chapter 1

introduction

I. GENERAL

OVERVIEW

The HDOT is tasked with maintaining and managing the roads and bridges between properties in the State of Hawaii. Many of these roads and bridges now meet or are approaching the age criteria for evaluation as historic properties. Federal funding and the State of Hawaii Revised Statutes (HRS) ensure that HDOT and its political subdivisions consider alternatives that are feasible and prudent before adversely affecting an historic site through undertakings that may include alterations, repair, and/or replacement. Federal funding cannot be distributed to a project until all alternatives have been thoroughly considered prior to initiating undertakings that may adversely affect a bridge eligible for listing on the NRHP. As there are hundreds of bridges in the HDOT inventory, it was concluded that an efficient process was needed to identify the bridges that are eligible for listing on the State and National Registers of Historic Places. The intent of this report is to evaluate the historic significance of bridges listed in the HDOT inventory.

The goal for the HDOT will be to utilize this inventory to aid in future consultation with respect to facilitating/streamlining the approval process for various construction projects with the SHPD and the ACHP. Note that this bridge inventory does not include archaeological or cultural concerns and does not propose treatment for each bridge.

This report is an update of a document titled *State of Hawaii Historic Bridge Inventory and Evaluation*, completed by The Heritage Center in 2008 under the supervision of Spencer Leineweber of Honolulu, Hawaii. The current scope of work did not involve re-visiting the already acceptable historic contexts previously developed and other major elements of the draft 2008 inventory. This report is based largely on the draft 2008 inventory. This 2013 inventory has been updated to include County bridges and all bridges identified with a construction date prior to 1968; the previous report included bridges constructed in 1941 or earlier. County bridges were added to the inventory since the Counties fall under the political subdivision category and must follow the same laws, statutes (for example, HRS, Chapter 6E as noted in the following section), and guidelines as HDOT.

REGULATORY BACKGROUND

STATE LAW

Hawaii Revised Statutes (HRS), Chapter 6E (1976). Chapter 6E of the HRS regulations requires the "development of a statewide survey and inventory to identify and document historic properties."[1] The State Historic Preservation Officer (SHPO) is required to coordinate the activities of the political subdivisions of the state in accordance with the state plan for historic preservation. Further, HRS §6E-8, *Review of effect of proposed State and County projects*, requires HDOT to provide the SHPD with an opportunity for review and must receive a written concurrence before a project can proceed.[2] In HRS §6E-2, a "project" is defined as any activity directly undertaken by the State or its political subdivisions or supported in whole, or in part, through appropriation, contracts, grants, subsides, loans, or other forms of funding assistance from the State or its political subdivisions or involving any lease, permit, license, certificate, land use change, or other entitlement for use issued by the State or its political subdivisions (Hawaii Senate Bill SB 3010).

[1] State of Hawaii, *§6E-3 Historic Preservation Program,* under Hawaii Revised Statutes Chapter 6E, http://www.state.hi.us/dlnr/hpd/hpfctsht.htm (accessed April 1, 2013).
[2] State of Hawaii, *§6E-8 Review of effect of proposed State and County projects,* under Hawaii Revised Statutes Chapter 6E, http://www.state.hi.us/dlnr/hpd/hpfctsht.htm (accessed March 28, 2013).

FEDERAL LAW

Since the 1960s, Congress has passed various federal laws to protect cultural resources. The laws that impact the HDOT process of protecting Hawaii's cultural resources are summarized below.

National Historic Preservation Act (NHPA) of 1966 (as amended) (16 United States Codes and Statues (U.S.C.) §470). NHPA recognizes the Nation's historic heritage and establishes a national policy for the preservation of historic properties. The act contains several sections, each specifying procedures and mechanisms for developing and implementing historic preservation programs. Section 106 notes that any project involving Federal monies to obtain permitting, licensing, and approval must follow an established review process to ensure historic partners an opportunity to comment. Section 110 notes the responsibility of Federal government to maintain an inventory of their historic property.

Department of Transportation Act (DOT Act) of 1966. This act includes a special provision - *Section 4(f)* - which stipulates that the FHWA and other DOT agencies cannot approve the use of land from publicly-owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless the following conditions apply:

- There is no feasible and prudent alternative to the use of land, and
- The action includes all possible planning to minimize harm to the property resulting from use.

"Use" of a property protected under Section 4(f) may be defined as a) permanent incorporation of land, b) temporary occupation of land if that temporary occupancy meets certain criteria, or c) by effect of proximity where noise, visibility, or other like conditions substantially impair the protected features of the property.

In 2005, as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU, Public Law 109-59, Aug. 10, 2005), Congress amended Section 4(f) to provide an alternative method of approving the use of protected resources where the impact is *de minimis*. The *de minimis* impact determination provides the basis for U.S. DOT to approve the minor use of a Section 4(f) property without identifying and evaluating avoidance alternatives—thus streamlining the approval process. The new regulations were also codified, for the first time, in a stand-alone section of the regulations—23 Code of Federal Regulations (C.F.R.) Part 774.

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. §§4321-4347). NEPA requires Federal agencies to identify and consider the environmental impacts of Federal actions and includes consideration of impacts on cultural resources. As required by the NHPA and NEPA, every Federal agency must provide for the identification and consideration of historic properties prior to undertaking any action that may potentially affect these resources. This applies to state agencies that receive Federal funds.

