil mantle (Campbell 1997). Soils developed in this parent material east of Bakersfield are mapped as the Cieneba and Vista soil series (Table 2-2). These soil series have a complex spatial arrangement across the landscape mapped as a soil complex called the Cieneba-Vista-Rock outcrop soil complex (Web Soil Survey 2011). Soils on steep slopes approaching a 60 percent gradient are likely underlain by the Cieneba soil series. This soil is classified as an Entisol (weakly developed soil consisting of basic A–C horizons) with a thin, dark A horizon over weathered granite or regolith. The Vista series is mainly in areas where deposition occurred during the Holocene, such as along the bases of slopes (footslopes). There, A horizons are thicker, and landscape stability has facilitated the formation of Inceptisols (soils with incipient subsurface soil horizons called B horizons). Radiocarbon dates from the Vista soil series in District 6 and 9 range in age from 910 to 200 years B.P. and have an average date of 545 years B.P. (Meyer 2010). This indicates footslope deposition in the Sierra Nevada is a late Holocene phenomenon.

2.2.2 Dissected Uplands

Bordering the Sierra Nevada Batholith to the west and the San Joaquin Valley to the east, a belt of mesas, hills, and cuestas forms an area known as the Dissected Uplands (Dale 1966). These landforms consist of westward-tilted marine and nonmarine San Joaquin Basin fill deposits along ancestral alluvial fans and deltas that date to the Miocene (about 5–24 mya). These strata dip to the west, where they are overlain by late Tertiary and Quaternary alluvial-fan deposits (Bartow 1991). The eastern boundary of the Dissected Uplands is delineated by the prominent Kern Gorge fault scarp (see Figure 2-2).

The Tertiary stratum of the Dissected Uplands has been exposed at the surface for a long time, subjecting it to extensive erosion episodes. Highly erodible silts and fine sands in the marine and lacustrine nonmarine formations have contributed sediment to later generations of Kern River alluvial fans, creating pockets of fine-textured soils. These finer-grained soils stand in marked contrast to the coarse alluvial soils derived from the weathered granites of the Sierra Nevada Batholith. Soils in the Dissected Uplands consist predominantly of the Trigo, Chanac, and Pleito soil series (see Figure 2-2; Table 2-2).

Because these soils form a complex spatial mosaic across the Dissected Uplands, they are mapped as soil complexes. Soils on stable surfaces, such as ridgetops, most likely consist of the Chanac

Table 2-2 Soil Taxonomy and Soil-Landform Correlations of the Three Major Geologic Provinces in the Bakersfield Area

Soil Series	Taxonomy	Allostratigraphic Unit	Age	Landform
Brecken	Typic Argixerolls	Turlock Lake/Riverbank	late Pleistocene	alluvial fan
Cajon	Typic Torripsamments	Post Modesto	late Holocene	proximal Kern River fan
Calflax	Sodic Haplocambids	Post Modesto	late Holocene	distal Kern River fan
Chanac	Calcic Haploxerepts	Post Modesto	Holocene	Dissected Uplands
Cieneba	Typic Xerorthents	Post Modesto	late Holocene	backslopes and slope shoulders, Sierra Nevada Batholith
Cuyama	Xeric Haplargids	Turlock Lake	Pleistocene	Kern River alluvial fan
Delano	Xeric Haplargids	Modesto/Riverbank	late Pleistocene	Kern River alluvial fan
Excelsior	Typic Torrifluvents	Post Modesto	late Holocene	low terrace/floodplain, Kern River
Hesperia	Xeric Torriorthents	Post Modesto	late Holocene	Kern River terrace
Kimberlina	Typic Torriorthents	Post Modesto	late Holocene	Kern River alluvial fan
Panoche	Typic Haplocambids	Post Modesto	late Holocene	medial and distal Kern River fan or alluvium from Dissected Uplands
Pleito	Calcic Pachic Haploxerolls	Post Modesto	Holocene	Dissected Uplands
Riverwash	no soil formation	Post Modesto	late Holocene-historical period	modern Kern River channel and bars
Trigo	Typic Xerorthents	Post Modesto	Holocene	Dissected Uplands
Vista	Typic Haploxerepts	Post Modesto	late Holocene	footslopes, Sierra Nevada Batholith
Wasco	Typic Torriorthents	Post Modesto	late Holocene	proximal Kern River fan
Westhaven	Fluventic Haplocambids	Post Modesto	late Holocene	distal Kern River fan

series, an Inceptisol with weakly developed argillic subsurface horizons. More-recently eroded areas along backslopes or modern channels are mainly underlain by the Trigo series, an Entisol with a thin A horizon over pedogenically unmodified alluvium. Areas along footslopes that periodically receive inputs of eroded sediment from upslope are likely underlain by the Pleito series, a Mollisol with thick, very dark A horizons (Web Soil Survey 2011).

Radiocarbon dates for the common soil series in the Dissected Uplands have not been obtained in District 6 and 9. Soil formation suggests that many of the slope deposits and alluvium along low-order tributaries are Post Modesto in age.

2.2.3 Kern River Alluvial Fan

The Kern River alluvial fan is a low-gradient, westward-sloping, slightly concave wedge of alluvial sediment derived from the granitic uplands of the Sierra Nevada Batholith and the Dissected Uplands. Geologic mapping in the Bakersfield vicinity has identified five generations of latest Tertiary through Quaternary alluvial fans (Bartow 1984) (see Figure 2-2). From oldest to youngest, these include (1) the Kern Gravels of the Laguna Formation, (2) the Turlock Lake fan, (3) the Riverbank fan, (4) a probable Modesto fan, and (5) a Post Modesto fan along the modern Kern River (see Table 2-1). Of particular interest to this study are the Modesto and Post Modesto fan surfaces, because these overlap in time with human occupation of the landscape, typically assumed to be less than 13,000 years B.P.

Correlating soil maps with Bartow's (1984) geologic map of the Kern River fan reveals that the upper Modesto/Post Modesto fan surface (Qya map unit) consists almost entirely of Entisols (weakly developed soils) in the Cajon, Excelsior, Kimberlina, and Wasco soil series (Web Soil Survey 2011) (Figures 2-3 and 2-4; see Figure 2-2 and Table 2-1). The Cajon series is classified as a Torripsamment, a weakly developed soil in relatively coarse-grained, sandy alluvium. The Wasco and the Kimberlina are both Torriorthents, also weakly developed but formed in finer-textured alluvium. Finally, the Excelsior series is a Torrifluvent; it has weak soil development, as with the other three soils, but an irregular decrease in organic carbon with depth (Soil Survey Staff 2010).

Radiocarbon dates from the Cajon soil series in the San Joaquin Valley indicate a late Holocene age (3642–1674 cal B.P.) for deposition, with a surface age range of 1601–272 cal B.P. (Meyer 2010:49, Table 7). Analysis of radiocarbon dates from buried contexts (buried soils and cultural features) in the Cajon series for all of Districts 6 and 9 (excluding lacustrine deposits and caves/rockshelters) range from 12,210 to 670 years B.P. at depths from 10 to 329 centimeters (Table 2-3). Radiocarbon dates from buried soils constitute the older end of the age range. Dates from surface contexts, mostly intrusive cultural features, in the Cajon series range from 4000 to 100 years B.P. and average 900 years B.P. (see Table 2-3).

Radiocarbon dates from buried contexts in the Excelsior series are generally younger than those from the Cajon series (although the sample size is considerably smaller), with a range of 4120–310 years B.P. at depths of 115 to 1,300 centimeters (see Table 2-3). The average radiocarbon age for the surface of the Excelsior series is 440 years B.P., with a range of 610–270 years B.P.

Dates from buried contexts in the Kimberlina soil series range from 14,100 to 1700 years B.P. at depths extending from 120 to 1,200 centimeters (see Table 2-3). Similar to the Cajon series, dates from buried soils underlying Kimberlina deposits constitute the older end of the age range.

