Caltrans Historic Bridges Inventory Update: Concrete Arch Bridges

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Environmental Program
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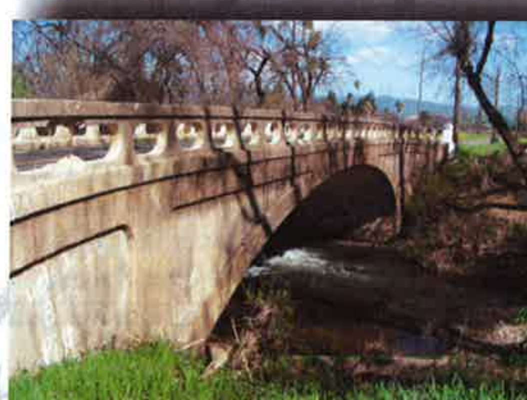

Volume I

Revised
October 2004

Cover Images: (Top to bottom, left to right)
Bridge 22C0003, Yolo County Road over Cache Creek, Yolo County;
Bridge 51 0110, State Road 192 over Romero Creek, Santa Barbara County;
Bridge 53C0399, Elberon Road over Gaffey Street, Los Angeles County;
Bridge 32C0040, Clarks Fork Road over the Middle Fork of Stanislaus River, Tuolumne County;
Bridge 23C0076, Suisun Valley Road over Suisun Creek, Solano County;
Background, Detail from Original Plans, Donner Summit Bridge (17C0052), 1924.

For individuals with sensory disabilities this document is available in alternate formats. Please call or write to Andrew Hope, Caltrans Environmental Program, Mail Station 27, P.O. Box 942874, Sacramento, CA, 94274-0001. (916) 654-5611 Voice, or use the CA Relay Service TTY number 1-800-735-2929.

Addendum
July 2005

This report concluded that Bridge 24C0268 (Orangevale Avenue over Gold Creek) is not eligible for listing in the National Register of Historic Places.

However, this bridge was re-evaluated in 2005 and determined eligible for National Register listing. The State Historic Preservation Officer concurred in this finding on April 14, 2005.

The DPR-523 forms for the 2005 re-evaluation have been inserted into this report, following the bridge rating sheet forms for the Orangevale Avenue Bridge.

Caltrans Historic Bridge Inventory Update: Concrete Arch Bridges

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VOLUME I: REPORT AND FIGURES

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SUMMARY OF FINDINGS

JRP Historical Consulting (JRP) prepared this report for the State of California Department of Transportation (Caltrans) Environmental Program at Caltrans Headquarters in Sacramento, as part of the department's program to update its historic bridge inventory. Caltrans intends to use this report to request determinations from the State Historic Preservation Officer (Office of Historic Preservation, OHP) of the eligibility of 202 concrete arch bridges built in California prior to 1960 to be listed in the National Register of Historic Places. These determinations will be used to assist the Federal Highway Administration (FHWA) and Caltrans comply with applicable environmental and historic preservation laws and regulations as these pertain to historic properties. The historic bridge inventory update will, most importantly, help with compliance to Section 106 of the National Historic Preservation and the California Environmental Quality Act (CEQA).

Caltrans completed its initial historic bridge inventory in 1986. The original inventory included the survey of all known examples of concrete arch bridges with an emphasis on evaluating structures constructed prior to 1936. Caltrans began updating its historic bridge inventory in 2002. Caltrans architectural historians and its consultants prepared the various components of the inventory. The inventory included preparation of a historic overview covering the period 1936 to 1959, which was not addressed in the initial bridge survey. Fieldwork and evaluations of bridges were divided by bridge type. For the concrete arch bridge survey, Caltrans decided to continue use of the numeric point rating system that had been developed for the initial bridge survey. Caltrans revised the numeric system to adjust for the change in historic time frame and to remove the category that provided a score for historical association. (Consideration of National Register Criterion A is treated separately from the numeric rating system.) The rating scores given to the bridges were used as indicators of possible significance and evidence of which structures retained historic integrity. The scoring system was coupled with historical research and a thorough analysis to draw conclusions on which bridges appear to meet the criteria for listing in the National Register.

This document is divided into sections that provide information on the inventory and evaluation update process as well as for historical background. The project description section provides information on the initial Caltrans bridge inventory and details on the current survey. This is followed by a description of the field and research methods used during this survey. This section includes a discussion of the numerical scoring system. Next is a historical overview that provides the historic themes and context by which appropriate evaluations can be made of the survey population. This is followed by a description of the survey population and the findings and conclusions of this study. The final component provides the preparer's qualifications and a list of works cited. Appendix A (included in Volume I) contains letters from the interested public, Appendix B (included in Volume I) has map figures, and Appendix C (Volume IIA and IIB) contains the bridge inventory rating sheets.

Figure 1 (Appendix B) illustrates the counties in which this survey was conducted and the number of bridges inventoried in each county. Figure 2 (Appendix B) provides a set of regional maps of California, based on Caltrans Districts, showing the location of each bridge studied for this report. The inventory rating sheets in Appendix C provide the scores of the 1980s survey, the scores from the current survey, photographs of each bridge, location data (including a location map), and historic evaluation information.

Of the 202 bridges studied for this report, eighty-eight were previously listed or determined eligible for listing in the National Register, fifteen additional bridges now appear to meet the criteria for listing in the National Register, and ninety-four do not appear to meet the criteria for listing in the National Register. There are also five bridges whose significance has been left undetermined at this time. None of bridges that were previously determined eligible have lost historic integrity, thus they appear to continue to meet the criteria for listing in the National Register.

Table 1: Bridges that appear to meet the criteria for listing in the National Register

County	Bridge #	Year Built	Feature Intersected	Road / Street
Siskiyou	02 0012	1929	Dry Gulch	State Route 263
	02 0014	1931	Shasta River	State Route 263
Alameda	33C0215	1930	Sausal Creek	Leimert Blvd
Los Angeles	53 0392	1906	Cesar E. Chavez Avenue Overcrossing	Cesar E. Chavez Avenue Overcrossing
	53C0399	1934	North Gaffey Street	Elberon Avenue
	53C1686	1928	Arroyo Canyon	Westridge Road
	53C1874	1912	Arroyo Seco Channel	York Boulevard
	53C1875	1939	Arroyo Seco Channel	Avenue 26
	53C1878	1939	Arroyo Seco Channel	Avenue 60
	53C1881	1929	Los Angeles River	Hyperion Avenue
	53C1882	1929	Hyperion Avenue	Hyperion Avenue
	53C1883	1929	Los Angeles river	Glendale Boulevard
	53C1884	1929	Los Angeles river	Glendale Boulevard
Riverside	56C0072	1931	Mount Rubidoux Overcrossing	Mount Rubidoux Overcrossing
San Diego	57C0596	1915	Laurel Street Overcrossing	Laurel Street Overcrossing

TOTAL 15 bridges

Revisions, October 2004

Minor revisions to this report were made in October 2004 by Caltrans' architectural historian Andrew Hope. The revisions were made following discussions among Caltrans staff and representatives of the state's Office of Historic Preservation, related to an earlier report which evaluated metal truss bridges. Section 4.1 was added to this report to provide additional information on changes to the population of concrete arch bridges since the original statewide survey of the mid-1980s, and Section 5.3 was expanded to include more detail on the process of evaluating bridges for National Register eligibility. There have been no changes to the report's conclusions with respect to which bridges are eligible or ineligible for National Register listing.

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1. PROJECT DESCRIPTION – HISTORIC BRIDGE INVENTORY UPDATE

1.1. Background

Caltrans conducted its first comprehensive historic bridge inventory between 1984 and 1986. Caltrans prepared reports and documentation on behalf of the Federal Highway Administration, in order to consult with and obtain concurrence from the California State Historic Preservation Officer (California Office of Historic Preservation or OHP) regarding the eligibility of the state's roadway bridges for listing in the National Register of Historic Places. OHP concurred with the findings of the bridge inventory between 1985 and 1987, and Caltrans subsequently published bridge logs that listed the National Register eligibility for all bridges within its jurisdiction, including both those owned by the state and by local agencies. Caltrans created two lists of bridges, those on state highways (including interstate highways, US routes, and state routes) and those on local agency roads, i.e. county or city roads / streets. Each list was organized by county name and bridge number. The historic eligibility categories were assigned as follows: 1) Listed in the National Register; 2) Eligible for the National Register; 3) Possibility Eligible for the National Register; 4) Historic Significance Not Determined; and 5) Not Eligible for the National Register.

From 1987 until the mid-1990s, Caltrans, local agencies, and others relied on the determinations cited on the historic bridge logs to indicate the historic significance of roadway bridges in California. These determinations were used, as applicable, for compliance with environmental and historic preservation statutes and regulations as they relate to historic resources, most often for compliance with Section 106 of the National Historic Preservation Act, National Environmental Policy Act, and California Environmental Quality Act.

By the mid-1990s, Caltrans began re-evaluating bridges (or requesting re-evaluations of bridges) on an individual basis as it became evident that the accuracy of the original survey was diminishing. First, bridges built in 1936 or later had not been 50 years old at the time of the first survey and now needed to be addressed under National Register criteria without consideration of exceptional importance. This accounted for hundreds of bridges that were built during a period when California's transportation system grew enormously in the late 1930s, 1940s, and early 1950s. Second, many older bridges had been replaced so that the population comparison of similar properties had been reduced. Third, there were also several innovative bridge types and technologies introduced for use on California's roadways during the 1930s, 1940s, and 1950s that had not been addressed in the 1980s survey. Case by case, project by project, evaluations continued throughout the late 1990s and into the 2000s. This method of re-evaluation, however, was generally inefficient and was, at times, inconsistent. Thus in 2002, Caltrans decided to conduct a thorough update of the 1980s survey. This update is important for producing more consistent and defensible results because it permits holistic, context-based evaluations to occur with state-wide comparisons of similar properties and a thorough examination of new and innovative bridge types and technologies from the 1930s, 1940s, and 1950s.

1.2. Current Project

The Environmental Program at Caltrans Headquarters in Sacramento began the project to update the Caltrans historic bridge inventory in 2002. Caltrans architectural historians reviewed and assessed the 1980s inventory, collecting all records related to the survey and evaluation process. They carefully considered what elements of the previous inventory could be re-used and which elements needed to be revised. Caltrans and OHP agreed that the Historic Bridge Survey Update would include bridges constructed prior to 1960 so that individual bridge reevaluations will not be necessary until 2010. Caltrans staff then assembled a database from the Office of Structures Maintenance and Investigation bridge logs, both for state bridges and local agency bridges, along with the logs listing the historical significance of bridges, to help derive a list of structures to be surveyed and evaluated. The database included information on the location, type, material, and construction date of each bridge. Caltrans architectural historians also examined other maintenance records, previous historical survey records, and recent historic evaluations to compile the survey population for the update project. Once the lists of bridge types were completed, information on each bridge was collected, including rating sheets from the original survey, photographs, and bridge reports archived at Caltrans Office of Structure Maintenance and Investigation. Caltrans staff also contacted local historical societies and other interested parties to assure compliance with the public notification requirements of Section 106. Caltrans architectural historians and consultants conducted the field inventory work and historic evaluations for the update. As a part of the update project, JRP prepared a historical overview for all roadway bridges constructed in California between 1936 and 1959, and conducted inventories and evaluations for concrete arch, metal truss, movable, steel arch, timber truss, concrete truss, and suspension bridges.

This report is part of the larger 2002-2004 Caltrans Statewide Historic Bridge Survey Update project that includes re-evaluations of most of the extant bridges surveyed and evaluated in the original 1986 Historic Bridge Inventory as well as evaluations of other bridges built before 1960. The survey population of concrete arches includes 202 bridges. Each was inventoried and recorded in the field and evaluated for National Register eligibility. At the onset, bridges that were listed in the National Register or determined eligible for the National Register in the original survey, or in individual evaluations since that time, were presumed to remain eligible unless they lost historic integrity because of substantial alterations.

The survey population for this report does not include all the concrete arches within the Caltrans system. There are an additional 57 bridges that were not re-surveyed because they appeared ineligible for National Register listing based on existing information at Caltrans' Headquarters Environmental Division. Bridges in this group meet one or both of the following conditions:

1) They do not possess engineering, design, or aesthetic significance, are not associated with historic roads or canals, and have no potential to be contributors to historic districts.
2) They have suffered a substantial loss of integrity because of later widening or other alterations.

This group of 57 bridges includes no open spandrel arches, none of the earliest or largest examples of this bridge type, and none which possess significant architectural treatment or ornamental features. Some are little more than large culverts. All are currently listed as "category 5" (ineligible for National Register listing) as a result of the 1980s statewide survey.