***Surface Transportation and Uniform Relocation Assistance Act of 1987* (*Public Law 100-17, April 2, 1987*).** This bill, which addresses highway improvement, planning and research throughout the United States, also declares that States are required to identify historic bridges listed in the National Bridge Inventory. Furthermore, it requires the Transportation Research Board to review and develop rehabilitation standards for historic bridges, as well as setting forth minimum allocations for each state for the purposes of transportation planning and research.

Advisory Council on Historic Preservation, Program Comment Issued for Streamlining Section 106 Review for Actions Affecting Post-1945 Concrete and Steel Bridges, 2012. The Program Comment issued by the ACHP addresses undertakings which affect a number of common concrete and steel bridges located throughout the nation and whose construction was generally standardized in the years after 1945. Although federal agencies must still complete the Section 106 review process for the identification of historic properties and effects of actions upon said properties, the Program Comment was issued for the following reasons: 1) It allows a federal agency to comply with Section 106 for a category of undertakings in lieu of conducting reviews for each individual proposed action, 2) It recommends state FHWA divisions develop a list of readily recognizable exceptional common bridges that may be excluded from the Program Comment, and encourages transportation agencies to update their historic bridge

inventories, and 3) It encourages the resolution of adverse effects that may result from potential replacement of existing common bridges.

SCOPE OF SURVEY

The updated 2013 bridge inventory includes State- and County-owned bridges that are listed on the National Bridge Inventory (NBI). The Federal government defines a "bridge" as a structure erected over a depression or an obstruction with a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or springlines of arches (23 C.F.R. 650.403). This definition is used as a criterion for eligibility to use Federal funds and includes all bridges that are inspected every two years. Due to this definition, HDOT does not maintain the same records for the bridges or culverts less than 20 feet. Pedestrian and other non-vehicular bridges were sometimes included in the inventory when listed on the NBI. Counties can opt to place a pedestrian bridge on the NBI to qualify for Federal funding.

The 2013 study involved the initial analysis of 708 potentially historic bridges constructed between 1894 and 1968, on the islands of Oahu, Hawaii, Maui, Molokai and Kauai. These bridges were first identified in the following reports: *Historic Bridge Inventory: Island of Oahu* prepared by Bethany Thompson in June 1983; *Historic Bridge Inventory and Evaluation: Island of Hawaii*, prepared by Patricia Alvarez in July 1987; *Historic Bridge Inventory: Island of Kauai* prepared by Spencer Mason Architects in October 1989; and *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai* prepared by The Hawaii Heritage Center in September 1990. The islands of Lanai and Niihau, although inhabited, have no bridges that meet the criteria. The statewide inventory and evaluation completed in 2008 by The Hawaii Heritage Center combined these reports to form a comprehensive perspective across the islands.

In general, this inventory does not include privately- or federally-owned bridges; however, some privately-owned bridges cross public roads and are maintained by the County or State. In such cases, only those private bridges already listed on the NBI were included in this 2013 report.[3]

SCOPE OF WORK

The *State of Hawaii Historic Bridge Inventory and Evaluation* was prepared in May of 2008 by The Heritage Center. A half decade later, this report provides an updated inventory with a focus on restructuring the evaluation system originally utilized to determine which bridges should be considered significant historic resources. The historic contexts developed in 2008 continue to be relevant to the statewide inventory and are referenced in this document where necessary. The updated inventory includes both State-owned bridges and County-owned bridges.

It should also be noted that since the previous inventory was taken, there are many more bridges that should be included for evaluation, especially as the first Interstate Highway H-1 approaches the 50-year age criteria mark to be considered an historic resource. Though the ACHP adopted the *Section 106 Exemption Regarding Effects to the Interstate Highway System* (IHS) on March 10, 2005, which effectively excludes the majority of the 46,700-mile highway system from consideration as an historic property under Section 106 of the NHPA, Interstate Highway H-3 is listed as exceptionally significant. In addition, the SAFETEA-LU includes a provision (Section 6007) that exempts the bulk of the IHS from consideration as an historic resource under Section 4(f) of the Department of Transportation Act.

With these two exemptions in place, Federal agencies are no longer required to consider the vast majority of the IHS as historic property under Section 106 and Section 4(f) requirements. Excluded from these respective exemptions are elements of the IHS that are exceptional in some way or meet a national level of significance under the criteria for the National Register of Historic Places, such as the already determined exceptional H-3. H-1 is excluded from consideration as an historic resource. However, all overpasses along H-1 built prior to 1968 are evaluated in this inventory.

[3] See "Meeting Agenda, Hawaii Statewide Bridge Inventory and Evaluation," for Oahu, Maui, Kauai, and Hawaii islands, July 2013.

RESEARCH

- Project team gathered reports from other states and reviewed previous inventories of and information pertaining to bridges located in the State of Hawaii
- Project team reviewed various national reports and guidelines pertaining to the preservation and significance of historic bridge structures

GATHER COMMUNITY AND PRESERVATION PARTNER INPUT

- Bridge committees were formed with the help of the SHPD, Historic Hawaii Foundation (HHF) and the appropriate Certified Local Government (CLG), which is identified as the Kauai Historic Preservation Review Commission (KHPRC) or the Maui Cultural Resources Commission (MCRC).
- Committees include a representative from each County Department of Public Works (DPW), as well as community members, such as representatives from Hanalei Roads Committee or Friends of Hana.
- A Facebook page was established and distributed through Historic Hawaii Foundation, HDOT and community members to provide outreach beyond the Bridge Committee.