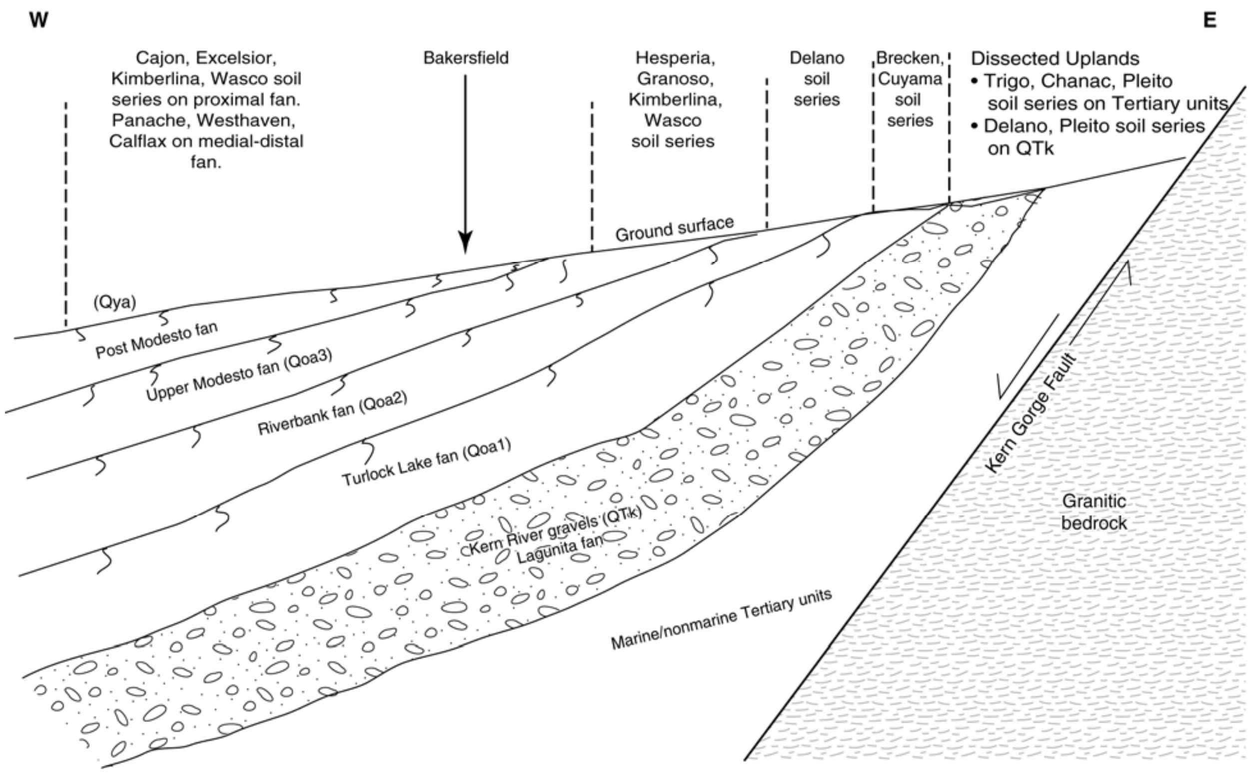

Figure 2-3. Generalized cross section of the Kern River alluvial fan

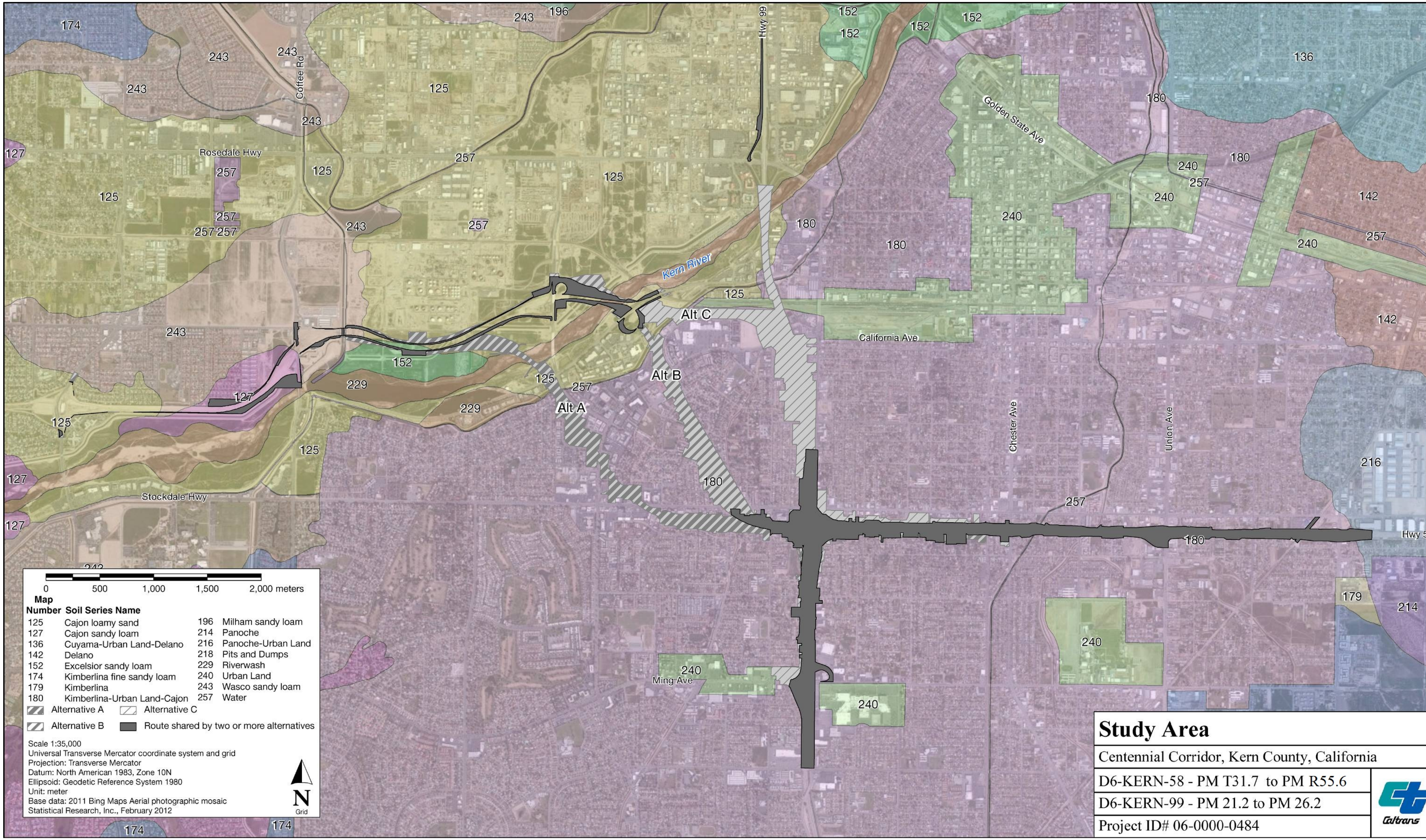

Figure 2-4 Soil Map: Kern River Alluvial Fan and the Centennial Corridor Study Area

Table 2-3 Centennial Corridor ^{14}C Analysis

	Cajon Buried	Cajon Surface	Excelsior Buried	Excelsior Surface	Kimberlina Buried	Kimberlina Surface	Panoche Buried	Panoche Surface	Westhaven Buried	Westhaven Surface
Number of ^{14}C dates	17	78	9	2	5	5	5	3	28	8
Mean age (years B.P.)	4512	904	2042	440	6730	1262	13,971	597	1905	703
Age range (years B.P.)	12,210–670	4000–100	4120–310	610–270	14,100–1700	1440–720	26,040–175	710–343	6920–220	2070–100
Depth range (centimeters)	10–329		115–1,300		120–1,200		70–640		67–730	

Note: Derived from Meyer 2010:Appendix B.

Immediately west of Bakersfield on the Kern River alluvial fan in an area mapped as the Kimberlina soil series, a radiocarbon date from 12 meters (39 feet) below the modern surface returned a date of 14,100 years B.P. (Marchand 1981). In Fresno County, radiocarbon dates from a deeply buried hearth feature at 4.4 meters (14.4 feet) below the modern surface along Arroyo Hondo Creek (CA-FRE-257) yielded a date of 1605 cal B.P. (Meyer 2010:83). Radiocarbon dates from surface contexts on Kimberlina soils range from 1440 to 720 years B.P. and average 1262 years B.P. (see Table 2-3).

A single radiocarbon date from a buried context in the Wasco soil series returned a date of 8070 years B.P. at 240 centimeters below surface. The association of the Wasco series with the Kimberlina, Cajon, and Excelsior soil series suggest it is primarily found on late Holocene fan surfaces (Meyer 2010:83).

On the medial to distal fan west of Bakersfield, the texture of the soil parent material changes to loam, clay loam, and occasionally silt loam. These finer-textured soils begin to show incipient subsurface soil-horizon formation and are commonly classified as Inceptisols or Aridisols. This increase in soil development appears to be associated with the change in texture and is not a function of soil age. Distal-fan soils and soils derived from eroded Tertiary strata include the Panoche, Westhaven, and Calflax series (see Table 2-1).

Panoche series soils throughout Districts 6 and 9 have been dated between 26,040 and 175 years B.P. at depths ranging from 70 to 640 centimeters below surface (see Table 2-3). In the San Joaquin Valley, radiocarbon dates from buried contexts have been constrained between 2992 and 185 cal years B.P., with an average of 1571 cal years B.P. (Meyer 2010:49, Table 7). The surface of Panoche soils ranges from 665 to 398 cal years B.P. and average 585 cal years B.P.

A total of 28 dates from buried contexts throughout Districts 6 and 9 in the Westhaven soil series reveal radiocarbon ages from 6920 to 220 years B.P. at depths from 67 to 730 centimeters below surface (see Table 2-3). Surface dates range from near modern (100 years B.P.) to 2070 years B.P. and average 703 years B.P.

Soils mapped on the Qoa3 fan also consist entirely of Entisols in the Wasco, Kimberlina, and Granoso soil series. This surface was assigned a middle to late Pleistocene age by Bartow (1984); however, based on soil-series correlations, it appears that this surface is much younger, dating to the late Holocene. Bartow also correlated this fan surface to a prominent terrace along the Kern River east of Bakersfield (see Figure 2-2). Soil-landform correlations indicate that this terrace is mapped as the Hesperia soil series. Radiocarbon dates from buried contexts in the Hesperia soil series within Districts 6 and 9 range from 5263 to 2246 cal years B.P. and average 3755 years B.P. (Meyer 2010:49, Table 7).

The older fan surfaces—Qoa2, Qoa1, and QTk (Kern Gravels)—may correlate to Riverbank or lower Modesto (Qoa2), Turlock Lake (Qoa1), and Lagunita (QTk) formations, respectively. Soils associated with these surfaces are generally strongly developed, classified as Haplargids or Argixerolls and have well-developed argillic subsurface horizons. The soil series most commonly associated with the Qoa2 surface is the Delano series, a Haplargid with moderately to strongly developed argillic horizons. Soils on the Qoa1 surface are mapped as the Brecken and Cuyama series. The Brecken series is classified as an Argixeroll, a Mollisol with a well-developed argillic horizon, whereas the Cuyama is a Haplargid. Although it is mapped as Turlock Lake in age, the Qoa1 is most likely a Modesto deposit. Soils mapped on the Kern River gravels are more variable in terms of soil development, because this deposit is more highly eroded than later fan surfaces. Erosional remnants on this surface, however, are commonly mapped as the Delano (Haplargid) or Pleito (Haploxeroll) soil series.

Radiocarbon dates from pre–upper Modesto deposits are rare in the San Joaquin Valley and are not discussed in great detail within the District 6 and 9 geoarchaeological overview. Based on general soil-landform correlations presented here, it appears that the ages assigned by Bartow for the Modesto and older fan deposits are far too old. Most of the areas identified as being Riverbank are more likely Modesto in age.

2.2.4 Paleoclimate

High-resolution paleoenvironmental data is rare in most localities, but late Quaternary paleoclimatic data is preserved in the lacustrine sediments of Tulare Lake north-northeast of Bakersfield in western Tulare County. Throughout the Pleistocene, Tulare Lake levels fluctuated in response to climatic shifts (glacial-interglacial periods) and the elevation of its spillover sill at the north end of the lake where the Kings River currently enters (Negrini 2006). Extensive alluvial-fan activity during the last glacial maximum created a hydrologic barrier at the spillover site, thus creating a closed lake system. The Kings, Tule, and Kern Rivers drain into the lake; however, the lake is currently dry, as the water has been diverted for agricultural purposes. The level of Tulare Lake is particularly important archaeologically over the last 10–15 ka, because Clovis and younger prehistoric sites are concentrated in an elongated region that parallels the southern shoreline (Fenenga 1993; Negrini 2006). These sites are believed to be associated with lower lake levels during the "Clovis Drought" at 12,900 cal years B.P. (Haynes 1991).