2. FIELD AND RESEARCH METHODS

2.1. Compilation of Information and Research

Caltrans provided JRP the newly compiled database and a list of 202 concrete arch bridges, along with information on each individual bridge including scoring sheets from the original survey, copies of photographs, and bridge reports. JRP organized these records into field research sets. JRP entered data from the original scoring sheets into the database and added other data fields to be used during survey work. JRP located all bridges subject to the survey on road and street maps and collected field research sets into units based on location of bridges, generally by groups of counties and/or by Caltrans district.

JRP also conducted historical research for the bridges prior to and/or after conducting field work, to help assess the possible significance survey population bridges may have under Criterion A. JRP used previously collected information, including from the current and previous historic overviews, city, county, and state maps, United States Geological Survey quadrangle maps, and other sources to make a preliminary determination of whether or not specific bridges might be eligible under Criterion A. JRP restricted this research to those bridges that were not already listed in or determined eligible for listing in the National Register.

2.2. Fieldwork

Caltrans architectural historians revised the numeric system used in the original survey for the update survey. Prior to starting fieldwork, JRP staff familiarized themselves with the scoring system and conferred with Caltrans regarding recordation standards. JRP prepared field survey forms with each bridge's location data, previous survey scores, current scoring fields, and notes fields. Caltrans specified that JRP take high-quality digital photographs of each bridge in the survey population. JRP used Olympus C-720 cameras, taking three megapixel photos at 1984x1488 pixel resolution.

2.2.1. Description of the Numerical Scoring System

The numerical scoring system used to survey California's concrete arch bridges constructed prior to 1960 is a modified version of the scoring system Caltrans used for the state's original concrete arch bridge survey conducted between 1984 and 1986. For this survey update project, Caltrans modified the original scoring system to account for bridges constructed after 1936 and to separate historical significance from the numerical system. The scoring system provides relational data that is used as the basis for evaluation of which bridges may be eligible for listing in the National Register.

Caltrans developed the scoring system for the 1980s bridge inventory from those used in other states in the 1970s and 1980s as well as from the City of San Francisco's historic building survey conducted in the 1970s. Caltrans modified the various numeric system examples to reflect the distinctive qualities of California's bridges and to improve upon previous methodologies. To provide continuity between the 1980s survey and the update, Caltrans decided to continue use of the numeric system. The eight categories of points in the revised scoring system represent variable elements of a bridge's possible significance. The system assigns points to each variable, creating a weighted system. As with the 1980s study, this point system transforms ordinals into integer ratings and distinguishes between the relative importance of the variables.

For the update survey, Caltrans dropped one category from the original point system as it was found to mix considerations needed to distinguish between a bridge's possible significance under Criterion A and Criterion C. Originally, Caltrans assigned 10 points for bridges that appeared to be significant at the national level, 7 points for bridges that appeared significant on the state level, 3 points for bridges that appeared significant at the local level, and 0 points for bridges that did not appear to be significant or their significance was unknown. In the revised scoring system, no points were given based on historical association or significance within the theme of transportation. Rather, Criterion A significance has been evaluated separate from the numeric system.

In the revised point system, Caltrans also modified the points given on the basis of a bridge's date of construction. Caltrans decreased the negative emphasis placed on the age of youngest categories of bridges in relation to other categories. At the same time, the new point system does not remove the value of age of the state's older bridges. In the 1980s, Caltrans assigned 4 points to bridges built between 1931-1937, 0 points to bridges built between 1937-1945, and –20 points to bridges built after 1945. In the new system, 4 points are assigned to bridges built between 1931-1945, and 0 points are assigned to bridges built between 1946-1960. The new scoring system provides a maximum score of 90 points, compared to 100 points for the 1980s system.

The categories are divided into two general groups, both of which contribute to an assessment of a bridge's significance under Criterion C, including information to evaluate a structure's relative significance for its type, period, and method of construction. Points are also given for the relative importance a bridge has as the work of a master designer or builder. The first group of points is assigned to bridges based on historical and physical facts. These categories are its date of construction, length of the main span, and total bridge length. The second group of categories is more subjective and requires interpretation of historical information, appraisal of decorative features, and assessment of aesthetics, historic integrity, and technological significance. These judgments were made when the bridges were recorded in the field as well as following completion of fieldwork when comparisons could be made between bridges from across the state. Caltrans instructed JRP to generally rely on scores from the previous survey that appeared correct or reasonable. JRP found it necessary, however, to conduct categorical assessments to provide greater consistency between the scores of similar bridges. In some cases, bridges appeared to be the similar or the same as they were in the 1980s, but JRP altered points in particular categories so that those scores were consistent with the overall bridge population and similar structures. JRP adjusted scores for consistency in the categories for: designer significance; aesthetics; and integrity. The numeric scoring system used for this survey is as follows:

Revised Scoring System for Concrete Arch Bridges

Category	**Points**
1. DATE OF CONSTRUCTION	
1910 and earlier	20
1911-1915	17
1916-1920	14
1921-1925	11
1926-1930	08
1931-1945	04
1946-1959	00
2. DESIGNER	
Major example of significant designer	12
Minor example of significant designer	06
Designer not significant, or not known	00

3. MAIN SPAN LENGTH (Feet)

Open Spandrel	Points	*Filled Spandrel*	Points
200 or more	08	100 or more	08
175-199	06	75-99	05
150-174	04	50-75	03
125-149	03	25-49	01
100-124	02	Less than 25	00
75-99	01		
Less than 75	00		

4. TOTAL LENGTH (Feet)

Open Spandrel	Points	*Filled Spandrel*	Points
1000 or more	08	200 or more	08
500-999	05	100-199	05
250-499	02	50-99	02
Less than 250	00	less than 50	00

Category			Points
5. AESTHETICS			
Structural			
Excellent			05
Good			03
Fair			01
Poor			00
Setting			
Excellent			05
Good			03
Fair			01
Poor			00
6. TECHNOLOGICAL SIGNIFICANCE			
Excellent			20
Very good			15
Good			10
Fair			05
Poor/unknown			00
7. SPECIAL FEATURES			
	Major	Minor	None
Decorative lanterns	02	01	00
Decorative railings	02	01	00
Pylons	02	01	00
Decorative spandrel area	02	01	00
Distinctive texture/facing	02	01	00
Pedestrian amenities	02	01	00
8. INTEGRITY			
Location / Setting			
Excellent			00
Good			-03
Fair			-06
Poor			-09

Category	Points
Design / Materials / Workmanship	
Excellent	00
Good	-03
Fair	-06
Poor	-09
Feeling / Association	
Excellent	00
Good	-01
Fair / Poor	-02
Maximum number of points possible	**90**

2.2.2. Bridge Recordation

JRP conducted the fieldwork survey in two person field crews. Each of the 202 bridges was field checked and its existing score was confirmed or amended. Recordation included photography of each bridge, examination of any alterations to the structure, review of alterations to the setting, and assessment of the potential for the bridge to be considered part of a historic district or historic landscape. As discussed above, JRP revised some scores to improve the consistency of scores upon review of the entire survey population.

Each of the 202 bridges was given a score according to the system described above. Based on the results of the survey and scoring, JRP then identified bridges that were possibly significant under Criterion C. To assess the eligibility of these bridges to be listed in the National Register, JRP reviewed the rating scores, the results of the public participation effort, whether or not the bridges examined appeared to be contributing resources to some larger historic district and/or historic landscapes, and analyzed the subset of bridges that might be eligible under Criterion A.

2.3. Public Participation

In April 2003, Caltrans sent letters to the county planning departments of each county in California, nine cities, and 58 historical societies and historic preservation organizations, informing them of the statewide historic bridge survey update and inviting their comments. Caltrans received one response from the Tuolumne County Historical Society, requesting continued consultation regarding the evaluation and re-evaluation of bridges in Tuolumne County. Caltrans sent a draft copy of this report, including Volume I and the evaluation forms for Tuolumne County Bridges, to the Tuolumne County Historical Society for their review on February 10, 2004. No response was received as of June 7, 2004.

Caltrans also sent a draft copy of this report to architectural historian Don Napoli of Sacramento on February 10, 2004. Mr. Napoli responded on March 5, 2004. His letter, and Caltrans' response, are included in Appendix A.

On May 19, 2004, Caltrans architectural historian Andrew Hope met with Mr. Richard Wilhelms of the Folsom Heritage Preservation League. Mr. Wilhelms presented information on the Orangevale Avenue Bridge in Folsom (Bridge 24C0268), which is currently planned for replacement, and requested that the National Register eligibility of this bridge be reconsidered. Mr. Hope's written response to Mr. Wilhelms, dated June 8, 2004, is included in Appendix A.

3. HISTORICAL OVERVIEW

The following section provides the background and details regarding the historic themes and historic contexts with which concrete arch bridges built in California before 1960 may be associated. Emphasis has been placed on collecting information regarding the historic context of bridges that were not previously listed or determined eligible for listing in the National Register, particularly from the period between 1936 and 1959, which was not covered by the original Caltrans bridge survey in the 1980s. This historic overview is intended to provide the basis for the evaluation of bridges in this study's survey population. The first part of this section deals with important events and trends in transportation history before 1960 and the role bridges played within that context and how, or whether, the construction of concrete arch bridges relates to these contexts. The second part of the section provides information on the engineering, design, and construction of concrete arch bridges in California prior to 1960.

3.1. Important Events and Trends in Transportation Development

Until the end of the nineteenth century, roadway bridge building in California was largely conducted by private companies or individuals, with little input from local or state government. Around the turn of the twentieth century, the state began to create legislation enabling counties to take over the role of establishing and maintaining roads and bridges. County officials continued to be the dominant players in bridge construction until the voters passed a series of bond measures beginning in 1910 that led to the creation of the California Highway Commission (later renamed the California Division of Highways). As motor vehicle use grew across California, the state, counties, and cities built ever increasing numbers of bridges. With the growing demand, bridge design and construction methods changed and designers and builders sought innovative solutions to meet the changing requirements of the state's roadway system. Improved bridge design and construction methods helped provide safer more efficient roadways and highways in the state. Highway and bridge engineers developed the necessary infrastructure to service regional markets and to provide the means to transport local resources widely for manufacturing and the public's consumption. Over time and throughout the mid-twentieth century, first and second generation bridges dating from the nineteenth or early twentieth century were replaced or modified as the state, counties, and local communities sought ways to provide appropriate transportation corridors to connect burgeoning towns and cities while accommodating the demands of an expanding state economy and growing population. During World War II and in the postwar years, bridges also became crucial links in a transportation system expanded to manage the movement of military personnel and equipment between the new military facilities located throughout the state. Naturally, bridges played a critical role in the state's roadway and highway system that continued in the 1940s and 1950s, as the nation's defense and growing transportation needs required reliable bridges in California to carry increasingly heavy loads and traffic volumes. Immense population and economic pressures following the war resulted in the construction of the freeway system that became a hallmark of mid-twentieth century California.

The following discussion divides the period 1900 to 1959 into four chronological periods. The first period addresses the changes that occurred at the turn of the twentieth century that brought county surveyors and consulting engineers to the forefront of bridge building. The second period details the shift of bridge building responsibility from the county officials to the bridge department of the California Division of Highways and the apex of the City Beautiful movement. The third period addresses roadway bridge building by the state government as California emerged from the Great Depression. The fourth period addresses the increasing role of the federal government in bridge building during and after World War II and the changes brought about by the development of extensive freeway systems.

3.1.1. County and Consulting Engineer Era: 1900 To 1910

Until the 1880s, highway bridge building in California was a predominantly private operation. While a few counties built public bridges as early as 1855, it was not until 1874 that the State Legislature adopted a comprehensive program through which counties could establish road districts, road commissioners, and property taxes reserved for road construction. The ability of counties to execute bridge construction was further enhanced by an 1893 state law mandating each county to seek the advice of its county surveyor on bridge design. This law had the effect of professionalizing the office of county surveyor and helped attract trained bridge engineers to the office.[1] Though counties typically built trusses early in this period and then began to shift to reinforced concrete structures, the bridges built in each county often reflected the local traditions and preferences of the county surveyor.

Some of the most important pioneering work in developing reinforced concrete occurred in California. In the late nineteenth century, steel was generally expensive in the state as much of it had to be imported from eastern states. Engineers in both the United States and Europe sought ways to enhance concrete for use in building and bridge construction. In California, such efforts were concentrated in and around San Francisco where it was used to construct sidewalks, floors, and buildings beginning in the 1880s. The first reinforced concrete bridge in the United States was the Alvord Lake Bridge built in 1888 in San Francisco's Golden Gate Park, shown in Photograph 1.

Photograph 1: Alvord Lake Bridge, San Francisco (Caltrans, 1990).

Ernest L. Ransome (1852-1917) designed the structure. Ransome was a leader in reinforced concrete building technology and a consulting engineer. The bridge was constructed to eliminate

[1] Paul Bryan Israel, "Spanning the Golden State: a History of Highway Bridges in California," (Masters Thesis, University of California, Santa Barbara, 1980).

a dangerous carriage road crossing between a trolley stop and a children's playground.[2] In the 1890s and 1900s, cities and counties began to use concrete for construction of bridges. Most of these early bridges, designed both by county surveyors and consulting engineers, were small, most little more than culverts over small creeks. They were also built as "plain concrete" structures without metal reinforcement.[3] An example of a bridge constructed in this early period is the Saratoga Creek Bridge (37 0074), a plain concrete bridge faced with stone masonry, constructed in 1902, shown in Photograph 2.