EVALUATION

- Historic bridges were assessed for their potential significance with respect to criteria employed by the NHRP. The NRHP criteria identifies historic resources as buildings, structures, objects, sites, and districts over fifty years of age (unless they are properties of exceptional importance, in which case they may be considered for listing at an earlier age) with sufficient historical integrity to be eligible for listing on the NRHP.
- Bridges were further evaluated for high preservation value to aid the HDOT in future planning. Evaluation criteria are fully outlined in the "Summary of Identification and Evaluation Methods" in Section III of this report.

REPORT PREPARATION

- The final draft report of the *Statewide Historic Bridge Inventory* (2013) will be printed in hard copy and bound in a three ring folder for HDOT use and updating. Additional copies will be provided in electronic format.
- The final in electronic pdf format will include minutes of various bridge committee meetings.
- Inventory details will be input into the HDOT Access database, which will be available to committee members. General public may access this computer database through the SHPD or HDOT.

II. METHODOLOGY

PROJECT PERSONNEL

This project was prepared under the direction and supervision of Tonia S. Moy, AIA, who meets the standards for Architectural Historian and Historic Architect as outlined in National Park Service Standard 36 CFR 61 Appendix A.

Preparation of the original 2008 draft report, which included fieldwork, research, and report writing, was conducted in two phases. The first phase of research spans the period of development and bridge construction from 1894 until 1941 and was completed by Spencer Leineweber, Barbara Shideler, and Ann Yoklavich. The second phase of research details mid-century infrastructure development in Hawaii from 1941 until 1959 and was completed by Spencer Leineweber and graduate assistants from The Heritage Center at the University of Hawaii at Manoa.

Fieldwork and research for the 2013 project report and inventory update was conducted by HDOT, Don Hibbard, Tonia Moy, Mayu Ohama, Michelle Cheang, and Alison Chiu. Data input was led by Mayu Ohama and Michelle Cheang from Fung Associates, Inc. and Neil Hasegawa from HDOT.

INVESTIGATION METHODS

The methodology of work for this project falls into three major categories: background research, data analysis, and community outreach as discussed below.

BACKGROUND RESEARCH/DATA COLLECTION

- Reviewed Sample Bridge Inspection Reports and previous bridge inventory for adequate information. The team also assessed existing information in previous community meeting minutes.
- Provided direction for evaluating and protecting significant historic resources with a statewide approach.
- Only information obtained through HDOT records was collected. Extensive archival research was not conducted.
- The majority of photographs were provided from HDOT records.

DATA ANALYSIS

- Some field work was completed for identification, historic assessment and documentation of basic character defining features of those that may be considered a district, such as Pali Highway or Kamehameha Highway and are not already listed on the Hawaii or National Registers of Historic Places. Fieldwork was performed and verified by HDOT in 2012. The primary purpose of field investigations was to photograph bridges for evaluation (except those that were unsafe to photograph) and to experience the connection between bridges in historic districts.

- Developed Inventory Data sheets from Bridge Inspection Reports for 708 bridges built before 1968 (i.e., those bridges over 45-years-old in 2013). Appropriate information includes the following:
    - Year Built/Builder/Designer
    - Map location/Tax Map Key (TMK) adjacent to include stream and road names
    - Federal Bridge identification number
    - Color photographs
    - Sketch plan and elevations, if available
    - Date(s) of renovations/repairs

- Character defining features include (but are not limited to):
    - Type of Construction
    - Deck
    - Railings
    - Setting
    - Historic integrity

COMMUNITY OUTREACH

- The project team worked with various oversight and CLG groups to establish bridge committees for each island or one committee with representatives from each county. Consultation involved a myriad of input from committee members, and/or island and County members depending on the focused outreach activity. Approvals were sought at several steps along the way, including: methodology, inventory sheet format, matrix development, and validation regarding which bridges are considered to have high preservation values.
- Members of the committees included individuals from:
    - HDOT
    - County DPWs
    - FHWA
    - SHPD
    - HHF
    - KHPRC
    - MCRC
    - Big Island community member
- A list of participating members involved with the Historic Bridge Committee may be found at the end of section 1.2. Approval from these committee members is documented in a sign-off sheet and meeting minutes

DOCUMENTARY RESEARCH METHODS

The following depositories were researched for materials specific to the bridges:

- State of Hawaii, Department of Transportation, Highways Division
- State of Hawaii, Department of Land and Natural Resources (DLNR), SHPD
    - Previous Inventory Reports
    - Nominations to the Hawaii and National Registers of Historic Places
- Resources provided by the HDOT and FHWA
- Internet Resources

Because the goal of this report is ultimately to provide an updated bridge inventory, the extent of additional research was limited to developing a brief historic context on bridges built after 1959, notably development of Interstate H-1 and Pali Highway. The bulk of historical context that appears in this report was provided by and should be attributed to past reports prepared by Spencer Mason Architects. See past reports for references and footnotes.

Field notes, maps, plans and other relevant materials used in the compilation of this report will be on file with the HDOT.