Lake-level reconstruction for the last 11,500 years has been based on radiocarbon dating and stratigraphic analysis of high-stand, wave-cut shorelines by Negrini (2006). They determined that during the early Holocene (prior to 6000 years B.P.), lake levels were generally higher, with the oldest high stand occurring at 8200 cal years B.P. and lasting for greater than 1,000 years. Two middle Holocene high stands lasted from 4000 to 2700 cal years B.P. and 2000 to 1200 cal years B.P., and there were several late Holocene high stands at 800 and 250 cal years B.P. Three major low stands were recorded at 9700, 5400, and 2600 cal years B.P. (Negrini 2006). Comparisons of the Tulare Lake record with other paleoclimatic records in the southwest from Owens and Pyramid Lakes (Benson 2002), Lake Elsinore (Kirby 2005), and Lake Mojave (Enzel 1992) all indicated that relatively wet conditions existed from 10,000 to 8000 cal years B.P. Some differences exist prior to this time (>10,000 cal years B.P.), with Lake Mojave experiencing a high stand, and all other lakes showing periods of drought. A dry period is evident in all records for the middle Holocene after 7500 cal years B.P., ranging in duration from 7500–5500 cal years B.P. This dry period was punctuated by a short wet period that lasted for at least several hundred years. This wet episode is evident in Tulare Lake by a thicker, clay-rich deposit associated with high stands (Negrini 2006). All lake records indicate a pronounced dry period centered around 5000 cal years B.P. and continuing to 4000–3000 cal years B.P. A return to wet conditions is centered around 2000–1600 cal years B.P. in all records, and the last 1000 years have been wet in general.

2.3 Climate

The mountains surrounding the southern end of the San Joaquin Valley profoundly influence the climate of the Bakersfield region. To the west, the Coast Ranges cut off moist Pacific air to create an arid to semiarid climate. During the winter, the high Sierra Nevada blocks much of the cold air that flows south over the continent and traps significant snowfall (Chang 1988). Over 90 percent of the annual precipitation in Kern County falls between October and April. The average annual precipitation from 1938 to 2010 was 15.7 centimeters (6.2 inches); there was average rainfall during the following periods: 1993–2001, 1980–1983, and 1940–1945 (WRCC 2011) (Figure 2-5). The average length of the growing season is 265 days. The mean temperature in January and July is 47°F and 84°F, respectively.

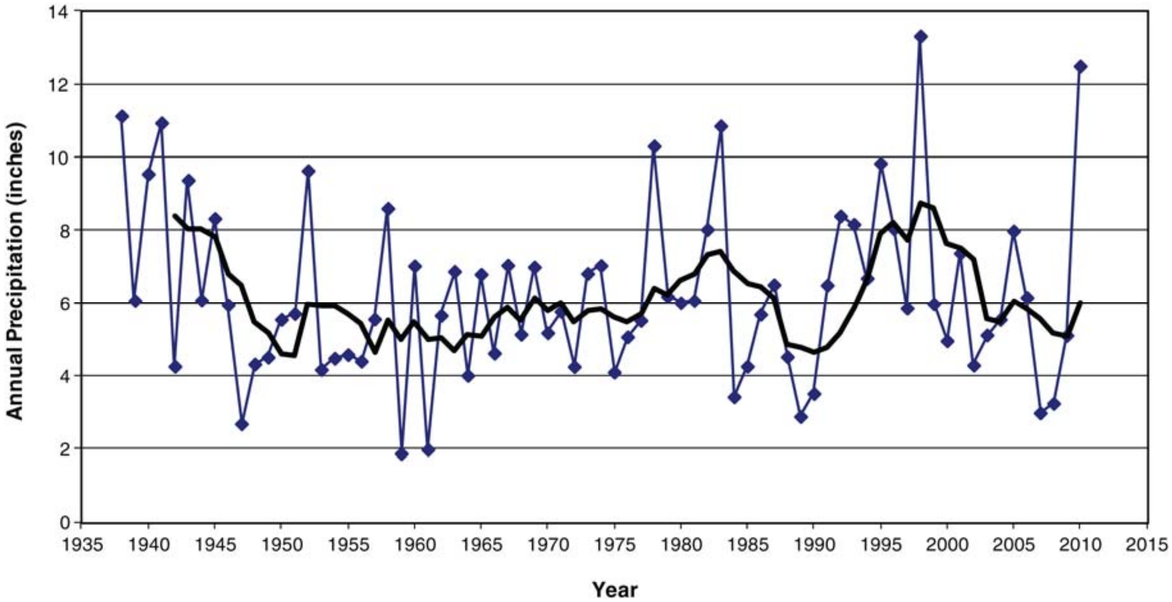

Figure 2-5 Average annual precipitation for Bakersfield, 1938–2010, with a 5-year moving average

2.4 Flora and Fauna

Before European settlement, the southern San Joaquin Valley supported large herds of elk (*Cervus elaphus*) and antelope (Bovidae) that fed on large expanses of native grass (Chang 1988). Much of the native plant species, however, have been replaced by invasive species, such as filaree (*Erodium cicutarium*), bermudagrass (*Cynodon aethiopicus*), Russian thistle (*Salsola kali*), mustard (*Brassica cretica*), wild sunflower (*Helianthus annuus*), and Johnsonsgrass (*Sorghum halepense*). Natural vegetation on unreclaimed saline-alkali flats consists of red brome (*Bromus rubens*), soft chess (*Bromus hordeaceus*), foxtail barley (*Hordeum jubatum*), and fescue (*Festuca* sp.). Vegetation around Bakersfield consists predominantly of red brome, foxtail fescue (*Vulpia myuros*), filaree, and foxtail barley. Trees along the Kern River riparian corridor are dominated by cottonwood (*Populus fremontii*), willow (*Salix* sp.), and elderberry (*Sambucus nigra*) (Chang 1988).

2.5 Cultural Setting

2.5.1 Archaeological Setting

The following archaeological background has been summarized from the Thomas Roads Improvement Program archaeological context statement (Schiffman 2007). For a complete review of the southern San Joaquin Valley archaeological setting, please see the archaeological survey report for the Centennial Corridor Project.

Schiffman (2007) based his classification on Fredrickson's (1973, 1974) adaptation of the Willey (1958) period and stage integrative theme. This framework has been revised slightly based on recently available calibrated radiocarbon dates (Groza 2002; Meyer 1997).

2.5.1.1 Paleoindian Period (11,550–8,550 cal B.C.)

There is abundant evidence of human occupation in the southern San Joaquin Valley during the latest Pleistocene to early Holocene. Evidence for Paleoindian period occupation of the region comes primarily from the shores of Tulare Lake, located north-northwest of Bakersfield near the city of Hanford at the Witt Locality (CA-KIN-32) (Fenenga 1994; Moratto 1984; West 1991). Materials recovered in this area include Clovis-like, fluted and unfluted basally-thinned points (cf. Great Basin Concave Base or Black Rock Concave Base); crescents; leaf-shaped knives; ovate domed and elongate keeled scrapers; and engraving implements, along with only a minimal complement of milling tools (Schiffman 2007). Uranium-thorium dates obtained from human skeletal remains from the Witt Locality are some of the earliest directly dated human skeletal materials in North America and provide uncalibrated dates of 11,379, 11,380, and 15,802 years B.P. (West 1991).

2.5.1.2 Lower Archaic Period (8,550–5,550 cal B.C.)

Lower Archaic sites are rare in the archaeological record of the southern San Joaquin Valley, with most cultural remains from the time period consisting of isolated finds. Stemmed points (Lake Mojave and Silver Lake forms) and distinctive formalized flaked stoned implements are key components of Lower Archaic period assemblages. An example of such remains has been recovered from a deeply buried context at Buena Vista Lake (Fredrickson 1977; Hartzell 1992) and at the Witt Locality (CA-KIN-32) along the ancient shoreline of Tulare Lake. Many Lower Archaic period sites in the southern San Joaquin Valley are likely buried by thick deposits of late Holocene alluvium.

2.5.1.3 Middle Archaic Period (5,550-550 cal B.C.)

The Middle Archaic period is associated with the advent of warmer and drier conditions of the middle Holocene. Sites dating to this period are commonly found in buried contexts on middle Holocene paleosols (Meyer 2010). During the early part of the Middle Archaic period (5550–2050 cal B.C.), burial mounds of the classic Windmiller Pattern occur. These are the oldest occupations recognized at CA-SJO-68 and date to a minimum of 3050 cal B.C. (Lillard 1939; Ragir 1972). Windmiller settlements represent a riverine adaptation and permanent year-round habitation sites, with a complex material culture. Windmiller cemeteries featured a unique expression of extended burials oriented to the west (Schiffman 2007).

2.5.1.4 Upper Archaic Period (550 cal B.C.–cal A.D. 1000)

Little is known concerning the Upper Archaic period cultures of the southern San Joaquin Valley during the wetter and cooler late Holocene (Siefkin 1999). Hartzell (1992) has reported year-round villages at Buena Vista Lake at CA-KER-116 and CA-KER-39 that exhibited diverse architectural features, including house floors and significant refuse deposits. Cultural materials included temporally diagnostic forms of beads and ornaments manufactured from *Haliotis* and *Olivella* shell. An extensive array of bone tools and flakers are also diagnostic to this period. During this time period, burial positions shift to be supine semiflexed, and mortuary artifacts include bifacial obsidian blanks of Coso or Casa Diablo volcanic glass (Schiffman 2007).

2.5.1.5 Emergent Period (cal A.D. 1000–Historical Period)

The archaeological record of the Emergent period in the southern San Joaquin Valley is more complete and diverse than the other, earlier periods. This Emergent period is marked by a change in subsistence strategy, with an increase in plant procurement and a decrease in hunting. The bow-and-arrow was also introduced at this time. Cottonwood-style arrow points begin to appear in the archaeological record approximately 500 years ago and are similar to those found in the Great Basin. Archaeological sites from this period contain a diverse assemblage of stone beads, clamshell disks, tubular smoking pipes, arrow-shaft straighteners, flat-bottomed mortars, cylindrical pestles, and small side-notched arrow points. Burials are tightly flexed on the side or supine with some mortuary offerings. Protohistoric era sites contain diagnostic trade items, such as brass buttons and glass beads.

2.5.2 Overview of Buried Sites in Kern County

Only four buried prehistoric sites have been identified in Kern County within alluvial settings similar to the Kern River alluvial fan (Table 2-4). Two of these sites are associated with the Kimberlina soil series, CA-KER-3085 and CA-KER-0116. The Elk Hills site (CA-KER-3085) contained a buried soil at 123 centimeters below surface that was dated to 1265 cal years B.P. (Culleton 2006). The Buena Vista Lake site (CA-KER-0116) contained buried cultural materials to a depth of 440 centimeters below surface that were dated to 8379–7738 cal years B.P. (Fredrickson 1977).