Photograph 2: Saratoga Creek Bridge (37 0074), built 1902.
February 2003.

It was designed by John Gilmore McMillan (1851-1935), an engineer for Santa Clara County, who had been experimenting with combinations of metal, stone, and brick with concrete for use in bridges in the 1890s. In the current survey, thirty of the 202 of the concrete arch bridges in the

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[2] California Department of Transportation, *Historic Highway Bridges of California*, (California Department of Transportation, 1990), 18.
[3] John Snyder and Steve Mikesell, "The Consulting Engineer and Early Concrete Bridges in California," *Concrete International* (May 1994), 39.

survey population were built in or prior to 1910, with over 75 percent of these located in northern California.

These early concrete arch designers influenced later designers to the general understanding of what a concrete arch bridge should look like. They helped to establish a belief, that was later continued by the Division of Highways Bridge Department, that concrete arches should be used in beautiful natural settings taking into account or responding to such environments. The challenge for these pioneer bridge designers was both technological and aesthetic.[4]

3.1.2. Early State Era: 1910 To 1930

The passage and approval of the State Highway Act in 1909-1910 provided funding for the construction and acquisition of a system of state highways. The California Highway Commission (later renamed the California Division of Highways) was created in 1911 to oversee this work and maintain the highway system. Though during much of this period many of the structures were still the responsibility of the counties, the state began to have increased influence on the design and construction of bridges throughout California. Beginning in 1912, the Commission required that all structures built as part of the state highway project be designed by competent engineers and the plans, specifications, and workmanship be subject to the inspection and approval of the Highway Engineer.[5] The increase in workload due to the design and approval requirements led to the creation of a Bridge Department within the Highway Commission. The 1912 Highway Commission policy statement emphasized a preference for concrete bridges, stating that the commission "declares itself in favor of concrete structures whenever such structures are consistently possible because of their substantial permanency."[6]

By the second decade of the twentieth century, much of the initiative in reinforced concrete design passed from engineers in Northern California to those in the Los Angeles area. Gathered in Los Angeles during this decade was a skilled and innovative group of engineers specializing

[4] Snyder and Mikesell, "The Consulting Engineer and Early Concrete Bridges in California," 40.

in reinforced concrete arch design that designed bridges such as the seven span Colorado Street Bridge, 53C0107, which was the highest bridge in the world at the time it was built in 1913.

During the early twentieth century, civic leaders and politicians sought ways to improve urban environments to thwart the ravaging effects of the Industrial Revolution that had become apparent by the late nineteenth century. The Chicago Columbian Exposition of 1893 was highly influential across the country, providing a model of how modern cities could be organized and built. This led to what became known as the City Beautiful Movement which inspired urban beautification in architecture, landscaping, and city planning in the United States from the 1890s through the 1920s. The central component of the City Beautiful Movement was the influence of Neoclassical architecture as practiced by the Ecole des Beaux Arts in Paris. As more American architects studied or were influenced by the school, its effect was seen in the design of urban commercial buildings, civic centers, grand boulevards, and parks. The City Beautiful Movement held that civic structures and public works should not only be highly functional, but also be civic monuments touting the tenets of Neoclassical architecture. Bridges, of course, were among the many civic structures that were treated in this manner and planned for integration with wider city or regional planning efforts.

In a 1913 article in *Architect and Engineer*, "Bridges in Relation to the City Plan," Chicago engineer Henry Gratten Tyrrell, for example, discussed the Beaux Arts potential for bridge design. Tyrrell offers general principles through which bridges could be "adorned" with classical-inspired architectural elements including ornamental columns, decorative railings, and spandrel walls. He emphasized that bridges were as much a part of the City Beautiful as the city hall, railroad depot, or other major public structures. Tyrrell discounted trusses as utilitarian and of little aesthetic value, but he did not specifically recommend concrete arches. Given the Beaux Arts embellishment of such structures at this time, for practical purposes, Tyrrell was likely implying the use of concrete arch bridges, particularly as the arch was a important feature of Neoclassical architecture.[7]

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[5] Israel, "Spanning the Golden State," 56-60.

[6] U.S. Bureau of Public Roads, "Report of a Study of the California Highway System," (1920), 63.

[7] Stephen D. Mikesell, "The Los Angeles River Bridges: A study in the Bridge as a Civic Monument," *Southern California Quarterly* (Vol 68, 1986), 372-373.

Engineers in California were aware of these national trends in city planning and in Los Angeles in particular, the connection between City Beautiful concerns and support for reinforced concrete arch bridges was established early through the efforts of the Municipal Art Commission, founded in 1903. The Municipal Art Commission was the voice for beautification in the city during the early twentieth century. It influenced the city's bridge department and its engineers, including Merrill Butler, who was served as an engineer within the Bureau between 1923 and 1963.[8] The results of the Commissions efforts can be seen in the many ornate Beaux Arts styled bridges spanning the Los Angeles River and adjacent railroad tracks including the 1909 Buena Vista Viaduct (53C0545) and Fourth Street Viaduct (53C0331), and the massive Glendale Hyperion Viaduct (53 1069, 53 1179, 53C1881, 53C 1882, 53C1883, 53C1884), the three part viaduct that carries traffic of both Glendale Boulevard and Hyperion Avenue over the river, providing a junction of the two streets to minimize cross traffic, and eliminating a dangerous street railway crossing at this location.

Concrete bridge construction in California, as with many public works, generally stopped during American involvement in World War I. Following the war, California entered into a period of unprecedented economic expansion and followed a much different approach to public works expenditures. The most important post-1919 development was the creation of a corps of highly-skilled public service bridge engineers who largely displaced consulting engineers as the designers of concrete bridges in California. The most important group of engineers were those working at the State Division of Highways, although cities and counties attracted talented engineers as well.[9]

3.1.3. Depression Era: 1930 To 1940

Following the lowest point of the Great Depression in the early 1930s, bridge construction in California became an integral part of state and federal plans for economic recovery through public works projects. Government employment relief programs largely spurred this recovery, with the federal government providing much of the funding for bridges constructed in the state

[8] Mikesell, "The Los Angeles River Bridges: A study in the Bridge as a Civic Monument," 373.
[9] Snyder and Mikesell, "The Consulting Engineer and Early Concrete Bridges in California," 43.

during this period. Infused with New Deal money, the California Division of Highways added new highways, built new bridges, and upgraded county roads into the state highway system. During this period, the state struggled to deal with its "old bridge problem" replacing inadequate often pre-automobile structures to accommodate growing volume of vehicular traffic and to address new safety issues.[10]

Concrete bridge building also took place within a much grander scale of highway construction and included concrete arches. During the 1920s and 1930s the Division of Highways built the great highways that link regions of California such as Highway 1 along the coast and Highway 99 at the center of the state. Great highway projects called for great bridges and most of the truly impressive bridges built in California in the 1920s and 1930s were concrete. Some of the best-known American concrete arches were built in California during this period, including the Big Sur arches along Highway 1 in Monterey County, the largest of which was constructed in 1932, the Bixby Creek Bridge (44 0019) with a main span of 330 feet, shown in Photograph 3.

Photograph 3: Bixby Creek Bridge, (44 0019), built in 1932.
September 2003.

[10] "Agency History," Department History File, 1927-1971, California Department of Transportation Library.

It is still the largest concrete arch span in the state. In California, the reinforced concrete bridge was the model highway structure before 1940 because of the durability of reinforced concrete as a building material and the flexibility that this type and material allowed in the design process, as well as for its aesthetic appeal. Following the war, labor and material costs rose substantially, making concrete arch bridges prohibitively expensive for most projects.

Architectural trends began to change during this period as well. By the mid-1930s, the architectural and design aesthetic for prominent new buildings and structures in California had started to shift away from the Beaux Arts and City Beautiful Neoclassicism of the early part of the century towards the aesthetic of the Moderne or International Modern styles that were more abstract, stripped-down, and unadorned. These styles were promoted as symbols of twentieth century technological progress and were a reaction to the perceived excesses of ornament adopted during the late 19th and early 20th centuries. This was attractive as the country emerged from the Great Depression and there was little extra money to be devoted to the excessive ornament, particularly on utilitarian structures such as bridges.[11]

During the 1930s, the Division of Highways Bridge Department became aware of the poor condition of many of the state's first- and second- generation highway and roadway bridges. Built for horse and wagon, these bridges were obviously obsolete because of increased automobile and truck traffic. This problem became one of statewide importance as the Division of Highways took over control of an increasing number of county and local roads across the state. Motorists demanded wider and safer bridges permitting higher speeds and straighter roadways. Despite an influx of federal funding into the state for roads and bridges, there was still insufficient money to replace or upgrade all the bridges that needed improvement. The Bridge Department sought to establish more efficient bridge types, erect better bridges for the same cost, and build bridges that could withstand decreased maintenance.[12]

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[11] Arthur L. Elliot, "Fifty Years of Freeway Structures," 1988, Bridges file, California Department of Transportation Library, Sacramento, 3-5 [Edited version of essay printed in *Going Places*, July-August 1989, 12-17], 2; Wilbur J. Watson, "Architectural Principles of Bridge Design," *Civil Engineering*, March 1938, 181 and 184; and Aymar Embury II, "Esthetic Design of Steel Structures," *Civil Engineering*, April 1938, 262.

[12] F.W. Panhorst, "The Old Bridge Problem," paper for Bridge Committee Meeting, American Association of State Highway Officials, Richmond, Virginia, October 10, 1939, introduction and 1-4; F.W. Panhorst, "Old Bridges are Menace," *California Highways and Public Works*, March 1938, 4, 5, and 9; and Steward Mitchell, "$3,000,000

California, like all states, received large allocations of federal money during the Great Depression. Many bridges constructed during the period before World War II were built, in some portion, with federal funding. During the Depression, local California governments sought to reduce their financial and road building responsibilities and lobbied the state and federal government to assume a greater burden of road and bridge improvements. In response, the state had the Division of Highways make improvements on city streets and county roads that connected with the State Highway system. Federal legislation enacted to provide jobs for the millions of unemployed Americans during the Depression provided funding for the majority of construction projects in the state during this period.[13] In the years preceding World War II, demand for bridge construction grew as the country mobilized for possible war. The importance of infrastructure improvements was fully revealed in 1940 when the War Department demanded improvements to the state highway system as part of the national defense effort.[14]

3.1.4. World War II and Postwar Era: 1941 To 1958

Preparations for possible war and the eventual involvement of the United States in World War II created new challenges for the California Division of Highways as mobilization necessitated immediate and widespread highway and bridge improvements. California's climate, Pacific Coast location, and available undeveloped land made it an attractive site for military training and war industries. As a result, the federal government located bases, airfields, shipyards, depots, and factories in the state, many of which were in Southern California and in the San Francisco Bay area. In addition to moving the military, the goal of the National Defense Highway System was to maintain roadways that could connect raw materials and agricultural products with manufacturing and industrial centers.

During the war, scarcity of personnel and materials halted much of the scheduled repair and maintenance needed on bridges, and federal restrictions on use of structural steel, reinforcing

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Needed to Make Bridges on Secondary Roads Safe for Legal Loads," *California Highways and Public Works*, January 1935, 2-3.

[13] David W. Jones, Jr., "California's Freeway Era in Historical Perspective," (Institute of Transportation Studies, University of California, Berkeley, June 1989), 152.