HISTORIC BRIDGE COMMITTEE

The Historic Bridge Committee was convened to act in an advisory position for this project. Members include the following individuals:

OVERALL

- Misako Mimura, *Project Manager*, HDOT, Environmental Permitting and Project Compliance Section, Highways Division
- Paul Santo, HDOT, Bridge Design Section, Highways Division
- Neil Hasegawa, HDOT, Bridge Design Section, Highways Division
- Domingo Galicinao, Federal Highway Administration Hawaii Division
- Meesa Otani, Federal Highway Administration Hawaii Division
- Kiersten Faulkner, Historic Hawaii Foundation
- Angie Westfall, DLNR, State Historic Preservation Division
- Michael Gushard, DLNR, State Historic Preservation Division
- PROJECT TEAM
    - Glenn Miyasato, MKE Associates LLC
    - Brian Kung, MKE Associates LLC
    - Tonia Moy, *Project Manager*, Fung Associates Inc
    - Mayu Ohama, Fung Associates Inc
    - Michelle Cheang, Fung Associates Inc
    - Alison Chiu, Fung Associates Inc

CITY AND COUNTY OF HONOLULU

- Chris Takashige, City and County of Honolulu, Department of Design and Construction, Civil Division
- Mark Yonamine, City and County of Honolulu, Department of Design and Construction, Civil Division
- Michael K.H. Yee, City and County of Honolulu, Department of Design and Construction, Civil Division
- Stanley Katsura, City and County of Honolulu, Department of Design and Construction, Civil Division, Design Branch Bridges and Structures Section
- Pratt Kinimaka, HDOT, Highways Division, Oahu District
- George Abcede, HDOT, Highways Division, Oahu District

COUNTY OF HAWAII

- Salvador Panem, HDOT, Highways Division, Hawaii District
- Robert Yanabu, County of Hawaii, Department of Public Works, Engineering Division
- Cres Rambayon, County of Hawaii, Department of Public Works, Engineering Division
- Geoffery S. Mowrer, Community Member
- Ron Terry, Community Member
- Carolyn Witcher, Pulama ia Kona Heritage Preservation Council

COUNTY OF MAUI

- Ferdinand Cajigal, HDOT, Highways Division, Maui District
- Fred Gutierrez, HDOT, Highways Division, Maui District
- Annalise Kehler, County of Maui, Department of Planning, Cultural Resources Commission
- Cary Yamashita, County of Maui, Department of Public Works Engineering Division
- Ty Takeno, County of Maui, Department of Public Works Engineering Division

COUNTY OF KAUAI

- Raymond J. McCormick, HDOT, Highways Division, Kauai District
- Fred Reyes, HDOT, Highways Division, Kauai District
- Stanford Iwamoto, HDOT, Highways Division, Kauai District
- Edmond Renaud, County of Kauai, Department of Public Works, Roads Division
- Wallace Kudo, County of Kauai, Department of Public Works, Engineering Division
- Kuppusamy Venkatesan, County of Kauai, Department of Public Works, Engineering Division
- Lee Steinmetz, County of Kauai, Planning Department
- Barbara Robeson, Hanalei Roads Committee
- Pat Griffin, Kauai Historic Preservation Review Commission

Sign Off Sheets

Members were asked to sign an agreement to the findings of the report. The signed sheets are noted in Addendum A. Ron Terry from the County of Hawaii, cited a conflict of interest and resigned from the committee on January 9, 2014.

III. SUMMARY OF IDENTIFICATION AND EVALUATION METHODS

INITIAL SELECTION OF HISTORIC BRIDGES FROM THE DRAFT 2008 REPORT

The draft 2008 report first examined the multiple property listings for Historic Highway Bridges of Hawaii (1894 – 1941) which is based upon inventory surveys completed for each county between 1983 and 1990.[4] The county surveys identified and evaluated 379 bridges constructed prior to 1941 (127 on Oahu, 119 on Hawaii Island, 51 on Kauai, and 82 on Maui.) The bridges were ranked, based on numerical ratings, under one of the following categories:

Category I – those with high historical significance

Category II – those bridges that have considerable historic significance but not enough research available to warrant being placed in Category I, or

Category III – those bridges with little, or no, historical significance.

Previous county surveys were each completed by a different consultant to the State Department of Transportation and utilized a different rating system, which resulted in apparent inconsistencies. For example, only 3% of Maui county bridges were placed in Category I, while the Kauai inventory included 31% of its bridges in Category I. Criteria for evaluation were revised for improved consistency, and the bridges were re-evaluated within a statewide historical context in the draft 2008 inventory. The initial field of bridges for re-evaluation utilized new statewide criteria.

CURRENT SELECTION OF HISTORIC BRIDGES FROM THE 2013 INVENTORY REPORT

Upon request from the HDOT and in response to the ACHP's Program Comments regarding Section 106 Review for bridges constructed after 1945, the current 2013 inventory utilized information provided in the draft 2008 report and revised selected information to reflect a more detailed current analysis of historic bridge resources in Hawaii. From the draft 2008 report, approximately 550 additional bridges were added to the overall inventory to include County-owned bridges and bridges built prior to 1968. Community members were asked for their input to help identify bridges that may have historical significance and they provided valuable insight into the final selection of bridges determined to be eligible and of high preservation value.