The remaining two sites, CA-KER-3939 (Clark Wash) and CA-KER-1627, are associated with the Arizo and Nahrub soil series (Entisols), respectively. The Clark Wash site contained buried cultural deposits to a depth of 450 centimeters below surface that were dated to 7997–6375 cal years B.P. (Gardner 2002). CA-KER-1627 contained buried cultural deposits in association with a buried soil at 52 centimeters below surface. A radiocarbon date from the buried soil returned a calibrated age of 3119 cal years B.P. (Breschini 1996).

Table 2.4 Known Buried Prehistoric sites in Kern County

Site No. (Name)	Maximum Depth (centimeters)	Minimum Age (cal years B.P.)	Maximum Age (cal years B.P.)	Soil Series
CA-KER-0116 (Buena Vista Lake)	440	7738	8379	Kimberlina
CA-KER-1627	52	3119	NA	Nahrub
CA-KER-3085 (Elk Hills)	123	1265	NA	Kimberlina
CA-KER-3939 (Clark Wash)	450	6375	7997	Arizo

Key: NA = not applicable.

Four other buried sites are known in Kern County (Rogers Lake; CA-KER-0490, CA-KER-0500, CA-KER-0501, and CA-KER-2378); however, these are associated with buried soils in an aeolian environment. Four buried sites in an alluvial setting are known in Fresno County, one in King County, and one in Tulare County (for a complete list, see Meyer 2010:Appendix F).

Section 3 Methods

Stage I of the XPI included the use of existing geologic data, aerial and satellite imagery, existing Centennial Corridor Project technical reports, and topographic maps to delineate late Quaternary landforms in the study area. Implementing Stage I is a multistep process. First, pertinent data for the study area from the U.S. Geological Survey, the California State Geological Survey, the U.S. Department of Agriculture Natural Resource Conservation Service, the Geoarchaeological Overview and Assessment of Caltrans Districts 6 and 9 (Meyer 2010), and numerous peer-reviewed journal articles were reviewed and analyzed to identify areas likely to contain buried soils. Second, records search information was used to identify the types and locations of known cultural resources in the study area. Third, the locations of known prehistoric cultural resources was correlated with soil type and landform age in an attempt to refine the resultant sensitivity model that identifies areas within the study area that possess low, moderate, high, and very high archaeological sensitivity.

The model presented here expands on the regional buried-site model constructed for the District 6 and 9 geoarchaeological overview (Meyer 2010). That overview provided buried-site potential maps based on regional soil age–landform relationships, radiocarbon dates, the distribution of known buried sites, and broad-scale environmental variables that likely impacted settlement location, such as percent slope and distance to water. Based on these variables a broad-scale potential map was produced for all of District 6 and 9 including Fresno, Kern, Kings, Madera, Tulare, Inyo, and Mono counties. The model was then tested against the known location of buried sites in the district using statistical methods.

This geoarchaeological overview was impressive in scope and useful for planning purposes; unfortunately, the resolution of the final maps is such that they generally are not applicable to highly localized settings such as the Centennial Corridor. This is made clear in the study area, as Meyer (2010) identified much of the area north of the Kern River as having only moderate potential for buried sites even though it is located adjacent to a major water source, has a slope gradient less than 5 percent, and is situated on late Holocene alluvial-fan deposits similar to those south of the river that previously have been identified as having very high potential for buried sites. It can only be assumed that increased slope gradient and/or the presence of older fan alluvium adjacent to this area impacted the final ranking and that the area of high potential could not be shown at the chosen map scale.

The goal of this research was to differentiate the temporal and spatial distributions of geomorphic surfaces and soils on the Kern River alluvial fan on a finer scale so that a preliminary geologic-potential model could be constructed. These surfaces were delineated based on soil development;

topographic position; surface characteristics visible in historic aerial photos, such as degree of dissection, vegetation patterns, and preservation of primary depositional features; lithofacies designations; and correlation with the existing late Quaternary stratigraphic sequence of the eastern San Joaquin Valley. The surficial geologic map was constructed using historical aerial photographs taken in August 1952. These particular early aerials were used rather than modern satellite imagery because the study area was not as heavily urbanized in the mid-twentieth century when more of the natural fan surface was visible.

As defined below, the buried-site potential for each mapping unit within and near the study area is identified as low, moderate, high, or very high:

1. Low—The underlying deposits likely predate human occupation of the landscape and/or are high-energy deposits unlikely to contain evidence of cultural occupation in primary context.

2. Moderate—The underlying deposits are likely terminal Pleistocene or Holocene but have experienced a high–moderate level of historical-period disturbance.

3. High—The underlying soils/sediments date to the terminal Pleistocene or Holocene, represent low-energy deposits, and likely contain buried, intact soils.

4. Very high—The underlying soils/sediments meet the same criteria as those in the high category but are adjacent to or very near known prehistoric channels on the Qa2 surface. These areas would have been attractive locations for settlement and should be subjected to more-intensive subsurface investigation.

The results of the records search allowed for the correlation of prehistoric cultural resources recorded on the modern surface with soil type and landform age. Although most of these consisted of undated isolated artifacts or features, this correlation revealed interesting trends among the number of prehistoric resources identified, the ages of specific landforms, and distance to the modern Kern River.

This model uses a ranking system based on landform age (assessed by soil development, topographic position, surface characteristics, and the regional radiocarbon dates), potential for buried soils, and proximity to known prehistoric water sources (abandoned channels). Previously recorded cultural resources within and near the study area were not incorporated into the model, because the majority of these are undated single artifacts/features or lithic scatters. Site function and age of occupation are generally not known (beyond what can be discerned from the age of the geomorphic surface) and, therefore, provide little relevant data for the sensitivity model beyond basic landform-site correlations.

Environmental factors, such as slope and proximity to water, as used in the geoarchaeological overview of Districts 6 and 9 (Meyer 2010), are not pertinent to our project, because the entire study area is less than 5 percent in slope and in close proximity to a major water source (the Kern River) that has changed its course across the study area multiple times during the Holocene. The dynamic nature of deposition on alluvial fans makes predicting the location of buried channels (prehistoric water sources) difficult. However, our analysis identified the existence of several abandoned late Holocene channels visible on the surface in historical aerial photographs. The areas adjacent to these channels (areas of very high potential for buried sites) should be the focus of any future geoarchaeological research because they represent *known* prehistoric water sources.

The second phase of this study will be implemented after an alternative route has been chosen. This phase will refine the preliminary model based on actual field data and absolute age dates. The final model will incorporate both the horizontal and vertical distribution of alluvial-fan deposits and delineate the spatial distribution of buried soils with high–very high potential for intact buried cultural resources.

Section 4 Results

4.1 Landform–Prehistoric Site Correlations

The records search for the Thomas Roads Improvement Program identified 3 prehistoric cultural resources within $^1/_2$ mile of the Centennial Corridor study area (Schiffman 2007) (Figure 4-1). In an attempt to compensate for the limited nature of this data set, all of the previously recorded prehistoric cultural resources for the entire Thomas Roads Improvement Program were plotted. In all, 41 prehistoric cultural resources (17 sites and 24 isolated artifacts) have been recorded within $^1/_2$ mile of each of the 11 individual Thomas Roads Improvement projects (see Figure 4-1). These consist primarily of individual or isolated artifacts and features that reflect a limited diversity in the types of remains present. The geomorphic surfaces on the Post Modesto Kern River alluvial fan are less than 500–1,000 years in age and, therefore, have not been available for occupation over an extended span of time. Surficial archaeological remains in the study area reflect a maximum of 800 years of prehistoric occupation. On the Qa1 surface along the modern Kern River, it is probably considerably less, perhaps a few hundred years at most. Limited diversity of feature and artifact types is to be expected in this geomorphic setting. Most of the archaeological resources in and near the study area most likely date to the Emergent period or possibly to the late Upper Archaic (Schiffman 2007).

A second factor that limits the visibility and integrity of archaeological resources in the study area is the extensive ground disturbance that has taken place over the last century as a result of urban development and agriculture. Much of the study area is presently covered by concrete, asphalt, and construction fills of variable thickness. Disturbance prior to urbanization of the area from agricultural activities likely destroyed or concealed much of the prehistoric record that was at or near the surface.

In order to gain insight into prehistoric settlement patterns, previously recorded archaeological resources were correlated with soil type and landform age within and near the Centennial Corridor study area. Unfortunately, the vast majority of the previously recorded cultural resources did not have a temporal or cultural affiliation, limiting their usefulness in dating the geomorphic surfaces.

Kern River alluvial-fan deposits that aggraded after the arrival of prehistoric groups in the area include all of the Post Modesto alluvium below Qa2 and Qa1 and the thin mantle of late Holocene alluvium capping the Qa3 surface. Because cultural occupation of the area occurred coevally with the accumulation of these deposits, at least a portion of the prehistoric archaeological record on these landforms will be found below the modern surface. Although the sample size is small, the number of cultural resources recorded on the surface decreased with increasing age of the landform between the Qa3 and Qa1 units. Twenty-seven percent of the archaeological resources

(11 total) were associated with the Qa1 (Post Modesto III, 1000–150 years b.p.) surface, and 22 percent (9 total) were associated with the Qa2 (Post Modesto III, 3500–1500 years b.p.) surface (Table 4-1). Only 12 percent of the archaeological resources (5 total) were recorded on the Qa3 (upper Modesto/early Post Modesto, 26,000–8000 years b.p.) surface. This trend also indicates an increase in prehistoric cultural resources on the surface, with decreasing distance from the Kern River (the Qa1 surface is closer to the channel than the Qa2 and Qa3 surfaces). No cultural resources were recorded on the Qa0 (Post Modesto IV, less than 150 years b.p.) surface.

This limited data set suggests that archaeological-resource density increases toward a known water source. This trend is well documented and was incorporated into the predictive model constructed for the District 6 and 9 geoarchaeological overview (Meyer 2010). This also has been taken into account in the "geologic" predictive model presented here. Areas of very high sensitivity have been delineated based on distance to known prehistoric water sources (late Holocene channels).