[14] Division of Highways, *Twelfth Biennial Report*, 1940, 25.

steel, timber, and hardware practically stopped new bridge construction for all bridges except those needed for defense purposes. This period saw a decrease in the number of concrete arch bridges being built relative to other designs due to the scarcity of labor and materials such as reinforcing steel and timber to be used for falsework. For example, the Division of Highways originally designed a concrete arch to be built as a replacement for an outdated timber span on Highway 1 over Albion River in Mendocino County (10 0036). When unable to obtain the necessary steel for the concrete reinforcement, they created a new combination steel truss and timber stringer design that utilized an older steel truss structure. Bridge Department engineers adapted designs for the situation using substitute materials for new construction as well as for repair of existing bridges. Steel was the greatest shortage, as the military controlled most of its use. The scarcity of nails needed for concrete forms even made unreinforced concrete structures difficult to construct. Wartime restrictions lasted well into 1946. The postwar bridge building campaign began in earnest in 1947 resulting in the construction of some unique bridges that reflect this unusual period of innovation in bridge design and construction.[15]

During the war years, the Division not only concerned itself with the national defense readiness of California's roads, but it also began long-range planning for postwar expansion and construction in partnership with the federal government. This was part of a government-wide effort to face the issues of postwar recovery. Starting in 1943 the Reconstruction and Reemployment Commission began planning and implementing a comprehensive program for transition to a peacetime economy. The influx of workers to defense industries in both northern and southern California, combined with the anticipated flood of returning service personnel, created a potential postwar unemployment problem. The commission identified a highway public works program, with bridge construction, as a key component of economic development in the postwar era as the labor-intensive construction projects could absorb much of the surplus manpower. In response, the Division of Highways developed a plan to modernize the state highway system that included replacing many of the state's aging bridges. Passage of the Federal Aid Highway Act in December 1944 assured California of federal funds for highway construction. Of primary importance, the act provided for the development of a national system

[15] F.W. Panhorst, "Lack of Material Forcing Engineers to Adopt Unusual Bridge Designs," *California Highways and Public Works,* February 1942, 2; and Division of Highways, *Fifteenth Biennial Report*, (Sacramento: California

of interstate highways, which in California totaled 2,820 miles, connecting major metropolitan centers. It also provided funding for construction and maintenance of a secondary or feeder network of highways designed to connect rural areas to urban centers, complementing the primary interstate highway system.[16]

Following World War II, California and the United States began a period of enormous prosperity and expansion. The state's economy grew and ever-increasing birth rates and migration into the state expanded California's population from just under seven million in 1940 to 10.5 million in 1950 and nearly 16 million by 1960. Perhaps more than any other state in the country, California linked its fate to its transportation infrastructure. The progress was most vivid in California's metropolitan areas and encouraged the shift in population and wealth to the state's urban centers. Both in response and as a contributor to the economic recovery and growth of the period, the state built hundreds of miles of highways and thousands of bridges.[17] The chief impetus of this surge was the massive increase in federal funding for highway construction during the 1950s, most importantly with the Federal-Aid Highway Act of 1956. In response, the Division of Highway developed a freeway master plan in 1958. By the mid-1950s, most bridge construction in California occurred as part of freeway or highway projects that incorporated new bridge designs and styles which superseded the concrete arch design.

Thus, few concrete arch bridges were built in California following World War II. As stated, concrete arches were labor and material intensive designs which became prohibitively expensive. In addition, new and innovative bridge materials and construction techniques were being

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State Printing Office, 1946), 19-23, 45-51.

[16] Division of Highways, *Fifteenth Biennial Report*, 1946, 19-23, 45-51; Division of Highways, *Thirteenth Biennial Report*, 1942, 16-17; California Department of Public Works, Division of Highways, *Fourteenth Biennial Report*, 15; and California Department of Public Works, Division of Highways, *Fifteenth Biennial Report*, 14.

[17] Andrew F. Rolle, *California A History*, (New York: Crowell, 1969), 595, 598, 602; Warren A. Beck and David A. Williams, *California: A History of the Golden State*, (New York: Doubleday, 1972), 435; Ralph J. Roske, *Everyman's Eden*, (New York: Macmillan Company, 1968), 529; and Richard B. Rice, William A. Bullough, Richard J. Orsi, *The Elusive Eden: A New History of California*, 2nd ed., (New York: McGraw Hill, 1996), 498; William H. Chafe, *The Unfinished Journey: America Since World War II,* (New York: Oxford University Press 1986), 117, 123; Richard L. Forstall, "California Population of Counties by Decennial Census: 1900 to 1990," Population Division, US Bureau of the Census, March 27, 1995, accessed October 2002 online at: www.census.gove/population/cencounts/ca_190090.txt; Kenneth T. Jackson, *Crabgrass Frontier: The Suburbanization of the United States*, (New York: Oxford University Press, 1985), 112, 123, 233, 241; Tom Lewis, *Divided Highways: Building the Interstate Highways, Transforming American Life*, (New York: Penguin Group, 1997), 85.

developed at this time. New and innovative designs were developed for slab, box girder, T-beam, and prestressed girders, many of which could be built for a lower cost and for longer spans than the concrete arch designs.

3.2. Engineering, Design, and Construction

In California, concrete is the most common material used for building bridges. Californians were among the pioneers in developing reinforced concrete for use in bridges and were responsible for building some of the most beautiful concrete arches in the world. Both in absolute numbers and in proportion to the total number of historic bridges, reinforced concrete structures appear to be more numerous in California than in any other state in America. Reinforced concrete, concrete with embedded steel bars which bond to the concrete and provide tensile strength, was first used as a building material in France in the 1840s. Use of this material in the United States dates to the mid 1870s. Early reinforced concrete structures built in the United States were large residences, sidewalks, and warehouses. What is distinctive about concrete arch bridges in California is that they are numerous and predominately developed in California, by Californian engineers. Owing to the high cost of steel on the west coast and the ready availability of high quality cement in California, concrete construction was economically feasible earlier in California than elsewhere in the United States.[18]

Every reinforced concrete arch is designed for a particular crossing. Elaborate falsework is needed during the construction of any reinforced concrete arch, from the smallest earth-filled structure to the largest open-spandrel spans, such as was built for construction of the "Lower Crossing" bridge on US99 in Siskiyou County in 1931 shown in Photograph 4. While a few designers experimented with pre-cast arch rings, the vast majority of reinforced concrete arch members were cast-in-place with forms specifically built for that structure. In addition, stresses are more complex in reinforced concrete than in steel structures because of the difference in elasticity of the concrete and steel. Concrete bridge engineers recognized this in designing particular structures for particular crossings.[19]

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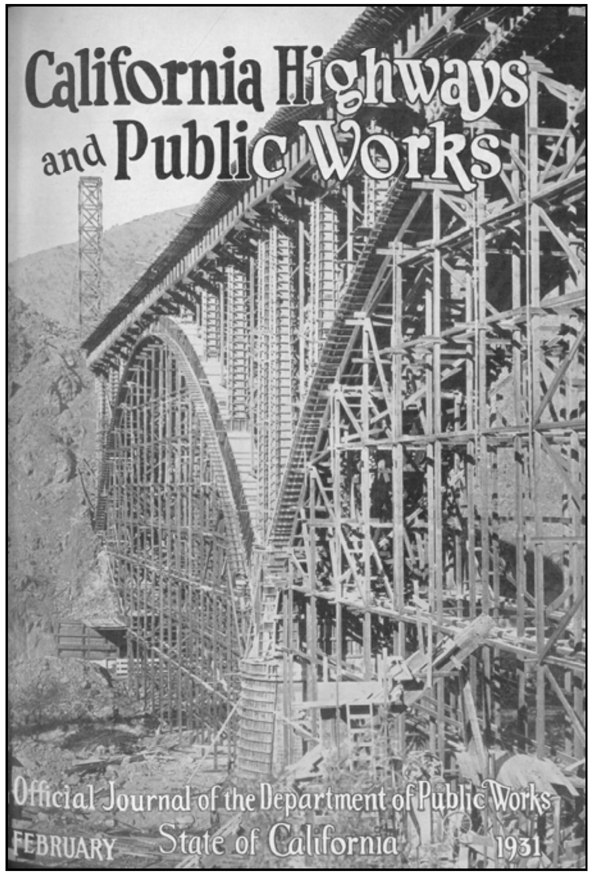
[18] California Department of Transportation, *Historic Highway Bridges of California*, 71.
[19] Mikesell, "The Los Angeles River Bridges: A study in the Bridge as a Civic Monument," 367



Photograph 4: Falsework, Shasta River
Bridge (02 0014), *California Highways and
Public Works* cover, February 1931.

Concrete arch bridges are classified in two forms: closed (or filled) spandrel arch and open spandrel arch. They are also noted by their arch type, such as round, elliptical, and parabolic. A round or semi-circle arch is an arch forming a complete half circle. An elliptical arch is an arch with a curve that becomes tighter towards the crown. A parabolic arch is an arch that resembles the curved form of a parabola. Choice of arch type was both a function of structural requirements and aesthetic intent.

The earliest form of concrete bridge was the closed-spandrel earth-filled arch, such as the Dry Slough Bridge (22C0121), shown in Photograph 5. As with a masonry arch, the closed spandrel arch includes the arch, a solid barrel form of rigid material, with vertical or spandrel walls. The cavity created by the arch and spandrel walls is filled with whatever material is available, usually dirt, and the driving surface is placed on top of the fill. The closed spandrel arch was sometimes constructed with plain, or unreinforced concrete. Reinforced concrete was increasingly used for bridges in California from the 1910s onward. Construction of concrete structures with steel embedded rods, first invented for building construction in warehouses, for example, had proved to be an extremely effective means of improving concrete's natural tensile weakness. While concrete was recognized for its strength when placed in compression, without steel support concrete tended to crack when placed in tension.[20]

Photograph 5: Closed Spandrel Arch, Dry Slough Bridge (22C0121), Yolo County. April 2003.

Open spandrel arches differed from the closed spandrel arch, both in appearance and the manner in which loads are carried. With the open-spandrel arch, both the arch and the spandrel walls are constructed of individual members, joined together at critical junctures. The arch is made of arch rings, which are members that do not form a continuous surface across the underside of the bridge. Usually, two arch rings were used, one at either side of the bridge. The arch rings were typically tied together with horizontal struts, with vertical columns connecting the arch rings to

[20] California Department of Transportation, *Historic Highway Bridges of California*, 78.

the deck. The Donner Summit Bridge (17CO052) is a good example of an open-spandrel arch bridge and is shown in Photograph 6. Open-spandrel arches were built in California in large numbers until World War II, and a few such bridges were constructed in the post war years.[21]

Photograph 6: Open Spandrel Arch, Donner Summit Bridge (17C0052),
Nevada County. May 2003.

As stated, increased cost of labor and materials associated with the construction of concrete arch bridges, including the construction of extensive falsework and manual pouring of concrete, led to the declining use of this type of bridge starting in the late 1930s. The falsework required became more expensive following World War II when there was a lumber shortage spurred by the vast housing construction programs in the state, and the labor required grew increasingly more expensive as postwar unemployment dissipated. Even though the Division of Highways continued to consider construction of concrete arches during the immediate postwar period where, for example, there was steep terrain and a wide span, few were built. Concrete arches were largely replaced when the Division of Highways fully implemented other more modern concrete types such as the reinforced concrete box girder and prestressed concrete girders.

[21] California Department of Transportation, *Historic Highway Bridges of California*, 78.

3.2.1. Aesthetics and Architecture of Bridges

Because of the plasticity of concrete, various architectural and aesthetic designs could be incorporated into concrete arch bridges. Closed spandrel arches could include treatments on the surface of the concrete and open spandrel arches could be formed to a variety of shapes and thicknesses.

Decorative masonry facing on the spandrel walls of the bridge is one feature used by bridge designers to create an aesthetically pleasing structure that was to be integrated with its natural environment. This is demonstrated in the two small masonry faced bridges, shown in Photograph 7, built on Highway 140, the first all-weather route into Yosemite National Park, in Mariposa County (40 0006 and 40 0007). These bridges, built in 1926, blend well with the canyon in which they are located and mimic the rustic stone bridge design in Yosemite Park itself.

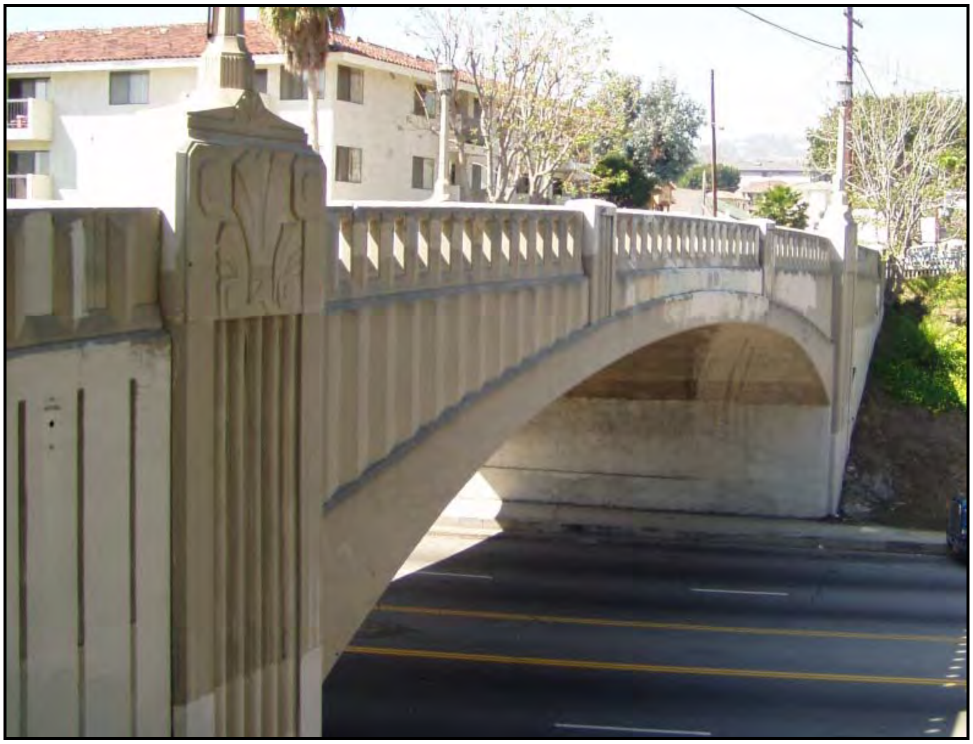
Photograph 7: Masonry faced Sweetwater Creek Bridge (40 0007)
on Highway 140, Mariposa County. May 2003.