A bridge matrix was developed which categorizes 708 bridges by degree of preservation value. The matrix includes a description of character-defining features (if any) for each bridge and evaluation. Significance of the historic bridges was organized into three basic categories:

- ***Eligible – High Preservation Value***: Bridges within this category include those that are generally unique or possess characteristics of a type and exhibit high degrees of historic integrity. These are recommended for listing on the Hawaii or National Register of Historic Places. HDOT must consider all feasible and prudent alternatives as required by Section 4F for the treatment of historic bridges deemed "eligible" and "high preservation value."

[4] Patricia Alvarez, *Historic Bridge Inventory and Evaluation: Island of Hawaii* (Honolulu, 1987); Hawaii Heritage Center, *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai* (Honolulu, 1990); Bethany Thompson, *Historic Bridge Inventory: Island of Oahu* (Honolulu, 1983); Spencer Mason Architects, *Historic Bridge Inventory: Island of Kauai* (Honolulu, 1989).

- ***Eligible***: Bridges which fall under this category include those that are not the best example of a type and are not unique. HDOT should consider maintaining bridges in this category as through attrition, these may become rare examples of a type at some point in time.

- ***Not Eligible***: Bridges considered not eligible for listing include those that have lost considerable historic integrity or do not exhibit any quality that relays historic significance.

The following section explains the criteria used to evaluate eligibility or high preservation value for individual bridges.

DEVELOPMENT OF EVALUATION CRITERIA

To develop the evaluation criteria for the 2013 Hawaii State Historic Bridges Inventory, the team first set up the base line of eligibility based on the National Register of Historic Places criteria. The National Register Bulletin 15: *How to Apply the National Register Criteria for Evaluation* was used as a guide.[5] Similar reports from other states and the four inventories completed for each county in Hawaii were examined.[6] While the previous report focused on developing a numerical rating system, the committee concurred that the best way to approach eligibility for the 2013 inventory was to focus on the National Register criteria. To further aid the HDOT in future planning, a second tier of eligibility for high preservation value was established and is discussed below. Bridges and districts already on the NRHP were automatically given high preservation value.

The following table identifies bridges listed on, or determined eligible for listing on, the Hawaii State and/or National Registers of Historic Places, as of 2013. Please note that the following list does not include those bridges which fall within the boundaries of special design districts.

BRIDGE NAME	**ISLAND**	**HAWAII REGISTER**	**NATIONAL REGISTER**
Steel Trestle Bridges on the Hamakua Coast (6)[7]	HAWAII	08/14/2010	
Kapaia Swinging (Pedestrian) Bridge	KAUAI	08/23/2008	
Puuopae Bridge	KAUAI	09/18/2004	05/25/2005
Kauai Belt Road – North Shore Section (10)[8]	KAUAI	3/29/2003	2/11/2004
Opaekaa Road Bridge	KAUAI	11/19/1982	03/28/1983
Naniloa Drive Overpass Bridge	MAUI	07/30/2005	
Hana Belt Road (59)[9]	MAUI	4/20/2001	6/15/2001
Waiale Drive Bridge	MAUI	07/19/1997	10/30/1998
Oheo Gulch Bridge (as part of the Kipahulu Historic District)	MAUI		1977 *Eligible*

[5] U.S. Department of Interior, *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (Washington D.C.: National Park Service, Interagency Resources Division, 1991).
[6] Pennsylvania (Commonwealth), *Historic Highway Bridges of Pennsylvania* (Pennsylvania Department of Transportation, 1986); Bruce Clovette and M. Roth, *Connecticut's Historic Highway Bridges* (Connecticut Department of Transportation, 1991).
[7] Refer to Chapter 6, Section 2.
[8] Refer to Chapter 3, Section 2.
[9] Refer to Chapter 5, Section 2.

Kalakaua Avenue Bridge	OAHU		10/28/1985 *Eligible*
North King Street-Nuuanu River Bridge (as part of the Chinatown Historic District)	OAHU		01/17/1973

Rather than rate all bridges numerically, each bridge was looked at holistically, with guidance from the committee and with consideration given to its significance and integrity using the criteria below.

NATIONAL REGISTER CRITERIA

For a bridge or district to be considered eligible for listing on the NRHP, it must meet at least one of the criteria below and have enough integrity to convey its significance. For a bridge or district to be considered to have high preservation value, it must meet the NRHP criteria in the higher standard noted and display a high amount of historic integrity, which will be described in the following paragraphs.

EVENTS (National Register Criterion A)

This criterion overlaps the Historic American Engineering Record (HAER) Standards No. 1 and No. 2 which relate to the property's contributions to the economic or industrial development of an area and its significance in the history of a branch of engineering. A bridge that was a significant contribution to state or local transportation patterns, an area's broad history (economic, industrial, or other trend), or where a specific significant event occurred and/or was important in the history of bridge engineering, would be considered eligible under this criterion if the bridge is documented to have existed at the time of these events. If there were no important events linked or known to be linked with a bridge, no consideration was given under this criterion.

> **High preservation value** was given to a bridge if the bridge has a clear association with a significant pattern in history that profoundly affected the development of Hawaii, such as railroad development for the sugarcane industry, or if it is associated with a well-known event in the timeline of our State's history, such as the bombing of Pearl Harbor.