Analysis of existing geologic and soil data sources along with the regional radiocarbon database indicate that most of the Centennial Corridor study area is on a late Post Modesto (late to latest Holocene) alluvial-fan surface inset into older upper Modesto (late Pleistocene to early Holocene) fan deposits. Analysis of historical aerial photographs revealed the study area has four distinct geomorphic surfaces distinguished by their surface characteristics, soil morphologies, and topographic positions. The topographically lowest/youngest of these surfaces, Qa0, is the modern channel and recently deposited mid-channel bars of the Kern River. The recently deposited bars are clearly visible in the aerial imagery as unvegetated surfaces with high reflectance. Adjacent to the modern channel of the Kern River, a low, vegetated terrace with clearly visible ridge-and-swale topography forms Qa1. The Qa0 surface is mapped as Riverwash; the Qa1 unit is mapped as Torripsamments or Torrifluvents of the Cajon and Excelsior soil series, respectively (Table 4-2).

Radiocarbon dates from the Cajon and Excelsior series in Districts 6 and 9 indicate that deposition on Qa1 took place over the last 3,500 years (see Tables 2-4 and 4-2). Surface dates are generally less than 1000 years b.p. with an average of 904 years b.p. for the Cajon and 440 years b.p. for the Excelsior series. Because the Qa1 appears to be inset into the Qa2 surface that is also composed of the Cajon soil series, both the age of deposition and the surface are probably younger than suggested by regional radiocarbon dates.

In total, 11 previously recorded prehistoric cultural resources were correlated with the Qa1 surface in the study area (see Table 4-1). This indicates the surface of Qa1 was available for occupation at least for a short period of time in late prehistory. Cultural resources identified on the Qa1 surface are probably less than 500 years in age. Ephemeral buried surfaces are likely adjacent to the Kern River channel where depositional rates were high. If buried cultural resources are present, they are most likely vertically separated into discrete occupational zones.

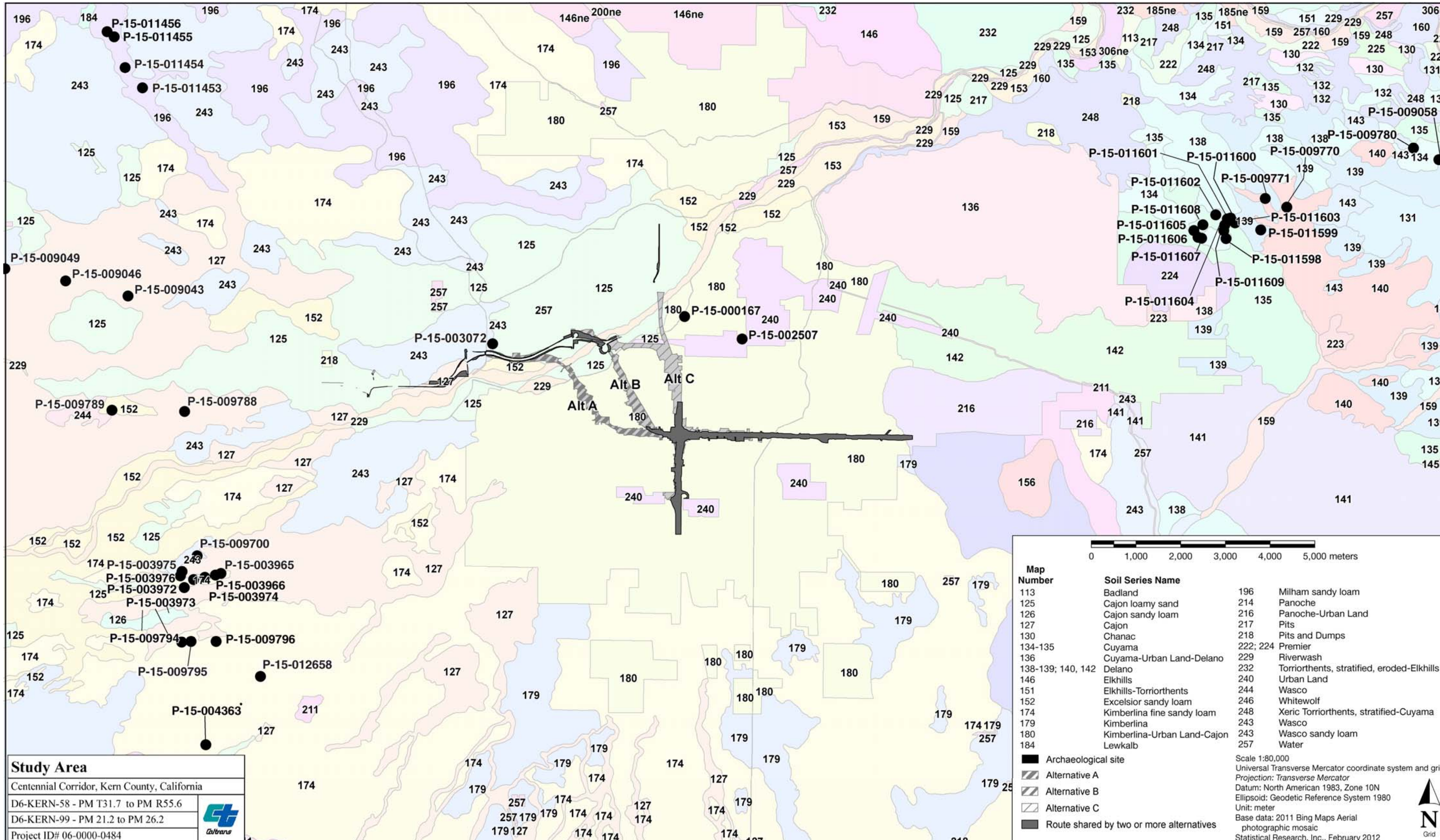

Figure 4.1. Surficial Prehistoric Cultural Resources Identified within 1/2 Mile of the Thomas Roads Improvement Program

Table 4-1 Soil, Landform, and Previously Recorded Prehistoric Cultural Resource Correlations

Surficial Geologic/ Allostratigraphic Unit	Soil Series	Resource Type	Site No.	Buried-Site Potential
Qa1	Cajon	site	P-15-3965	high
Qa1	Cajon	site	P-15-3966	high
Qa1	Cajon	site	P-15-3973	high
Qa1	Cajon	site	P-15-3974	high
Qa1	Cajon	site	P-15-3975	high
Qa1	Cajon	site	P-15-3976	high
Qa1	Cajon	isolated artifact	P-15-3972	high
Qa1	Cajon	isolated artifact	P-15-9700	high
Qa1	Cajon	isolated artifact	P-15-9794	High
Qa1	Cajon	isolated artifact	P-15-9795	High
Qa1	Cajon	isolated artifact	P-15-9796	High
Qa2	Kimberlina–Urban Land–Cajon complex	site	P-15-167	High
Qa2	Wasco	site	P-15-3072	High
Qa2	Kimberlina	site	P-15-4363	High
Qa2	Kimberlina	isolated artifact	P-15-12658	High
Qa2	Cajon	isolated artifact	P-15-9043	High
Qa2	Cajon	isolated artifact	P-15-9046	High
Qa2	Cajon	isolated artifact	P-15-9049	High
Qa2	Cajon	isolated artifact	P-15-9788	High
Qa2	Cajon	isolated artifact	P-15-9789	High
Qa3	Milham	site	P-15-11456	High
Qa3	Kimberlina–Urban Land–Cajon complex	prehistoric village site	P-15-2507	moderate–high
Qa3	Milham	isolated artifact	P-15-11453	High
Qa3	Milham	isolated artifact	P-15-11454	High
Qa3	Milham	isolated artifact	P-15-11455	High
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	site	P-15-11600	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Cuyama	site	P-15-9058	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	site	P-15-9770	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	site	P-15-9771	Low

Surficial Geologic/ Allostratigraphic Unit	Soil Series	Resource Type	Site No.	Buried-Site Potential
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	isolated artifact	P-15-11599	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	isolated artifact	P-15-11601	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Delano	isolated artifact	P-15-11602	Low
Qoa2: Riverbank/Lower Modesto alluvial-fan deposits (middle–late Pleistocene)	Cuyama	isolated artifact	P-15-9780	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	site	P-15-11598	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	site	P-15-11608	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11603	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11604	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11605	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11606	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11607	Low
QTk: Kern River gravels of Lagunita alluvial-fan deposits (late Pliocene–early Pleistocene)	Cuyama	isolated artifact	P-15-11609	Low

Table 4-2 Soil Morphologies and Relative Ages of Surficial-Geology Map Units

Geologic Unit	Soil Series and Morphology	Estimated Age	Potential for Buried Soils <13,000 years B.P.	Buried-Site Potential
Qa0	Riverwash: no soil horizons developed	latest Holocene and historical period	low	low
Qa1	Cajon-Excelsior: A-C-AC?	Surface (<1000 years B.P.) Buried (4000–300 years B.P.)	moderate: high-buried surfaces likely in the upper 5 meters	high
Qa2	Kimberlina-Cajon: A-C-Ab-C?	Surface (1300–900 years B.P.) Buried (3700–1700 years B.P.)	very high: buried surfaces likely in the upper 5 meters	high–very high near abandoned channels, moderate in areas of urban development
Qa3	Panoche-Milham:	Surface (700–400 years B.P.) Buried (26,000–200 years B.P.)	very high: buried surfaces likely in the upper 2–3 meters	high

A second fan terrace, Qa2, is topographically higher than Qa1, but primary ridge-and-swale topography is slightly less pronounced in the former. Several abandoned Kern River channels are clearly visible on the Qa2 surface as linear, northeast-southwest-trending bands that contain relict mid-channel bars separated by numerous shallow braided channels. Soils on the Qa2 surface are mapped exclusively as Entisols of the Cajon, Kimberlina, and Wasco soil series.

Regional radiocarbon dates for the Cajon and Kimberlina soil series indicate deposition on Qa2 took place during the late Holocene from 4000 to 1000 years B.P. Because Qa1 is incised into this surface, the Qa2 surface represents an earlier phase of late Holocene aggradation. Surface dates for the Kimberlina series slightly predate those of the Excelsior and Cajon series, 1262 years B.P. versus 900–440 years B.P., further supporting this interpretation (Tables 2-4 and 4-2).

According to the regional radiocarbon database and the District 6 and 9 geoarchaeological overview (Meyer 2010), Middle Holocene to latest Pleistocene buried soils are common below the Cajon, Kimberlina, and Wasco soil series. Buried soils underlying areas mapped as Kimberlina and Cajon in Kern County have been dated to 2050 years B.P. at Elk Hills (Culleton 2006) and from 9100–2510 years B.P. at Indian Wells Canyon (Young 2007). These soils were found at depths ranging from 50 to 275 centimeters below surface (Meyer 2010:Appendix B). Deeply buried latest Pleistocene (14,000 years B.P.) alluvium has also been dated below Kimberlina soils immediately west of Bakersfield at depths of 12 meters (39 feet) (Marchand 1981).