The City Beautiful Movement in the early 20th century had a great effect on the design of concrete arch bridges, especially within the City of Los Angeles. These bridges were considered public monuments, like post offices and city halls, and decorated in the same manner. Their Beaux Arts style is characterized by wall surfaces with decorative garlands, floral patterns, or shields; facades with quoins, pilasters or columns (usually paired with Ionic or Corinthian capitals); walls of masonry; and a symmetrical façade. While Beaux Arts styling, such as classic column lanterns and decorative railings and brackets, is most commonly found on larger structures like many of the viaducts over the Los Angeles River including the Fourth Street Viaduct (53C0331), these elements are also found on smaller structures such as the Woods Creek Bridge (32C0043) in a rural area of Tuolumne County.

By the mid-1930s, the architectural and design aesthetic for prominent new buildings and structures in California had shifted towards the aesthetic of the Moderne or International Modern styles that were more abstract, stripped-down, and unadorned. This trend derived from a shift of tastes away from Greco-Roman Classicism, instead breaking the elements of classical architecture down to their fundamental elements of order, symmetry, and proportion to achieve the tenets of functionalism, efficiency, harmony, balance, as well as material and functional honesty. This reaction to the perceived excesses of ornament adopted during the late 19th and early 20th centuries was particularly attractive as the country emerged from the Great Depression and there was little extra money to be devoted to the aesthetics of bridges, which at the time meant adding ornamental features to utilitarian designs.[22] While many bridges across the state continued to be constructed using utilitarian designs, the Division of Highways Bridge Department emerged during this period as a national leader in the design of not only boldly engineered bridges, but also of structures with aesthetic appeal that responded to the changing visual sensibilities of professionals and the public at the time. Such spectacular aesthetic examples of this shift in taste from the 1930s include the Bixby Creek Arch (44 0019). One need only to compare this bridge with the Classical-inspired monumental City Beautiful bridges constructed across the Los Angeles River during the 1910s and 1920, such as the Spring Street

[22] Elliot, "Fifty Years of Freeway Structures," 1988, Bridges file, California Department of Transportation Library, Sacramento, 3-5 [Edited version of essay printed in *Going Places*, July-August 1989, 12-17], 2; Wilbur J. Watson, "Architectural Principles of Bridge Design," *Civil Engineering*, March 1938, 181 and 184; and Aymar Embury II, "Esthetic Design of Steel Structures," *Civil Engineering*, April 1938, 262.

Bridge (53C0859), built 1928. The use of Art Deco elements on the North Gaffey Street Overcrossing (53C0399) in Los Angeles, shown in Photograph 8, is another example that illustrates how the evolution of architectural styles was incorporated into bridge design.



Photograph 8: Art Deco style North Gaffey Street Bridge (53C0399), Los Angeles. March 2003.

As in many design fields during the mid-20th century, some bridge engineers of the period sought to design structures that would not only be functional and efficient but also to represent the essence of their material, eschewing concealment and extraneous decoration for the simplicity, clean graceful lines, and expressiveness of Moderne and International Modern styles. This was expressed by the Bridge Department starting in the mid-1930s as a desire to design bridges without "archaic bric-a-brac" adornment, aiming instead for bridges whose components were "pleasingly proportioned and harmoniously arranged."[23] The Bridge Department appears to have been influenced by the designs and concepts of Alfred Eichler who worked for the Division of Architecture in the Department of Public Works from the 1920s to the 1960s.

[23] Watson, "Architectural Principles of Bridge Design," 183; and Division of Highways, *Eleventh Biennial Report*, 1938, 54.

Eichler who pointed out that not only did applied architectural elements such as moldings, cornices, brackets, and pilasters add cost to bridge design, but that it was difficult to properly apply those classical forms in bridge design resulting in typically unsuccessful compositions. The trend, thus, was away from using historical precedents in hopes that the new structures would transcend the shifts of taste from one generation to another.[24]

The evolution of bridge design accompanied the development of technological innovations such as new materials and construction methods that were less expensive and impeded less on existing roadways. Improvements included the introduction of the concrete box girder, prestressed concrete, and welded steel. Designers had been cladding concrete bridges in stone or brick to not only imitate masonry bridges, but also to cover the material which at that time still tended to permit water infiltration, a problem that decreased the structural soundness of those structures. As concrete improved, there was less need for exterior cladding. Later, Moderne and Modern stylistic choices made their way into California's bridges.

Although one can clearly see a shift in aesthetics and taste in mid-20th century bridge design, many bridges constructed during this period, particularly after World War II, were designed for the greatest economy with less emphasis on the aesthetics of siting, formal expression, viewer and driver experience, or their place as civic monuments. Some of the innovations, and the economies achieved through their application, led to increased standardization of bridge design across the state and thus, in the eyes of critics, greater visual monotony. The result was a dual effect. Bridge standardization coincided with post-World War II aesthetic values that sought form to follow function, yet Modern design qualities were co-opted for mass production of bridges in postwar period. The Division of Highways was aware that some of its designs had aesthetic shortcomings and began to hire architects in the 1950s to work on enhancing the visual effects of bridges. Eventually the Bridge Department created an aesthetic review section in the 1960s.

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[24] Leonard C. Hollister, "The Modern Highway Bridge, as Expressed by Recent Designs of the California Division of Highways," *Roads and Streets*, October 1937, 45-50.

3.2.2. Engineers, Designers, and Builders

During the heyday of the concrete arch bridge, several engineers became distinguished for their concrete bridge designs. Most of the concrete arch bridges were built by local city and county engineers addressing the needs of their communities. Private consulting firms produced some of the larger and more important examples of concrete arch bridges.

One of the pioneers in the use of reinforce concrete in bridge construction, John Gilmore McMillan was a self educated engineer. After a career in railroad engineering with Central Pacific Railroad, Southern Pacific Railroad, the San Francisco cable car system, and the Guatemala Central Railroad, in 1889 McMillan relocated to the Bay Area to contribute to the early surveys and construction of the Leland Stanford Junior University. He became a county surveyor for Santa Clara County in 1890 and served in that position until 1914. By 1891, McMillan designed one of the United States' first part concrete bridges over Penitencia Creek. Building several similar bridges, McMillian specialized in brick arch and fabricated steel reinforced concrete arch bridges into the early years of the twentieth century. McMillan's turn of the century bridges in Santa Clara County illustrate how tentatively county surveyors moved into the use of reinforced concrete. Between 1891 and 1900, he designed twenty-nine bridges, of which eighteen, more than sixty percent, were timber and metal combination trusses. Only after 1905 did McMillan design what is considered conventional reinforced concrete structures.[25] All of his stone and concrete bridges, including the Saratoga Creek Bridge (37 0074) built in 1902, survived the 1906 earthquake.[26] Later examples of his work include the heavily modified 1911 Stevens Creek (37C 0018) and Los Gatos Creek (37C 0280) bridges.

One of the most important innovators of concrete and its use in bridges was John Buck Leonard (1864-1945). After working for several different firms, including the American Bridge Company and Healy-Tibbetts & Company, in 1905 Leonard became an associate editor of the journal, *Architect and Engineer of California*. The position of editor of the reinforced concrete section of the journal provided Leonard influence and prestige. His career was greatly advanced

[25] Snyder and Mikesell, "The Consulting Engineer and Early Concrete Bridges in California," 40.
[26] Israel, "Spanning the Golden State: A History of the Highway Bridge in California," 190-192.

as his own bridges were frequently featured. As he promoted the use of concrete in bridges and buildings, Leonard continued to design important bridges both in concrete and in metal. In 1911, the Fernbridge (04 0134), considered to be Leonard's masterpiece, was constructed with a total length of almost 2,500 feet. At the time of its completion, the Fernbridge's seven spans were the longest spans of any concrete bridge in the world and the bridge it self was the largest concrete highway bridge in the United States. A few years later, Leonard collaborated with William P. Day in writing a book entitled, *The Concrete Bridge: A Book on Why the Concrete Bridge is replacing other forms of Bridge Construction*. Leonard and Day then had a combined practice. Leonard left private practice for an appointment as superintendent of building inspection for the City of San Francisco in 1928 but returned as a consulting engineer in 1934 and continued until his death in 1945.[27]

Merrill Butler (1891-1963) was a Los Angeles native who was responsible for designing the greatest number of significant concrete arch bridges in this study. After a short stint with the Los Angeles Railway Company, he graduated from the Polytechnic High School and continued his education with the University of Wisconsin through correspondence courses in mathematics and civil engineering. He began a career with the City of Los Angeles in 1912, but was interrupted by military duty in World War I which was followed by four years with the Arizona State Highway Department as a bridge engineer. Returning to Los Angeles in 1923, Butler rejoined the Los Angeles City Bureau of Engineering and received responsibility for the Macy Street and Ninth Street Viaducts.[28] Butler continued with the city until shortly before his death in 1963 guiding engineers and architects through the difficult task of designing many large bridges in the City of Los Angeles. The significant surviving examples of concrete arch bridges designed by Butler during his thirty-eight year career with the Bureau include the Los Angeles River Viaducts at Fourth Street (53C0044), Cesar Chavez Avenue (53C0130), Spring Street (53C0859), and First Street (53C1166).

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[27] Israel, "Spanning the Golden State: A History of the Highway Bridge in California," 47-50 and 153-155.
[28] Israel, "Spanning the Golden State: A History of the Highway Bridge in California," 175-176.

4. DESCRIPTION OF THE SURVEY POPULATION

The survey population for this report consists of 202 concrete arch bridges. To comprehend their known or possible historic significance, they have been studied in various different ways. The following discussion provides categorical descriptions of the survey population properties including their location, age, type, size, and decorative elements. There is also an overall assessment of the historic integrity of the survey population. Each bridge is described on its rating sheet in Appendix C.

4.1. Changes in the Population of Concrete Arches Since the 1986 Bridge Survey

51 of the pre-1960 concrete arch bridges that were in the original bridge survey of the mid-1980s are no longer in Caltrans' bridge database, and therefore were not included in present survey. Of these 51 bridges, 36 have been replaced since the original survey. 14 others have been reclassified as culverts because they have spans of less than 20 feet, and one bridge has been relinquished to private ownership. Of the 36 bridges that have been replaced, 11 were eligible for National Register listing and 25 were ineligible.

The 36 concrete arch bridges that have been demolished since the original survey include bridges from 24 different counties. Alameda County lost four of its concrete arch bridges, with Shasta and Solano Counties losing three each, while no other counties lost more than two. The demolished bridges were predominantly in northern California. Only seven were located in the Southern California Counties from Santa Barbara County south, while the other 29 were located from Santa Cruz County north. 30 of the 36 demolished bridges were built between 1910 and 1929, with two others dating to the 1930s, while only four of the earliest (pre-1910) examples have been demolished since the original survey.

Of the eleven eligible bridges that have been demolished since the original survey, the oldest was built in 1907, while the other ten were built between 1912 and 1925. All were in Northern California, extending from Humboldt and Shasta Counties south to Stanislaus County. Among the 11 eligible bridges demolished were several large, open spandrel concrete arches, such as the Route 101 bridge over the Van Duzen River in Humboldt County (Bridge 04-0017R), which had three spans of 163 feet each. However, the eligible bridges lost were not among the very oldest or very largest examples of this bridge type.

4.2. Location

The survey population includes concrete arch bridges on local roads, city streets, and state highways throughout California. As shown in Figures 1 and 2 (Appendix B), these bridges are located in 39 of the state's 58 counties in a variety of topographical and cultural settings. The distribution of concrete arch bridges in California is about equal in the northern and southern portions of the state. There are 105 concrete arches in the north half of the state in Caltrans Districts 1, 2, 3, 4, and 10, and 97 concrete arches in the southern half of the state in Caltrans Districts 5, 6, 7, 8, 11, 12. The greatest concentration of concrete arch bridges in the state is in Los Angeles County which contains 53 concrete arches, accounting for over a quarter of the survey population bridges. San Mateo and Humboldt counties each have eleven concrete arches, and the remaining counties each contain fewer than ten concrete arches, twenty-three of which have fewer than five concrete arch bridges. There are no concrete arch bridges in this survey population in all of District 9, Mono and Inyo counties, or in Modoc, Trinity, Lassen, Plumas, Sierra, Colusa, Sutter, Napa, Amador, Contra Costa, Alpine, San Francisco, Merced, Madera, Fresno, San Benito, and Kings counties.