PERSONS (National Register Criterion B)

If the bridge is uniquely and directly associated with an historic person during the person's productive life and reflects the time period in which he or she achieved significance, it may be considered eligible under Criterion B. Under this criterion, a significant person must be demonstrably important within a local, national or international context, and the property must be demonstrably associated with said person(s). Properties shall illustrate, not commemorate, a person's significant achievements.

Few bridges in the state are known to be linked with famous historical figures. Among these bridges, none of them are associated with the person's most productive period, and it was determined that none of these bridges have acquired significance through attrition as the sole remaining example of work. Thus this criterion was not used for bridge significance. Bridges designed by known builders are discussed in the "Work of a Master" paragraph under Design/Construction (National Register Criterion C).

DESIGN/CONSTRUCTION (National Register Criterion C)

> ***Distinctive Characteristics of:***
>
> Type, period, and method of construction are inter-related criteria. A bridge type is usually an example of a given time period and method of construction.
>
> > **Type:** Type categorization of bridges was based largely on structural designations given by the HDOT. This criterion is similar to the first part of HAER Standard No. 5 regarding a "sole remaining example" and also mentions "representative" examples of specific types, even when multiple examples exist. **High preservation value** was given if a bridge is the only

remaining example of its structural type in the state or county. If it is one of many structurally similar bridges, integrity considerations further refined determination whether the bridge is considered to be of high preservation value, eligible, or not eligible.

Period: Where structural or maintenance concerns affect the level of integrity or quality of a bridge, that bridge was deemed of average preservation value but still eligible for National Register listing. Bridges that are unable to convey a time period or which have such an uncertain date for its period of construction were not considered eligible under this criterion. **High preservation value** was given to bridges that are excellent or distinctive examples of a period of bridge construction.

Method of Construction: This criterion constitutes the main technological component of State of Hawaii bridge evaluations. The most critical dimensions are the maximum span (distance between supports), length of the bridge, and height of the bridge over the bed (typically a stream, but occasionally a road or railroad.) This data was obtained from the HDOT. Depending on bridge type, the span and dimensions of each bridge were taken into consideration and analyzed to determine significance and value. Engineering complexity of a bridge was related to the above dimensions but also took into account other factors such as period of design and construction. Eligibility was given to bridges that were considered to display a standard level of engineering for the period of construction. **High preservation value** was given to a bridge that utilized patented technology, was innovative or complex for its time, and/or had a longer span/length than was typical for its type.

Work of a Master: If the designer and/or builder were well-known within the state or county and the bridge retained a level of historic integrity, the bridge was considered eligible under this criterion. There does not appear to be any bridges in Hawaii designed by engineers of national renown. **High preservation value** was given to a bridge if it was considered an exemplary work by the designer's hand. Bridges by undocumented designers and builders may be considered eligible under different criteria.

High Artistic Value: This criterion is related to a bridge's overall design or certain ornamental elements. Typically, the design and pattern of the railing is considered the most ornamental part of the bridge; sometimes the piers, end posts or other component of the bridge has aesthetic appeal. **High preservation value** was given to a bridge if it displays overall high artistic value of design. Bridges with plain, utilitarian designs and low artistic value are not considered to fall within the category of high preservation value under this criterion.

Distinguishable Entity Whose Components Lack Individual Distinction: This criterion applies to districts such as Hana Highway (Route 360) or Kuhio Highway (Route 560) where multiple bridges strung together make a district that conveys a greater sense of an historic association. Each bridge is interrelated to the same historic context and may be of average to high preservation value in and of itself, but when strung together, all bridges holistically attain **high preservation value**, provided that the district maintains a high level of historic integrity.

INFORMATION CONTENT (National Register Criterion D)

While this criterion is generally used for archeological sites, use within this category is typically reserved for preservation of unique information that is only attainable by retention of the existing site. Determination of the research potential of a bridge may include noting specific construction techniques that are otherwise unusual and not documented in another manner. Bridges deemed unlikely to yield unique important information not otherwise obtainable from documents and other sources are not considered under this criterion. All of the bridges identified in the 2013 inventory were constructed under the jurisdiction of the Territory or State government; thus, they are well documented and none fall under this criterion.

INTEGRITY CRITERIA

Historic integrity criteria determines how well the bridge or property conveys its significance. The seven integrity criteria are described below. Each integrity criterion relates to each other and affects the overall integrity of association and feeling. It is rare to be able to judge a property on any singular criterion. Hence, a more holistic approach is necessary when evaluating a site for integrity.

Integrity of Location: Integrity of location relates to whether the bridge has been moved from the original site. The relationship between a bridge and its location is necessary in understanding the historical development of transportation and commerce in an area. Due to the nature of historic concrete and masonry bridges, this criterion rarely affects consideration of eligibility. Alternatively, the "very nature of early [steel] truss fabrication and erection enabled [metal bridges] to be conveniently moved to other sites as crossings were upgraded."[10] However, it should be noted that for the location to have no effect on the metal truss bridge, the setting should be similar. There are rare cases in Hawaii that the setting could be similar enough for the move of a metal truss bridge to have no effect on its integrity of location.

Integrity of Design: Integrity of design is associated with the continuance of a bridge's original design elements. Alterations that have occurred during the period of significance of an historic property are considered part of the design history of the resource. If design elements such as proportion, scale, shape, dimensions, style and ornament remain, a bridge may be considered to retain a high level of integrity. Modifications that range from slight (e.g., addition of removable guardrails) to major (e.g., additions and replacement) may affect consideration of eligibility.