Nine previously recorded prehistoric cultural resources were correlated with the Qa2 surface in the study area, or 21 percent of all known cultural resources. Based on surface radiocarbon dates, some of these likely predate those found on the Qa1 surface, and a slightly broader temporal span of prehistoric occupation is expected.

The oldest and highest surface in the Centennial Corridor study area is represented by the Qa3 unit. By 1952, most of this surface was heavily urbanized and modified for agricultural purposes, making identification of intact surface features difficult. Qa3 most likely represents upper Modesto fan alluvium deposited at the end of the Tioga Glaciation in the late Pleistocene. On the eastern edge of the study area, this fan is capped with late Holocene alluvium and mapped as the Panoche (Haplocambid) soil series. To the west, the late Holocene alluvial cap appears to be thinner, and the area is mapped as the Milham series (Haplargid).

Several radiocarbon dates from the Milham series have been obtained in Fresno County along Arroyo Hondo and Tumey Gulch (Meyer 2010:Appendix B). Dates from soil organic matter ranged from 26,000–14,450 years B.P. at Arroyo Hondo (170–230 centimeters below surface) to 8790 years B.P. at Tumey Gulch (80 centimeters below surface). Dates for the Panoche series indicate deposition of the late Holocene cap occurred between 3000 and 600 years B.P. in District 6. Dates from the Panoche series for all of Districts 6 and 9 indicate an average surface age of 600 years B.P., with a range of 710–343 years B.P.

Buried soils identified below areas mapped as Panoche tend to date to the latest Pleistocene. In Kern County along Salt Creek, a buried soil from 70 to 120 centimeters below surface in an area mapped as Panoche has been dated to 16,600–14,230 years B.P. (soil organic matter) (Meyer 2010:Appendix B). Along the Cuyama River, charcoal from a Panoche buried soil dated to between 26,040 and 10,894 years B.P. (DeLong 2007).

Five prehistoric cultural resources (12 percent) were correlated with the Qa3 surface in the study area. This is a significant decrease from the number of cultural resources identified on the Qa1 and Qa2 surfaces, likely reflecting the increased distance to water. The temporal span of occupation on the Qa3 surface is likely similar to that on the Qa2 surface. Possible buried occupations associated with a potential late Pleistocene buried soil below the Panoche series could date to anytime between 13,000 and 3000 years B.P.

4.2 Latest Pleistocene–Holocene Geomorphic History, Kern River Fan

The geomorphic history of the upper Modesto and Post Modesto Kern River alluvial fans can be reconstructed based on the findings of this analysis and correlation with regional studies on Sierra Nevada fans. Because the upper Kern River drainage was glaciated during the late Pleistocene, deposition during this time on the Kern River fan is likely linked to glacial outwash cycles (Harden 1987; Marchand 1981; Weissmann 2002). The upper Modesto unit in the eastern San Joaquin Valley corresponds to the onset of the Tioga Glaciation, beginning approximately 26 ka and ending around 9 ka (Atwater 1986; Lettis 1988; Marchand 1981). Rapid aggradation in response to elevated sediment supply and glacial discharge began on most glaciated drainages in the Sierra Nevada at that time (Figure 4-2). The buried soil identified below the Panoche and Milham soil series in Districts 6 and 9 dated to 26,000 to 8790 years B.P., with most dates falling between 26,000 and 11,000 years B.P. This suggests that the Qa3 surface identified in this study is primarily underlain by late Pleistocene alluvium associated with outwash from the Tioga glaciation.

Sometime during the latest Pleistocene or early Holocene, the late Pleistocene alluvial fan was deeply incised. The exact timing of this event is not known, because most of the early–middle Holocene alluvium is likely deeply buried below the Qa2 surface (late Holocene) surface. A radiocarbon date from charcoal near the top of the buried late Pleistocene soil (upper Modesto) along the Cuyama River suggests incision occurred shortly after 10,900 years B.P. (DeLong 2007).

The Qa2 surface identified in this study is inset into the Qa3 (upper Modesto) surface and dates to the latest Holocene (average surficial radiocarbon dates range from 1260 to 900 years B.P.). Alluvium underlying the Qa2 surface could range in age from 14,000 to less than 1,000 years B.P. Buried soils below both the Kimberlina and Cajon soil series have been documented in Kern County with dates ranging from 9100 to 2050 years B.P. at depths of 65 to 120 centimeters below surface. As discussed previously, late Pleistocene (upper Modesto) alluvium dating to 14,000 years B.P. has been documented on the Kern River alluvial fan west of Bakersfield at 12 meters (39 feet) below the modern surface.

In aerial photographs, the Qa2 surface is recognizable by the presence of abandoned channels, well-preserved constructional topography, and generally low vegetation density compared to the Qa1 surface. Late Holocene surfaces along other major Sierra Nevada drainages are often characterized by distinctive and well-preserved fluvial features, such as abandoned meanders and levees (Marchand 1981:64). This further suggests that the Qa2 primarily represents late Holocene deposition. This depositional event was apparently widespread and of a sufficient magnitude to bury most of the late Pleistocene fan (Qa3 surface) near the fan apex.

During the latest Holocene, probably after 1000 years B.P., the Kern River further incised its channel, and the intersection point on the fan migrated to the east (downfan). The Qa1 unit in the study area represents deposition along this newly created floodplain. Qa1 now forms a low terrace adjacent to the modern channel of the Kern River and is inset into Qa2 deposits. Qa1 is generally characterized by well-preserved constructional topography and an increase in vegetative cover

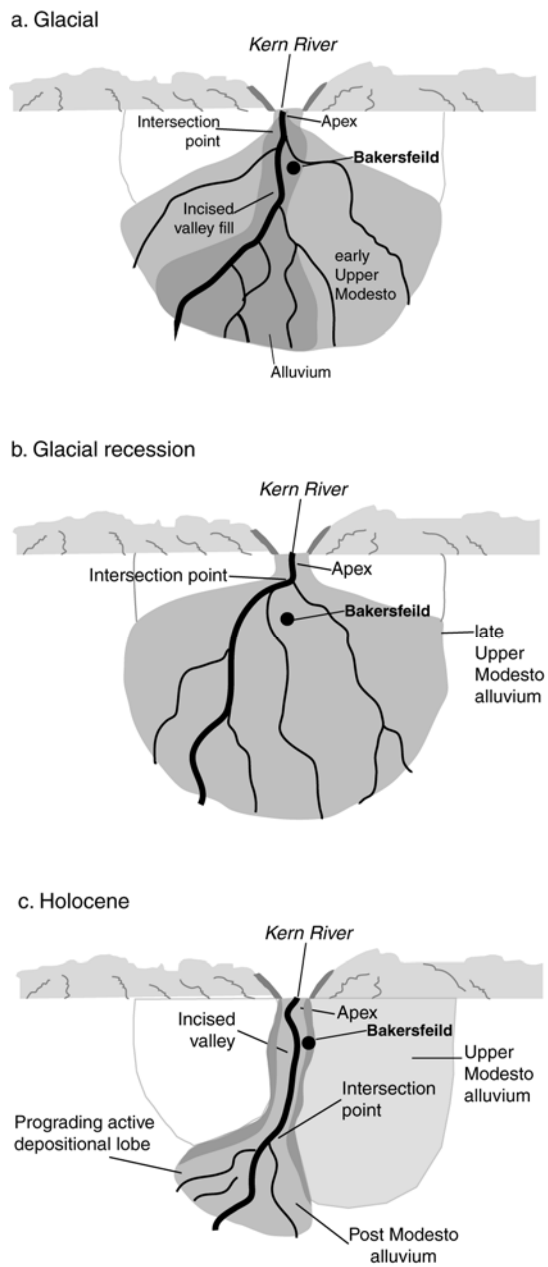

Figure 4-2 Response of the Kern River Alluvial Fan to Tioga Glacial Outwash Cycles

(Figure 4-3). In the 1952 aerial photographs, this surface appears to be covered, at least in some areas, with mature deciduous trees. Regional radiocarbon dates suggest this surface is less than 900 years B.P. and likely less than 450 years B.P. Alluvium below Qa1 likely dates to less than 1000 years B.P.

The youngest surface in the preliminary study area is represented by the Qa0 unit. This unit forms unvegetated mid-channel bars, levees, and the modern channel of the Kern River. The Qa0 surface is considered to date to the historical period.

4.3 Buried-Site Potential

The surficial geology and geomorphic history presented above provides a solid foundation on which to build a model of the probability for buried archaeological sites. This model is reasonable for predictive purposes, but because it is based primarily on preexisting data sources rather than fieldwork and dating of deposits in the study area, there are inherent limitations. In the regional predictive model presented in the District 6 and 9 geoarchaeological overview (Meyer 2010), all of the area south of the Kern River in the vicinity of Bakersfield was identified as having very high potential for buried sites. By combining this previous model with an intensive study of historical aerials and local geologic and archaeological data, we were able to significantly increase the resolution of this model. Unfortunately, limitations in the available data prevented us from conducting more-sophisticated analyses to incorporate local environmental variables during this phase of research. However, we were able to pinpoint the location of known prehistoric water sources where abandoned channels are located, which significantly narrows down the most likely settings for human occupation in the study area.

4.3.1 Low Potential

Areas of low potential for buried sites include all of the Qa0 unit and the abandoned channels identified on the Qa2 surface (Figures 4-4–4-6; see Figure 4-3). Within the study area, the Qa0 unit represents higher-energy deposition along the modern channel of the Kern River. These deposits are considered to be historical period in age and most likely do not contain intact buried soils. Older late Holocene deposits below the Qa0 surface are likely, but the upper portion of these deposits have been truncated and reworked by the Qa0 channel.

The abandoned channels identified on the Qa2 surface also represent areas of higher-energy deposition that are unlikely to contain buried soils (see Figures 4-4–4-6). Any cultural deposits that may be present within these channels are most likely not in a primary context. In general, active stream channels are unlikely locations for prehistoric sites. Similar to the Qa0 channel along the modern Kern River, Qa2 channels have truncated and reworked the older Holocene deposits they cut into. Intact soils at a more significant depth are still possible, however, and should be taken into consideration during fieldwork.

4.3.2 Moderate Potential

Soils mapped as urban land represent areas that have experienced extensive historical-period disturbance related to the building of roads and structures. Construction of these features typically involves earthmoving activities to significant depth, such as mechanical excavation and redeposition of fill materials, and can remove, truncate, or bury archaeological sites. Because the level of disturbance and depth of burial by fills are generally unknown, these areas are considered to have moderate potential for the preservation of intact cultural deposits. These areas should still be investigated during fieldwork but to a lesser extent.