4.3. Age

The survey population bridges were constructed between 1900 and 1958. The oldest bridges in the survey population, both built in 1900, are the Pilarcitos Bridge (35C0025) and the Bear Creek Bridge (35C0122), both in San Mateo County. Both of these structures were determined eligible for listing in the National Register during the 1980s Caltrans Bridge Survey. Table 2 shows the distribution by date of construction periods of the entire survey population.

Table 2: Quantity of Bridges from Periods of Construction

Date of Construction	Number	Percentage of Total
Pre-1910	35	17
1911-1915	35	17
1916-1920	17	8
1921-1925	26	13
1926-1930	40	20
1931-1945	40	20
1946-1960	9	4
	202	100

Three quarters of the bridges in the survey population were constructed before 1930, with the decade of the 1921 through 1930 accounting for a third of the survey population. Only four percent of the bridges were built after World War II.

4.4. Type

Bridge type is important to categorize so that one can understand the technological achievement embodied in any example. Concrete arch bridges can be classified by their methods of construction and arch type. Arches are built in one of two forms: closed (or filled) spandrel and open spandrel. The survey population is almost evenly split with 105 closed spandrel arches and 97 bridges open spandrel arches. Open spandrel concrete arch bridges can also be categorized according to their configuration with the roadway. Of the 97 open spandrel arches, nine are classified as through arches, in which two rib arches sit above the roadway with lateral ties connecting them. The remaining 88 bridges are deck arches in which the roadway is situated atop the arch. Almost all concrete arch bridges in California are built with reinforced concrete. Only two of the 202 bridges in the survey population are constructed with plain, un-reinforced concrete. These structures are in Santa Clara County and were determined eligible for National Register listing during the 1980s survey. They are the Saratoga Creek Bridge (37 0074) built in 1902 and the Penitencia Creek Bridge (37C00237) built in 1909. Of less importance for comparison, arch bridges are also categorized by arch type. These types include round arches, elliptical arches, parabolic arches, and partial-parabolic arches. The selection of arch type depended on the structural engineering requirements of the bridge site as well as for the intended aesthetic design effect.

4.5. Size

The size of concrete arches is measured in various ways and is important in understanding the boldness of engineering achievement or innovativeness of construction method that a structure may represent. The most important measurement for comparison of engineering achievement is the length of the main span. Measurement of a bridge's total length is also useful, but of less value because some concrete arches are flanked by long approach or viaduct structures that are not concrete arches. Main span and total bridge lengths of concrete arches are assessed separately for open spandrel and for closed spandrel structures because of the technical differences in constructing each type.

The longest span of a closed spandrel concrete arch bridge in the survey population is the Eel River Bridge (04 0134) in Shasta County with a main span of 196 feet. Of the 105 bridges of this type, 14 bridges, less then 15 percent, have a main span over 100 feet, and over 75 percent have main spans that are less then 75 feet long. The longest span of an open spandrel concrete arch bridge in the survey population is the Bixby Creek Bridge (44 0019) in Monterey County with a main span of 330 feet. Of the 97 open spandrel bridges, only 17, less then 20 percent, have a main span over 200 feet. Over half of these structures have a main span of less than 100 feet.

4.6. Decoration

California engineers developed a comprehensive design aesthetic for bridges that could conform to the urban, rural, and wilderness environments of the state through use of various decorative features. Only 32 of the 202 bridges in the survey population have no decorative features. The difference between major and minor decorative features relates to the size of those features and the volume of those features relative to the overall structure. Decorative features on the survey population bridges include decorative lanterns, railings, and pylons, as well as decoration on the spandrel area or distinctive texturing, and inclusion of pedestrian amenities, such as sidewalks. Over seventy percent of the survey population have decorative railings, predominately classical arch window railings. Twenty percent of the survey population demonstrate a distinctive texture such as rustication and stone facing.

Many of these features have their origins in classical architectural forms, such as the well-known Los Angeles River bridges. Some later examples have more stylized decoration, such as the Art Deco style Elberon Road Overcrossing (53C0399) in Los Angeles, and several later bridges have clear aesthetic appeal with no decorative features that show the influences of mid-twentieth century Modernism. An example of a modernist expression of a concrete arch is the Dog Creek Bridge, 06 0027, in Shasta County, built in 1956 (widened in 1989).

4.7. Historic Integrity

Well over half of the bridges in the survey population retain historic integrity. Most of the historic features of the bridges in the survey population have been maintained, usually with some small alterations or replaced components. Thus many of these bridges look much like they did when they were constructed, and can convey their known or possible significance. Over 90 percent of the bridges surveyed exhibited little to no loss of integrity of setting, while over 80 percent of bridges were found to have good or excellent integrity of design, materials, and workmanship. Similarly, 85 percent of the survey population bridges were considered to have good to excellent integrity of feeling and association. Some bridges lost integrity because of major alterations or widenings that obscured the original structure.

5. FINDINGS AND CONCLUSIONS

5.1. Evaluation Criteria

Bridges in California are usually evaluated under two National Register criteria: Criterion A, for their role in local or regional history, especially their contribution as links within the transportation system, and Criterion C, relating to possible significance in the field of engineering. Bridges are infrequently, if ever, found to be significant under Criteria B or D. Important historic persons associated with bridges are usually involved with their design, thus making them significant as a "work of a master" under Criterion C. Historic structures, such as bridges, can occasionally be recognized for the important information they might yield regarding historic construction materials or technologies making them significant under Criterion D. Bridges in California built during this period, however, are extremely well documented, so they are not themselves principal sources of important information in this regard.

Under Criterion A, California roadway bridges are potentially significant if they are importantly associated with trends and/or events in transportation development, regional or local economic development, community planning, or military history. Establishing this fact, though, should be done with certain principles in mind. Bridges, like other infrastructure, are inherently vital to communities as they are critical elements of essential city or regional planning, and they substantially impact communication and the distribution of people, goods, and services that affects development on both the local and regional levels. These common effects of bridge construction do not typically provide sufficient evidence to demonstrate how a structure may be deemed significant for its association with an important historic context; otherwise virtually any bridge would be shown to be important in this way. To be eligible for listing in the National Register, resource types such as bridges and other infrastructure must have demonstrable importance directly related to important historic events and trends, with emphasis given to specific demand for such facilities and the effects the structure had on social, economic, commercial, and industrial developments locally, regionally, or nationally. In this way, bridges may be significant as physical manifestations of important transportation and community planning developments on the local, regional, state, or national level.

The most common instance in which a bridge might be considered under Criterion A would be if it were the first bridge at its site, thus providing expanded transportation opportunity and advancing economic development into previously isolated areas. Bridges that are possibly significant under Criterion A were likely built to meet specific demands, and their construction brought immediate and / or substantial effects to a geographic location. While this level of importance typically can be associated with the initial bridge at a particular location, it can be true of subsequent bridges in some cases. Analysis of individual cases may result in exceptions to this general rule. An example of this type of significance is the Leimert Boulevard Bridge (33C0215) in the City of Oakland. This bridge appears eligible for listing under Criterion A due to the bridge being specifically constructed to open up a previously isolated area in the Oakland Hills to be developed as the residential subdivision, Oakmore.

Under Criterion C, California roadway bridges are possibly significant for their importance within the field of bridge engineering and design. This significance derives from a bridge embodying distinctive characteristics of its type, period, or method of construction, or representing the work of a master engineer, designer, or builder. The historic significance of bridges within the field of bridge engineering and design has been studied in great detail in California and other states as a result of dozens of historic bridge inventories sponsored by the Federal Highway Administration during the 1970s, 1980s, and 1990s. While bridge types and inventory methods varied from state to state, the many historic bridge inventories have generally established salient attributes that help define significance of structures within the field of bridge engineering and design. These attributes are as follows:

- Rarity – the number of remaining examples of a bridge construction type;
- Innovative design techniques or use of construction methods that advanced the art and science of bridge engineering;
- Boldness of the engineering achievement – representing the measures taken to overcome imposing design and construction challenges related to load, stress, and other engineering and environmental complexities;
- Aesthetics – the visual quality achieved in a bridge's individual design or with its appropriateness within the natural or man-made setting.

These attributes contribute to the evaluation of a bridge's type, period, or method of construction. Also considered is a bridge's association with an engineer and / or builder (or department of designers, in some cases) who is of possible historic significance.

In order to be listed in the National Register, a bridge must have historic and/or engineering significance as well as historic integrity. Loss of integrity, if sufficiently great, will overwhelm the historic significance a bridge may possess and render it ineligible. Likewise, a bridge can have complete integrity, but if it lacks significance, it must also be considered ineligible. Integrity is determined through applying seven factors defined by National Register guidelines. Those factors are location, design, setting, workmanship, materials, feeling, and association. These seven can be roughly grouped into three types of integrity considerations. Location and setting relate to the relationship between the property and its environment. Design, materials, and workmanship, as they apply to historic bridges, relate to construction methods and engineering details. Feeling and association are the least objective of the seven criteria and pertain to the overall ability of the property to convey a sense of the historical time and place in which it was constructed.

5.2. Bridges in Historic Districts and Historic Landscapes

Bridges can also be eligible for listing in the National Register as contributors to a significant historic district. This occurs when the structure is associated with the significant period of development of the adjacent properties. Bridges have been included in districts in California, along with adjacent buildings, as gateways to towns and as important transportation links to their regions. Some groups of bridges in California are listed in the National Register as a historic district. These groups are found in distinct geographic locations, such as the National Register listed district of concrete arches over canals in Venice, California (bridges 53C1688, 53C1689, 53C1690, and 53C1691).

Bridges may also be eligible for listing in the National Register as part of historic landscapes, also referred to as cultural landscapes. Historic landscapes that include structures are geographic areas that have undergone past modification by human design, were used in identifiable patterns, or were the sites of a significant event. They can be designed landscapes that present a conscious work of creation based on design principles of landscape architecture. Bridges along a parkway, for instance, could be eligible as part of the designed plans for that roadway. Historic landscapes that include structures can also be vernacular landscapes that have evolved through time. These reflect human activities or occupancy from a certain time. Of the two types of historic landscapes that can include structures, vernacular landscapes are more difficult to define and find eligible. Designed landscapes can be compared with original design intent, whereas the boundaries, significance, and integrity of vernacular landscapes can be difficult to distinguish. Nevertheless, it is possible that concrete arch bridges that may or may not appear to be individually eligible under evaluation in this survey could be eligible as part of a historic landscape. This could occur, for instance, in a rural area where there is not the concentration of buildings or structures to indicate the presence of a historic district. Rather, the bridge would be part of the visual character of an open space, perhaps agricultural, with no concentration of buildings or structures. To find a bridge eligible as part of a historic landscape, its contributing significance would need to be explicitly stated. Such a conclusion would occur only if the structure could not be otherwise understood as an individual structure or as a structure within a local, regional, or statewide transportation context as examined in this survey.

One bridge in the survey population may be a contributor to a potential historic landscape. The Mount Rubidoux Drive Overcrossing in Riverside (56C0072) was built in 1931 as part of an integrated design effort by the city that had a goal of creating a aesthetically pleasing western entrance to the city. There is a possibility that the area involved in this 1930s beautification project may be eligible as a historic landscape. In order to be able clearly determine eligibility of such a landscape, a complete inventory of all landscape elements would have to be undertaken in order to assess their integrity and significance. Only the Mount Rubidoux Drive Overcrossing, which appears to possess significance individually, was assessed in this evaluation.

5.3. Conclusions from Assessment of Scoring System Points

The scoring system used for the inventory of concrete arch bridges provided indicators of the significance of these structures under Criterion C. Elements of the original point system that referred to possible significance under Criterion A were removed from the current scoring system. For many bridges, the scores for individual categories did not change from the 1980s survey to the current survey. The total scores as well as the individual category scores provided relative information regarding the significance of these structures and in what way they each may, or may not, embody the distinctive characteristics of a type, period, and method of construction. The first group of points assigned value based on historical or physical facts. These were for the age of the structure, the size of the structure, and for special features that the bridge may possess. The second group of points was more subjective and included assessments of builder / designer significance, technological significance, historic integrity, and aesthetic value.

As fieldwork progressed, JRP noticed that scores in the second, more subjective, group of points appeared to have been inconsistently applied in the 1980s survey. Similar bridge types or bridges with similar alterations were sometimes given different scores. This may have been a function of multiple historians working on the project compounded by the relative challenges they may have faced preparing the entire historic bridge inventory. Caltrans architectural historians may have also found it difficult to manipulate the data to check for inconsistencies. JRP carefully examined these categories for relative inconsistencies between scores. This was achieved by organizing the data in various ways in the database used for this survey and by reviewing photographs.[29] JRP verified that the appropriate points were given to all bridges built or designed by significant builders or designers, and JRP scrutinized the integrity and aesthetic scores so that bridges of similar type and size or with similar alterations were given consistent scores.