***Integrity of Setting*:** Integrity of setting concerns the character of environment surrounding the resource, and whether changes in the setting compromise the relationship of the bridge to its surroundings. Physical features that form the setting of a bridge can be man-made or natural, including nearby period buildings for urban bridges and topographic features for both urban and rural bridges. An example of substantial change in setting is the rerouting of a water course such that a bridge no longer spans the topographical feature that originally required its construction.

***Integrity of Materials*:** Integrity of materials evaluates whether materials originally used in bridge construction have been substantially altered by deterioration or replacement. If multiple periods of construction exist for a particular structure, for instance if the abutments are older than the superstructure, the materials of each period may be considered of value if the respective periods are deemed historically significant. This criterion does not reflect the structural condition of a bridge, but only the "intactness" of the material from an historic point of view.

***Integrity of Workmanship*:** Integrity of workmanship concerns type and level of craftsmanship as well as methodology of assembly. Evidence of an artisan's labor and skill may reflect vernacular methods of construction as well as highly sophisticated configurations and ornamental detailing. Developments in technology, aesthetic principles, and local, regional or national applications of construction practices may be addressed under this criterion.

***Integrity of Feeling*:** Integrity of feeling addresses the embodiment of a historical expression of time and whether that quality or character is communicated by a structure. While this is among the most subjective of the criteria, it is typically related to the physical appearance or dimensions of a bridge. It is further affected by additional integrity criteria because lack of design or material integrity can affect the "feel" or ambience of a structure.

[10] William P. Chamberlain, *Historic Bridges – Criteria for Decision Making*, National Cooperative Highway Research Program Synthesis of Highway Practice 101 (Washington D.C.: Transportation Research Board, 1983), 16.

***Integrity of Association*:** Integrity of association relates to the interpretation of a structure and its direct link to specific historic periods, trends, or events. The presence of physical features is required to convey association, but this criterion, like Integrity of Feeling, is also a subjective determination. Because feeling and association are each dependent upon individual interpretation, these two criteria alone are insufficient to support eligibility.

NATIONAL REGISTER CRITERIA CONSIDERATIONS

Bridges that have been relocated or reconstructed, are commemorative, or have achieved significance in the past fifty years, are generally not considered for listing on the National Register. They can, however, be listed if they meet certain criteria considerations. Applicable Criteria Considerations are described as follows:

MOVED PROPERTIES (National Register Criteria Consideration b)

If a bridge has been moved from its original location but is significant for its architectural value or is the only surviving structure associated with a significant historic event or person, it may be considered eligible for listing on the National Register. Steel truss bridges, which are often moved, may be considered eligible under this criterion. For example, the wrought-iron Wailua River Bridge, the first bridge built on Kauai between 1894-1895, was dismantled in 1919; parts of the original bridge were relocated and used for construction of the Opaekaa Road Bridge.

RECONSTRUCTED PROPERTIES (National Register Criteria Consideration e)

If a bridge has been accurately reconstructed in a suitable environment (characterized as one that reflects the physical context provided by an historic district or an appropriate interpretive scheme) and is presented as part of a larger restoration plan, and when no other suitable examples exist, it may be considered eligible for listing. An accurately reconstructed bridge may be considered a contributing feature to the historic district in which it belongs.

COMMEMORATIVE PROPERTIES (National Register Criteria Consideration f)

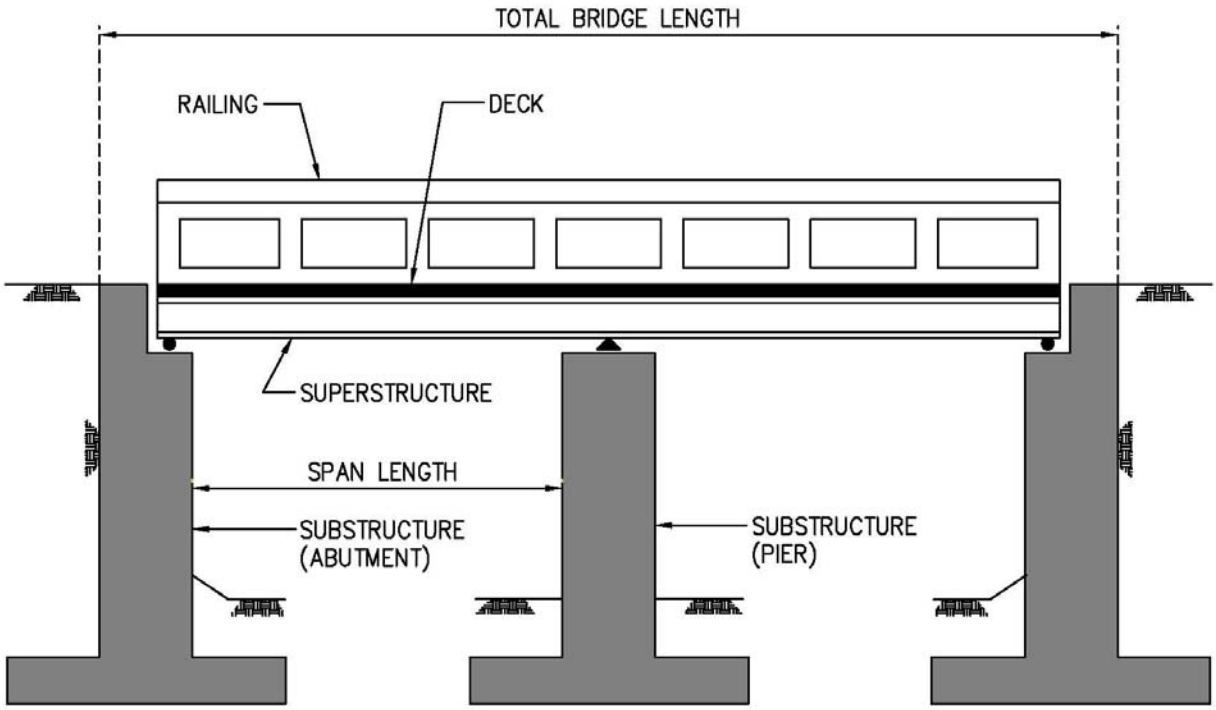
A commemorative bridge may be considered eligible for listing if it displays exceptional significance or great symbolic value to the public.