4.3.3 High Potential

The deposition of Qa2 and Qa1 overlap in time with prehistoric occupation of the Bakersfield area. These units also very likely contain buried soils that represent formerly stable Holocene land surfaces. These surfaces would have been available for occupation over a period of time sufficient enough to allow soil formation to take place. The Qa1 surface most likely dates to less than 500 years B.P., whereas the underlying alluvium is probably less than 1,000 years B.P. Within the study area, Qa1 consists of a narrow terrace adjacent to the modern Kern River channel that was, prior to urban expansion, densely vegetated (see Figure 4-2). The terrace surface is now capped in many places by construction fills.

The alluvium underlying the Qa2 surface represents a late to latest Holocene deposition that dates to between 4000 and 1000 years B.P. Regional radiocarbon dates suggest the surface was available for cultural use after 1200 years B.P. Buried Holocene soils have been documented in similar landscape settings at depths exceeding 4 meters below the modern ground surface. The potential for intact cultural resources below both the Qa1 and Qa2 surfaces must be considered high down to a depth of 10 meters (33 feet) based on regional and local studies of Holocene alluvial fans. The planned maximum depth of disturbance during construction of the Centennial Corridor on these surfaces extends down to 7.6 meters (25 feet). Buried soils with high potential for intact cultural resources can be expected within this depth, with the highest potential likely being in the upper 4–5 meters, based on previous investigations in the region.

A mantle of late Holocene alluvium coeval with Qa2 deposition caps the Qa3 surface in the far eastern section of the study area (see Figure 4-3). Soils here are mapped as the Panoche series, a fine-textured soil with incipient soil development. Radiocarbon dates from surface contexts on the Panoche series range from 710–343 years B.P. Radiocarbon dates from a buried paleosol below the Pancho series dates to 26,040 years B.P. The buried soil has been encountered less than 70 centimeters below the modern surface. This surface was likely available for occupation until