Generally, the overall scores of these bridges provided an excellent means to assess the significance of bridges under Criterion C and the historic integrity of the structures. Total scores provided indicators, but were not the definitive factors to the evaluations. While generally higher scoring bridges are eligible or appear eligible, some bridges that are or appear eligible scored relatively low. There were also a few high scoring bridges that do not appear to be eligible. These results reveal the limits of a point based system of evaluation. Although the

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[29] The database used for this survey was in Microsoft Access 2000.

scoring system is useful, the historic evaluation process still required careful analysis by a qualified architectural historian applying the National Register criteria.

The highest possible score within this rating system was 90 points. The range of scores given to bridges during the survey was a high of 80 down to 0 with one bridge receiving a negative number rating. Bridges scoring at least 35 points appeared to have some possible significance. Scores of less than 35 points indicated a lack of possible significance under Criterion C. Nearly 70 percent of the bridges that are listed in, determined eligible for listing in, or appear eligible for listing in the National Register scored 50 points or higher with over 90 percent scoring 35 points or higher. Conversely, bridges that do not appear to be eligible scored less than 45 points and over 80 percent of those bridges scored less than 35 points. JRP closely examined all bridges that scored 35 points or higher and reviewed possible significance for bridges that scored less than 35 points. The highest scoring bridges in the survey population that were not determined eligible for National Register listing are four bridges that scored from 40 to 43 points: 10C0106, 24C0268, 30C0036, and 32C0043. All four are relatively small bridges, and all received 10 of their points for structure and site aesthetics. While scoring relatively high in several categories, none of these bridges appear to be sufficiently important in any one area to meet Criterion C.

As noted, the rating system has some limitations. In general, it is skewed to give greater weight to certain facets of Criterion C while disregarding other areas of possible significance. Many more points are given to older structures than newer structures, and bridges constructed by significant builders or designers are afforded many points. Points given for decorative features overlooks the design aesthetic of the mid-twentieth century that rejected ornament. Conversely, the point system also can provide a limited assessment of variation between structures. It is unlikely that any point system can take into account all the variables presented in a survey population of 202 bridges. Thus, JRP used the point system as one of several components in evaluating the structures in the survey population.

As discussed in section 5, some relatively low scoring bridges were determined eligible during the 1980s survey, indicating that the initial Caltrans survey accounted for more than just bridge rating scores in their evaluations. One of the bridges evaluated for this survey that appears eligible also scored low. The Mount Rubidoux Drive Overcrossing in the City of Riverside, 56C0072, scored relatively low (36 points) as a bridge of modest size built in 1931, at a time when a closed spandrel reinforced concrete arch of this type was not an innovative design. However, this bridge was part of an integrated design effort pursued by the City of Riverside in order to create an aesthetically pleasing western entrance into the city. The design of the bridge, including decorative masonry facing, is a significant example within the context of city beautification efforts that were occurring during this period, and the bridge appears to meet National Register Criteria A and C. In addition, Bridge 33C0215, Leimert Blvd. over Sausal Creek in Oakland, scored only 22 points but appears to be eligible for National Register listing under Criterion A, for its association with the development of the Oakmore subdivision in the Oakland Hills.

5.4. Eligibility for Listing in the National Register of Historic Places

Of the 202 bridges studied for this report, eighty-eight were previously listed in or determined eligible for listing in the National Register and fifteen appear to meet the criteria for listing in the National Register. These structures account for a little over half of the concrete arch bridge survey population. The significance of five bridges has been left undetermined, due to their possible association with potential historic roads. The remaining ninety-four bridges studied for this report do not appear to meet the criteria for listing in the National Register.

Beyond the Caltrans historic bridge inventory, bridges are examined for their historical significance by methods other than the National Register criteria. These include designations by the American Society of Civil Engineers (ASCE) and by cities or counties. The ASCE designates important engineering features across the country as National Historic Civil Engineering Landmarks. These include both individual bridges as well as bridges that are components of important highways. Most, if not all, bridges designated as civil engineering landmarks in California have also been listed in or determined eligible for listing in the National Register for their important design qualities. The ASCE designation does not have official status within the National Historic Preservation Act Section 106 process, but is useful in indicating structures of particular importance within the field of civil engineering.

Many cities and counties in California have local historic preservation ordinances that list buildings and structures as local landmarks. These local lists include a wide range of resources and some include bridges. Local authorities apply varying levels of protection to these resources. Some lists are honorary designations while other seek to physically protect the historic resources. Sonoma County and the cities of San Francisco, San Jose, Oakland, and Los Angeles are among the local agencies to have designated bridges as local historic landmarks. These local designations do not have any direct bearing on the Section 106 process, but they do become an issue when Caltrans seeks to comply with the California Environmental Quality Act (CEQA) as it pertains to impacts to historical resources. Buildings and structures that are listed in, determined eligible for, or appear eligible for listing in the National Register are automatically eligible for listing in the California Register of Historical Resources, i.e. are historical resources for the purposes of CEQA. In addition to resources listed in or determined eligible for listing in the California Register, CEQA also takes into account locally designated resources. Such resources are also usually considered historical resources for the purposes of CEQA. Therefore, it is possible that a bridge determined not eligible as a result of this report could be a historical resource for the purpose of CEQA. Caltrans will need to clarify local designations of bridges on a project-by-project basis.

5.4.1. Bridges Previously Listed or Determined Eligible

The following bridges have been re-examined, and they all retain sufficient historic integrity to continue meeting the criteria for listing in the National Register:

Table 3: Bridges previously listed in or determined eligible for listing in the National Register

County	Bridge #	Year Built	Feature Intersected	Road / Street
Humboldt	04 0097Z	1925	Van Duzen River	State Route 36
	04 0101Z	1925	Van Duzen River	State Route 36
	04 0134	1911	Eel River	State Route 211
	04C0026	1928	North Fork Mad River	Maple Creek Road
	04C0155	1932	East Branch South Fork Eel River	Lake Benbow Drive
	04C0189	1920	Mattole River	Mattole Road

County	Bridge #	Year Built	Feature Intersected	Road / Street
Mendocino	10 0030	1933	Big Dann Creek	State Route 271
	10 0031	1933	Cedar Creek	State Route 271
	10 0151	1940	Russian Gulch	State Route 1
Glenn	11C0196	1913	Stony Creek	Road 99W
Lake	14C0035	1908	St. Helena Creek	Wardlow Street
Nevada	17C0052	1924	Donner Summit	Donner Pass Road
Placer	19C0067	1929	Sierra Blvd. Overhead	Sierra Blvd.
Sonoma	20C0242	1915	Maacama Creek	Chalk Hill Road
Yolo	22C0003	1930	Cache Creek	County Road 41
Solano	23C0018	1911	Ulatis Creek	School Street
	23C0076	1909	Suisun Creek	Suisun Valley Road
	23C0077	1911	Suisun Creek	Suisun Valley Road
	23C0092	1923	Putah Creek	Stevenson Bridge Road
	23C0096	1907	Miller Canyon Creek	Pleasant Valley Road
	23C0243	1907	Putah Creek	Winters Road
Sacramento	24C0067	1917	American River	Greenback Lane
El Dorado	25C0116	1914	Weber Creek	Forni Road
Marin	27C0050	1909	Corete Madera Creek	Sir Francis Drake Blvd
	27C0078	1909	Ross Creek	Shady Lane
	27C0149	1908	Ross Creek	Norwood Avenue
	27C0150	1925	Alexander Avenue Overhead	Alexander Avenue
Calaveras	30 0019	1909	Angels Creek	State Route 49
Tuolumne	32C0044	1908	Woods Creek	Rawhide Road
San Mateo	35C0025	1900	Pilarcitos Creek	Main Street

County	Bridge #	Year Built	Feature Intersected	Road / Street
	35C0042	1901	San Mateo Creek	Crystal Springs Road
	35C0122	1900	Bear Creek	Mountain Home Road
	35C0123	1905	West Union Creek	Kings Mountain Road
Santa Cruz	36C0048	1915	Bean Creek	Glenwood Drive
	36C0075	1928	Aptos Creek	Soquel Drive
Santa Clara	37 0074	1902	Saratoga Creek	State Route 9
	37C0237Z	1909	Upper Penitencia River	Penitencia Road
Stanislaus	38 0062	1918	Snake Ravine	State Route 32
	38C0073	1915	Dry Creek	Tim Bell Road
	38C0323	1907	Dry Creek	Gilmore Avenue
Mariposa	40 0006	1926	Slate Gulch	State Route 140
	40 0007	1926	Sweetwater Creek	State Route 140
Monterey	44 0012	1932	Granite Canyon	State Route 1
	44 0016	1933	Wildcat Creek	State Route 1
	44 0017	1935	Malpaso Creek	State Route 1
	44 0018	1931	Garrapata Creek	State Route 1
	44 0019	1932	Bixby Creek	State Route 1
	44 0036	1932	Rocky Creek	State Route 1
	44 0056	1938	Big Creek	State Route 1
Tulare	46 0029	1922	Kaweah River (Pumpkin Hollow Bridge)	State Route 198
	46C0196	1923	East Fork Kaweah River	M375A Mineral King Rd
San Luis Obispo	49C0431	1921	Atascadero Creek	Capistrano Avenue
Santa Barbara	51 0027Y	1918	Arroyo Honda	U.S. Highway 101
	51 0028L	1917	Arroyo Quemado	U.S. Highway 101
	51 0110	1916	Romero Canyon Creek	State Route 192
	51C0039	1915	Rincon Creek	Rincon Hill Road

County	Bridge #	Year Built	Feature Intersected	Road / Street
Los Angeles	53 0121	1912	York Blvd Overcrossing	York Blvd
	53 0430	1939	Avenue 60 Overcrossing	Avenue 60
	53 1069	1928	Hyperion Avenue Viaduct	Hyperion Avenue
	53C0044	1931	4th St. Viad. -Santa Fe Ave	Fourth Street
	53C0107	1913	Arroyo Blvd and Arroyo Seco	Colorado Blvd
	53C0130	1926	Los Angeles River	Cesar E. Chavez Ave. (Formally Macy St.)
	53C0131	1937	Union Station Overcrossing	Cesar E. Chavez Ave. (Formally Macy St.)
	53C0161	1925	Myra Avenue	Franklin Avenue
	53C0163	1925	AT&SF Railroad, Los Angeles River, UP Railroad	Olympic Blvd
	53C0331	1928	Lorena Street and Bernal Avenue	Fourth Street
	53C0545	1909	Los Angeles River Bridge and Overhead	North Broadway
	53C0757	1922	Arroyo Seco Channel	San Rafael Avenue
	53C0759	1914	Arroyo Seco Channel	La Loma Road
	53C0859	1928	Los Angeles River	North Spring Street
	53C1010	1910	Los Angeles River	North Main Street
	53C1041	1925	Arroyo Seco	Holly Street
	53C1166	1929	Los Angeles River	First Street
	53C1179	1927	Waverly Drive	Waverly Drive
	53C1321	1927	Los Angeles River	Seventh Street
	53C1688	1907	Carroll Canal	Dell Avenue
	53C1689	1907	Linnie Canal	Dell Avenue
	53C1690	1907	Howland Canal	Dell Avenue
	53C1691	1907	Sherman Canal	Dell Avenue
San Bernardino	54 0345	1948	East Fork City Creek	State Route 330
	54 0365	1947	City Creek	State Route 330
	55 0064	1929	San Juan Canyon	State Route 74
Riverside	56C0055	1928	Tequesquite Arroyo	Victoria Avenue
San Diego	57 0043Z	1925	San Luis Rey River	State Route 76
	57 0215	1915	Laurel Street Overcrossing	Laurel Street

County	Bridge #	Year Built	Feature Intersected	Road / Street
	57C0002	1917	Sweetwater River	Los Terrinetos F47
	57C0361	1913	Santa Ysabel Creek	Black Canyon Road
	57C0418	1914	Georgia St. University Ave	Georgia Street

TOTAL: 88 bridges

5.4.2. Bridges that Appear to be Eligible for National Register Listing

The following fifteen bridges appear to meet the criteria for listing on the National Register of Historic Places. Of these, six appear to be eligible based on evaluations made during this survey. Four of these bridges are parts of the original Glendale-Hyperion Bridge in Los Angeles that was evaluated and determined eligible as part of the 1980s survey under only two of the total of six bridge numbers that make up the total group of structures. Three of these bridges are extensions of bridges spanning the original section of the Arroyo Seco Parkway that were constructed to span the adjacent Arroyo Seco Channel. All three of the portions of these bridges spanning the Parkway were determined eligible as part of the 1980s survey. The remaining one bridge, 57C0596, is the bridge number assigned to the city owned portion of the Cabrillo Bridge, 57 0215, which is a contributing element of the Balboa Park National Historic Landmark which was listed in 1977.