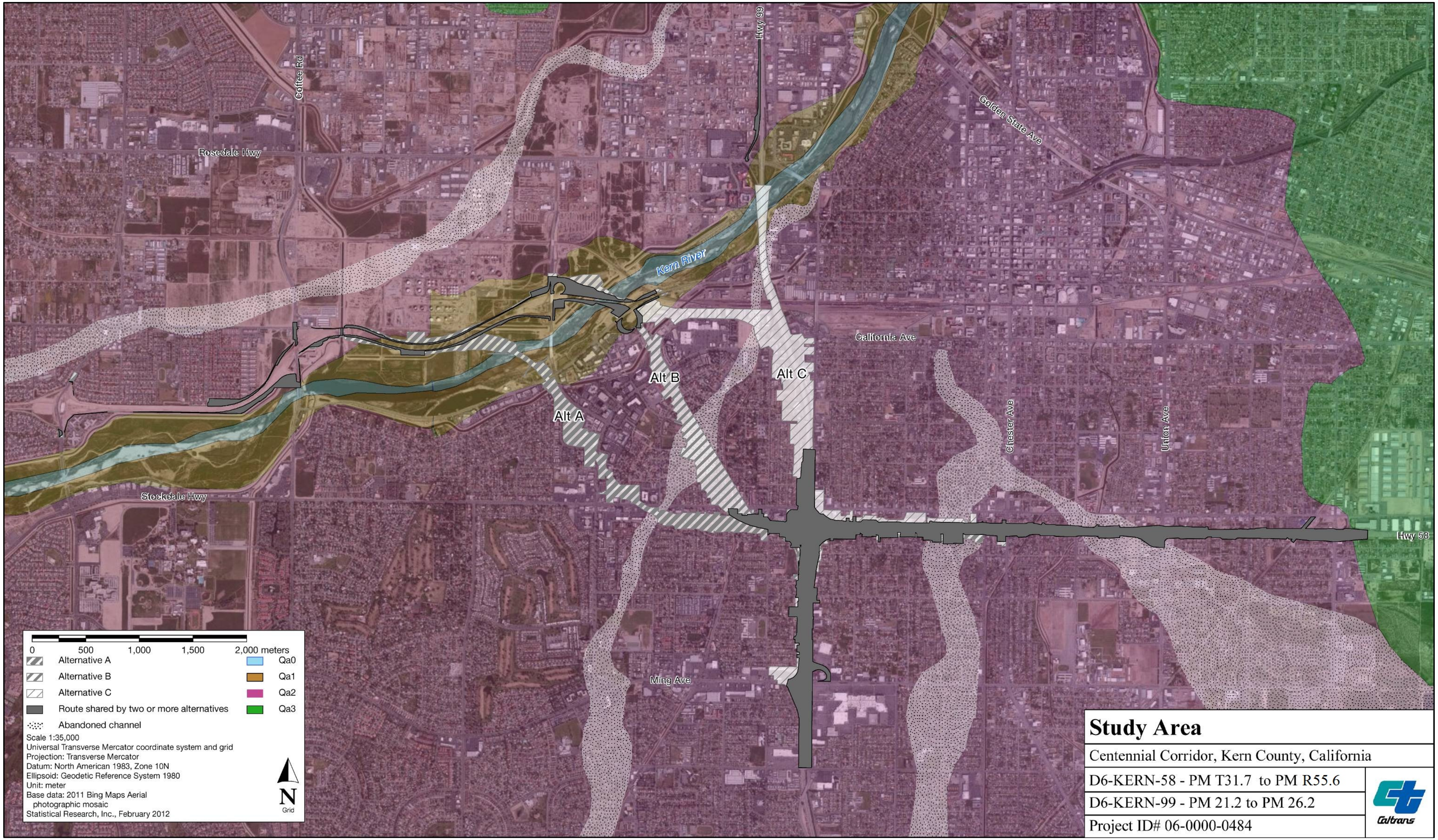

Figure 4-3 Surficial Geology of the Centennial Corridor Study Area

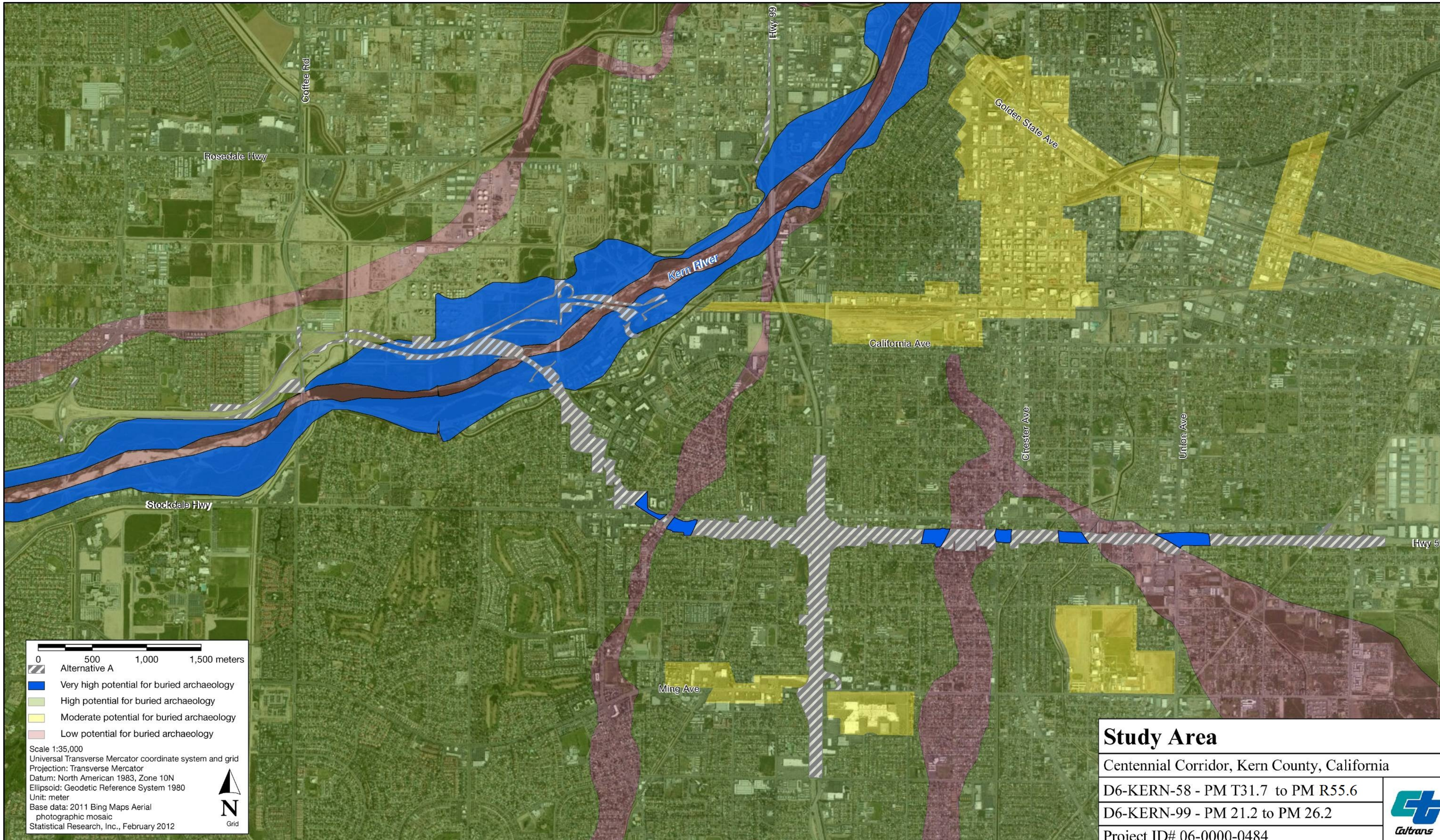

Figure 4-4 Buried-Site Potential of Alternative A

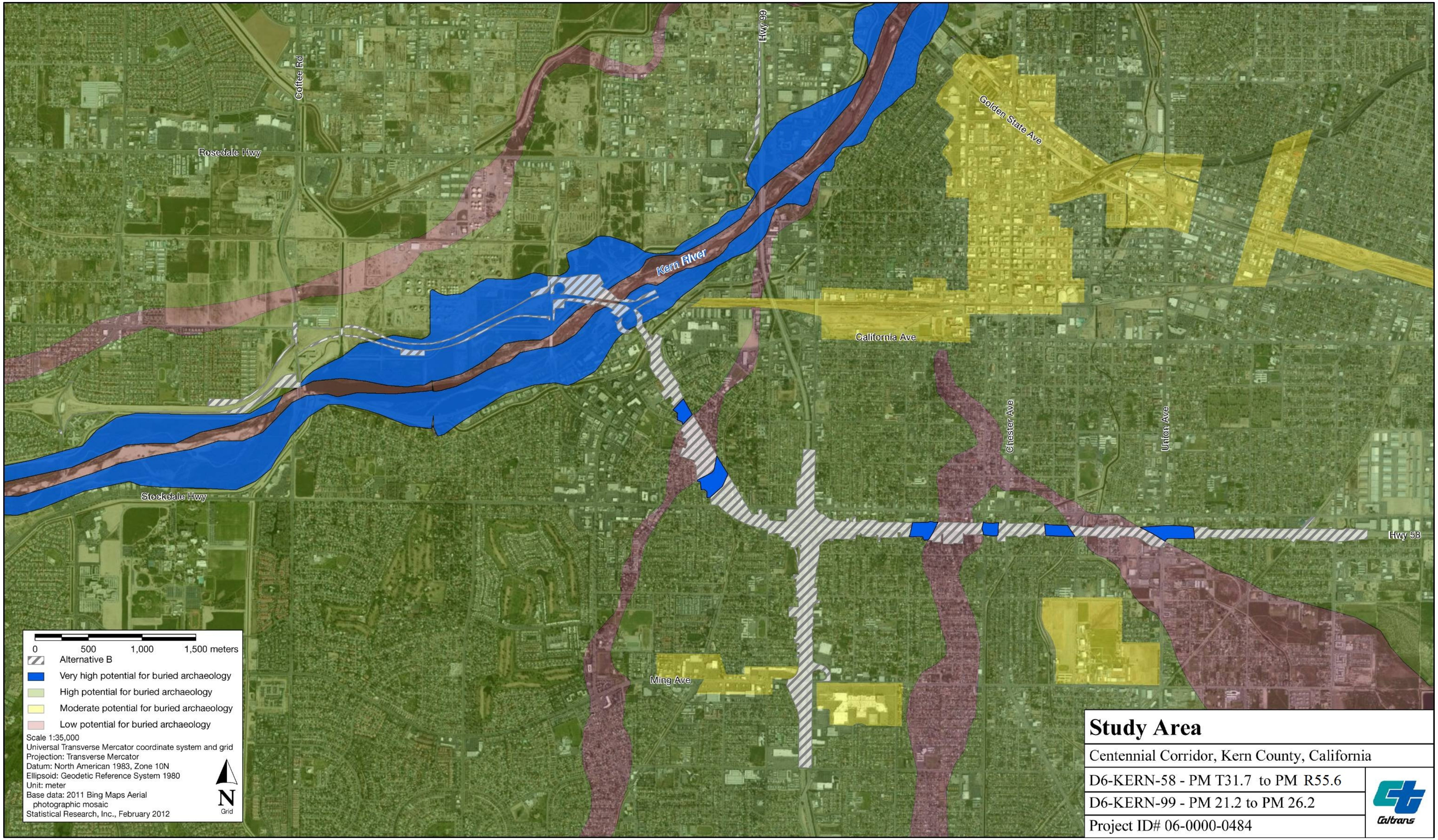

Figure 4-5 Buried-Site Potential of Alternative B

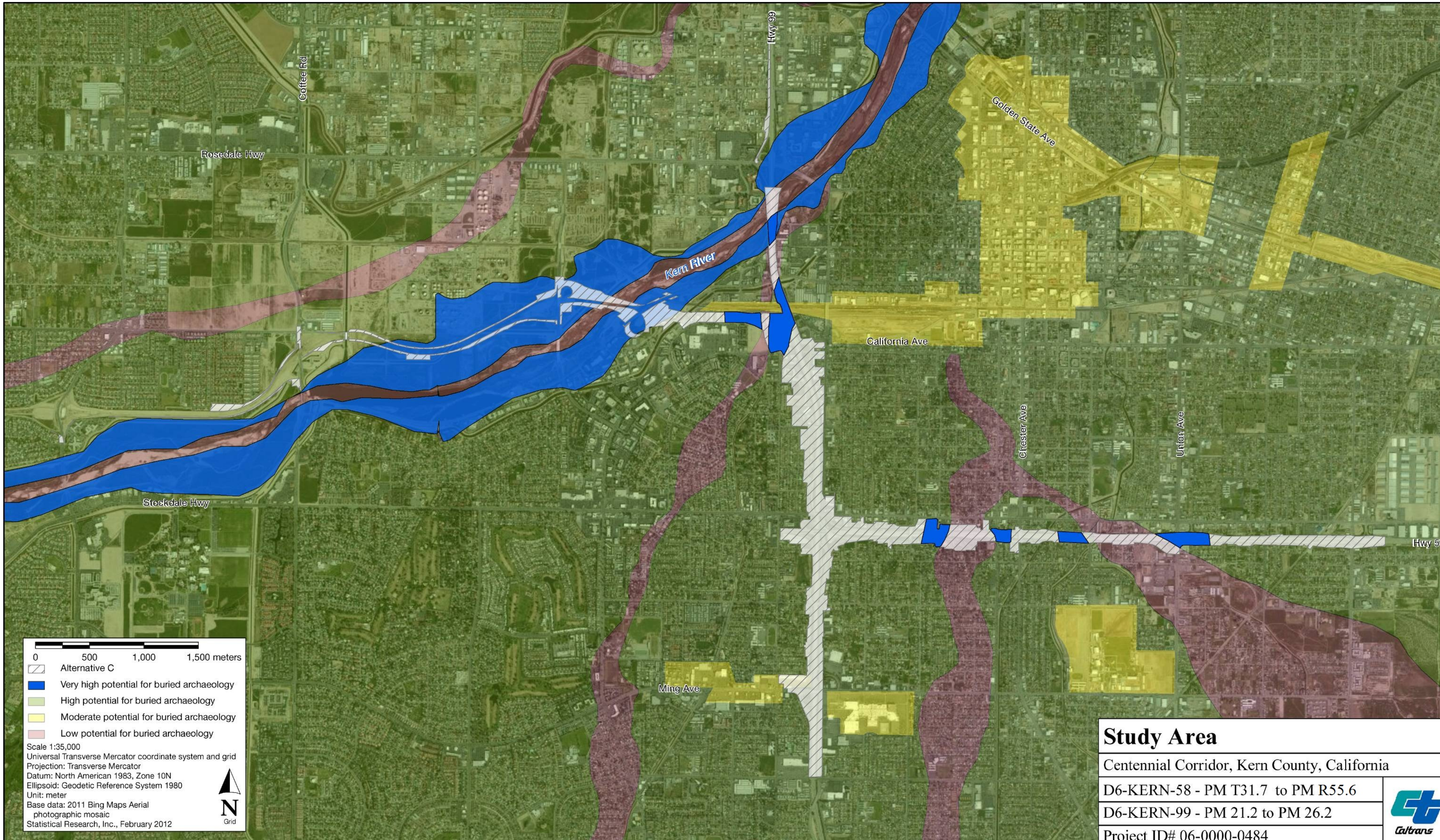

Figure 4-6 Buried-Site Potential of Alternative C

the late Holocene, when the alluvial cap was deposited. Therefore, the Qa3 surface is considered to have a high potential for buried archaeological resources in association with this buried soil. The late Pleistocene paleosol below Qa3 is likely buried below less than 2–3 meters of late Holocene alluvium.

4.3.4 Very High Potential

Areas of very high potential on the Qa2 and Qa1 surfaces are adjacent to the abandoned channels identified in the 1952 aerial images and the modern channel of Kern River (see Figures 4-2–4-5). The nearby water would have made these areas particularly attractive locations for prehistoric settlement (see Figures 4-3–4-5). Depositional rates would also have been higher on the proximal floodplain adjacent to these channels, making burial of prehistoric occupation surfaces more likely.

4.3.5 Distribution of Sensitivity Areas within Alternative A, B, and C

Among the three alternatives, Alternative C crosses the highest number of acres with very high and high potential (354 total acres) on the Qa1 and Qa2 alluvial-fan surfaces (Table 4-3). Alternative B crosses the lowest number of acres of very high and high potential (321 total acres) and the highest number of acres of low potential (69 total acres) on the Qa0 surface. All three alternative routes extend over areas of very high potential that are adjacent to abandoned channels and the modern channel of the Kern River, where buried sites (if present) are most likely to be found.

Table 4-3 Buried-Site Potential for Alternatives A, B, and C, in Acres

Buried-Site Potential	Alternative		
	A	B	C
Very high	25	30	52
High	319	291	302
Moderate	154	133	175
Low	36	50	69

Section 5 Summary and Conclusions

The objectives of this stage of the Extended Phase I study were to define the spatial distribution of late Quaternary landforms within the study area from existing soil and geologic data sources and then to construct a geologic-sensitivity model addressing the potential for buried intact archaeological resources. This model has increased the resolution of the regional District 6 and 9 model in the study area.

The study revealed the presence of four distinct late Quaternary surfaces on the Kern River alluvial fan. The Qa3 surface is underlain by a thin cap of late Holocene alluvium dating to less than 3000 years B.P. that is deposited on top of a latest Pleistocene soil dating to 11,000 years B.P. The Qa3 surface has a high potential for buried archaeological resources within 2–3 meters of the modern surface. The Qa2 surface is underlain by up to 10 meters of early–late Holocene alluvium with buried soils dating from 9000 to 2000 years B.P. Radiocarbon dates indicate that the Qa2 surface is less than 1,200 years old. Several late Holocene Qa2 channels were identified from historical aerial photographs on the Qa2 surface, each of which represent prehistoric water sources. In all likelihood, areas adjacent to these channels have a high potential for containing buried intact cultural resources.

The Qa1 surface is inset (incised) into the Qa2 surface and is therefore considered to be younger. Regional radiocarbon dates indicate that this surface is underlain by alluvium less than 1,000 years in age. The surface of this unit most likely dates to less than 500 years B.P. Because prehistoric sites have been recorded on the Qa1 surface adjacent to the Kern River, we interpret this setting as having a very high potential for buried archaeological resources. Potential cultural deposits could extend down to 10 meters below the surface of Qa1.

Then Qa0 surface is underlain primarily by recent (historical-period) channel alluvium, so it has a low potential for intact buried cultural resources. Areas of extensive historical-period disturbance mapped as urban land in the Kern County soil survey are considered to have a moderate potential for intact buried archaeological resources.

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