Table 4: Bridges that appear to meet the criteria for listing in the National Register

County	Bridge #	Year Built	Feature Intersected	Road / Street
Siskiyou	02 0012	1929	Dry Gulch	State Route 263
	02 0014	1931	Shasta River	State Route 263
Alameda	33C0215	1930	Sausal Creek	Leimert Blvd
Los Angeles	53 0392	1906	Cesar E. Chavez Avenue Overcrossing	Cesar E. Chavez Avenue Overcrossing
	53C0399	1934	North Gaffey Street	Elberon Avenue
	53C1686	1928	Arroyo Canyon	Westridge Road
	53C1874	1912	Arroyo Seco Channel	York Boulevard
	53C1875	1939	Arroyo Seco Channel	Avenue 26
	53C1878	1939	Arroyo Seco Channel	Avenue 60

County	Bridge #	Year Built	Feature Intersected	Road / Street
	53C1881	1929	Los Angeles River	Hyperion Avenue
	53C1882	1929	Hyperion Avenue	Hyperion Avenue
	53C1883	1929	Los Angeles River	Glendale Boulevard
	53C1884	1929	Los Angeles River	Glendale Boulevard
Riverside	56C0072	1931	Mount Rubidoux Overcrossing	Mount Rubidoux Overcrossing
San Diego	57C0596	1915	Laurel Street Overcrossing	Laurel Street Overcrossing

TOTAL 15 bridges

5.4.3. Bridges for which Historic Significance has not been Fully Determined

The survey concluded that there are five bridges for which their historic significance could not be fully determined within the confines of the statewide historic bridge inventory. One of these structures is associated with an extension of the Arroyo Seco Parkway in Los Angeles that was constructed in the early 1940s that is currently being evaluated as a potential addition to the already eligible Arroyo Seco Parkway. This bridge is being assigned an undetermined status at this time pending the outcome of the Arroyo Seco Parkway historic district extension evaluation. The remaining four bridges have all been assigned a status of undetermined because they may be contributors to historic roads. Three of these bridges are associated with the Angeles Crest Highway (State Route 2) in Los Angeles County and one is associated with State Route 74 in Riverside County.

Table 5: Bridges for which historic significance has not been fully determined

County	Bridge #	Year Built	Feature Intersected	Road / Street
Los Angeles	53 0542L	1942	Park Row Overcrossing	Park Row Overcrossing
	53 0061	1930	La Canada Arch	State Route 2
	53 0063	1931	Slide Canyon	State Route 2
	53 0086	1931	Woodwardia Canyon	State Route 2
Riverside	56 0180	1929	Strawberry Creek	State Route 74

TOTAL: 5 bridges

5.4.4. Bridges that do not Appear to be Eligible for National Register Listing

The following ninety-five bridges do not appear to meet the criteria for listing in the National Register. Under Criterion A, they are not important for their association with significant historic events or trends. Under Criterion C, they are not significant within the field of roadway bridge engineering and do not embody distinctive characteristics of a type, period, or method of construction. They also are not important examples of master bridge builders or designers.

Table 6: Bridges that do not appear to meet the criteria for listing in the National Register

County	Bridge #	Year Built	Feature Intersected	Road / Street
Del Norte	01 0015	1925	Middle Fork Smith River	U.S. Highway 199
Siskiyou	02 0002	1915	Sacramento River Bridge and Overhead	Interstate 5
Humboldt	04C0052	1937	Mad River	Butler Valley Road
	04C0062	1923	Boulder Creek	Maple Creek Road
	04C0156	1921	Bear Gulch	Redwood Drive
	04C0174	1928	Mattole River	Ettersburg Honeydew Road
	04C0187	1929	Maple Creek	Butler Valley Road
Shasta	06 0027	1956	Dog Creek	Interstate 5
	06C0052	1926	Doney Creek	Lakeshore Drive
	06C0054	1925	Charlie Creek	Lakeshore Drive
	06C0229	1915	Slate Creek	Slate Creek Road
	06C0349	1928	Boulder Creek	Access Road
Tehama	08C0110	1920	Thomes Creek	Old Highway 99W
Mendocino	10 0154	1938	Jug Handle Creek	State Route 1
	10 0175	1948	Hare Creek	State Route 1
	10C0032	1951	Navarro River	Philo Greenwood Road
	10C0106	1928	East Fork Russian River	Main Street
Glenn	11C0020	1940	Butte Creek	Road 67
Butte	12C0002	1930	Canyon Highlands Drive	Canyon Highlands Drive
	12C0203	1912	Lindo Channel	Esplanade

County	Bridge #	Year Built	Feature Intersected	Road / Street
	12C0264	1920	Lower Honcut Creek	Dunstone Drive
	12C0277	1950	Big Chico Creek	Vallombrosa Avenue
	12C0293	1914	North Fork Honcut Creek	Bangor Highway
Yuba	16C0026	1920	South Honcut Creek	Los Verjeles Road
Placer	19C0140	1925	Auburn Ravine	Gold Hill Road
Sonoma	20C0186	1915	Santa Rosa Creek	Melita Road
	20C0246	1916	Mark West Creek	Laughlin Road
	20C0495	1914	Nathanson Creek	4th Street East
Yolo	22C0095	1911	Hamilton Creek	County Road 49
	22C0121	1913	Dry Slough	County Road 91A
	22C0135	1918	Buckeye Creek	County Road 89
	22C0138	1920	Slough S7	County Road 97
Solano	23C0047	1920	Pleasants Creek	Putah Creek Road
Sacramento	24 0001L	1915	American River	State Route 160
	24C0268	1915	Gold Creek	Orangevale Avenue
El Dorado	25C0003	1940	North Fork Cosumnes River	Bucks Bar Road
	25C0115	1924	Mid Fork Cosumnes River	Old Mount Akum Road
	25C0117	1940	Hangtown Creek	Clay Street
Marin	27C0074	1920	Corte Madera Creek	Winship Road
	27C0143	1930	Fairfax Creek	Bothin Road – Marin Drive
San Joaquin	29 0013L	1908	Stanislaus river	Southbound State Route 99
Calaveras	30C0026	1914	San Andreas Creek	Main Street / Gold Strike Road
	30C0036	1909	Angels Creek	Main Street
Tuolumne	32 0010	1937	South Fork Stanislaus River	State Route 108
	32C0002	1920	South Fork Stanislaus River	Old Strawberry Road
	32C0017	1914	Curtis Creek	Old Wards Ferry Road

County	Bridge #	Year Built	Feature Intersected	Road / Street
	32C0040	1940	Middle Fork Stanislaus River	Clark Fork Road
	32C0043	1915	Woods Creek	Harvard Mine Road
Alameda	33 0115	1901	San Leandro Creek	State Route 185
	33C0083	1911	Oakland Avenue Overcrossing	Oakland Avenue
	33C0160	1913	San Lorenzo Creek	Center Street
San Mateo	35 0044	1903	West Union Creek	State Route 84
	35 0068	1903	Bear Creek	State Route 84
	35C0037	1904	San Mateo Creek	Crystal Springs Road
	35C0038	1904	San Mateo Creek	Crystal Springs Road
	35C0050	1903	Cordilleras Creek	Stafford Street
	35C0088	1900	San Mateo Creek	Delaware Street
	35C0111	1913	Pilarcitos Creek	Pilarcitos Creek Road
Santa Cruz	36 0009	1921	Boulder Creek	State Route 236
	36 0010	1921	Boulder Creek	State Route 236
	36 0013	1947	Soquel Creek	State Route 1
	36 0046	1927	San Lorenzo River	State Route 9
	36 0047	1933	San Lorenzo River	State Route 9
	36 0051	1931	Boulder Creek	State Route 9
Santa Clara	37C0018	1911	Stevens Creek (Fremont)	Fremont Avenue
	37C0280	1911	Los Gatos Creek	Meridian Street
	37C0562	1909	Little Arthur Creek	Redwood retreat Road
Stanislaus	38C0055	1918	Dry Creek	Oakdale – Waterford Highway
San Luis Obispo	49C0201	1926	Arroyo Grande Creek	Mason Street
	49C0243	1925	Beach Creek	Beachcomber Drive
	49C0290	1909	Stenner Creek	Broad Street
Kern	50C0261	1934	Kern River Park Bridge	River Road
Santa Barbara	51 0024L	1931	Gaviota Creek	U.S. Highway 1
Ventura	52C0201	1940	North Fork Matilija Creek	Matilija Road

County	Bridge #	Year Built	Feature Intersected	Road / Street
Los Angeles	53 0144	1934	Topanga Creek	State Route 27
	53 0166	1953	Arroyo Seco	State Route 134
	53 0316	1926	Main Street Overcrossing	Main Street
	53 0405	1944	Los Angeles River Bridge and Overhead	U.S. Highway 101
	53C0075	1929	Sunset Blvd Overcrossing	Sunset Blvd
	53C0134	1934	Glendale Blvd	Sunset Blvd
	53C0252	1931	Los Angeles River	Atlantic Blvd
	53C0302	1925	Pacoima Wash	San Fernando Road
	53C0605	1941	Big Tujunga Canyon	Angeles Forest Highway
	53C0643	1958	Big Tujunga Canyon east Crossing	Big Tujunga Canyon Road
	53C0758	1927	Arroyo Seco Channel	Arroyo Blvd
	53C0860	1924	Flint Canyon Channel and Equestrian Trail	Berkshire Place
	53C0867	1928	Los Angeles River	Soto Street
	53C0868	1930	Los Angeles River	26TH ST
	53C1309	1922	Arroyo Seco Channel	San Fernando Road
	53C1764	1938	Vignes Street Underpass	Vignes Street
Orange	55C0192	1926	Carbon Canyon Channel	Golden Avenue
Riverside	56 0198	1926	Potrero Creek	State Route 79
	56C0408	1910	Tahquitz Creek Channel	North Palm Canyon Drive
Imperial	58 0270R	1942	Myer Creek	Interstate 8

TOTAL: 94 bridges

6. PREPARER'S QUALIFICATIONS

Principals Rand Herbert and Stephen Wee directed this project. Mr. Herbert (M.A.T. in History, University of California at Davis), and Mr. Wee (M.A. in History, University of California, Davis) have more than 27 years experience each in conducting historic resources inventory and evaluation studies. Based on their levels of education and experience Mr. Herbert and Mr. Wee qualify as historians and architectural historians under the United States Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61).

JRP senior architectural historian Christopher McMorris was the general project manager / lead historian for the project. Mr. McMorris directed research and field survey crews, data management and graphics production, and prepared the contextual statement and evaluations. Mr. McMorris holds a M.S. in Historic Preservation from Columbia University in New York. He has been with JRP since 1998, conducting historic survey and evaluation studies and other historic preservation projects. Mr. McMorris also qualifies as historian and/or architectural historian under the United States Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61).

Staff historians for this project were Amanda Blosser and Toni Webb. Staff historians conducted the field surveys of historic bridges, performed research and contributed to the evaluation analysis, as well as data management. Staff historians also contributed to the production of the narrative context developed for the study area. Ms. Blosser received a M.S. in Architecture from Texas Tech University with a specialization in historic preservation and has over three years of experience in public history and historic preservation. Ms. Webb received a B.F.A. in Historic Preservation from the Savannah College of Art & Design and has over four years of experience in public history and historic preservation. Ms. Blosser, and Ms. Webb also qualify as historians and/or architectural historians under the United States Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61).

Research assistants and technicians on this report were Brandon De Lallo, Stacie Ham, Julia Cheney, Susan Hotchkiss, Eric Johnson, Nella Cornwall, Cindy Toffelmier, and Andrew Walters. The assistants and technicians assisted with field survey and research tasks, as well as data management, graphics production, and writing historic contexts and evaluations. Many of the research assistants at JRP are recent graduates or current students of the Public History program at California State University, Sacramento. Others are graduates of the University of California, Davis or California State University, Sacramento, with bachelor degrees in history or related fields.

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ATTACHMENTS

APPENDIX A:
LETTERS FROM
THE INTERESTED PUBLIC

APPENDIX B:
FIGURES

APPENDIX C:
BRIDGE RATING SHEET FORMS

See Volumes IIA and IIB

Caltrans Historic Bridges Inventory Update: Concrete Arch Bridges

Prepared For:

State of California
Department of Transportation
Environmental Program
1120 N Street
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VOLUME IIA

April 2004

Caltrans Historic Bridge Inventory Update: Concrete Arch Bridges

Contract: 43A0089
Task Order: 01
EA: 43-984433

VOLUME IIA:
BRIDGE RATING SHEET FORMS
DEL NORTE COUNTY (01) – SANTA CLARA COUNTY (37)

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Volume IIB

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Caltrans Historic Bridge Inventory Update: Concrete Arch Bridges

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EA: 43-984433

VOLUME IIB:
BRIDGE RATING SHEET FORMS
STANISLAUS COUNTY (38) – IMPERIAL COUNTY (58)

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