ACHIEVING SIGNIFICANCE WITHIN THE PAST 50 YEARS (National Register Criteria Consideration g)

A bridge may be considered eligible if it has achieved significance in the past 50 years and if it is determined to be of exceptional importance.

IV. BRIDGE IDENTIFICATION

IDENTIFICATION OF BRIDGE COMPONENTS[11]



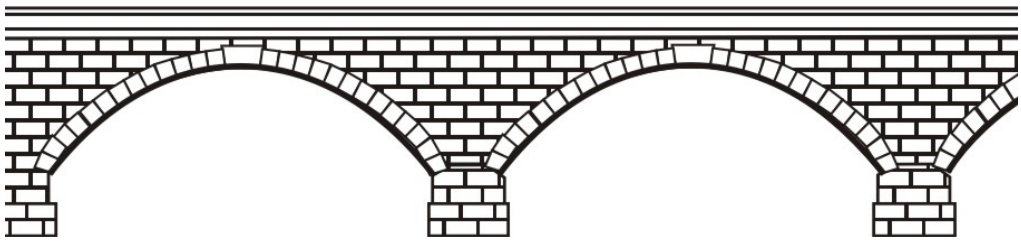
[11] Drawing provided by MKE Associates LLC, 2013.

SUMMARY OF BRIDGE TYPES

Bridge type is defined by the form or method in which the structure functions. It is not exclusively determined by any of the following: materials, method of connection, type of span, or if the bridge structure exists above or below the grade. However, many bridge systems were patented with the material type and/or form detail.

The historic bridges of Hawaii are composed of several different material and structural types: masonry arch bridges (frequently constructed of local basalt, often referred to as "lava-rock"); steel truss and stringer bridges; timber stringer bridges; and concrete solid-and open-spandrel arch bridges, deck girder bridges including tee beam types, flat slab bridges, and rigid-frame bridges. The most prevalent construction material for Hawaii's existing bridges is reinforced-concrete since the corrosive nature of the salt air from the Pacific Ocean and the presence of insects makes the maintenance of steel and wooden bridges less practical than in the mainland United States. Stone, sand, gravel, and lime are found in abundance in the islands; however, reinforcing steel was generally imported from the U.S. mainland.

MASONRY ARCH BRIDGES

Masonry Arch[12]	

DESCRIPTION

Unreinforced masonry arch bridges is the most common remaining nineteenth-century bridge building technology, and was among the first permanent bridge type constructed in the islands. Masonry arch bridges were constructed in Hawaii from approximately 1840, when the first recorded bridge was built, to 1904, when the Territory made it standard practice to use reinforced-concrete for bridge building. These bridges were generally constructed in residential areas over small or intermittent streams along important transportation arteries. The remaining masonry arch bridges in Hawaii are generally small, single-span circular arches with solid spandrels, a span of fifteen to thirty feet and a relatively low-rise over the stream bed. Although usually quite narrow (eight to twelve feet) for wagon traffic, some examples are quite wide (such as the thirty-foot wide Mamalahoa-Pukihae Bridge and Mamalahoa-Kalalau Bridge), demonstrating forethought uncommon for its time. Masonry arch bridges in Hawaii are constructed of local basalt also known as “lava rock.” This material was commonly used as basalt rubble set in an ashlar pattern for the spandrel walls and parapets. Occasionally, carefully cut blocks with dressed margins were utilized for the parapets. Coursed blocks, twelve to twenty-four inches in diameter, were used for the arch ring, although rare examples of concrete or brick arch rings remain.

[12]Parsons Brinckerhoff, and Engineering and Industrial Heritage, “A Context For Common Historic Bridge Types,” prepared for The National Cooperative Highway Research Program, Transportation Research Council, National Research Council (October 2005), 3-51.

SIGNIFICANCE

Stone was abundant in Hawaii, and stone arches at Nuuanu and Waikiki on the island of Oahu were among the first bridges constructed by the Kingdom of Hawaii's Interior Department in the 1840s. However, no known bridges constructed by the Kingdom remain. Masonry arch bridges continued to be constructed by the Republic of Hawaii, which was established between the overthrow of the Hawaiian monarchy and the annexation of Hawaii by the United States (1893-1898), and by the early territorial government prior to the establishment of the county governments (1898-1904). The nineteenth-century bridges, built by the Republic of Hawaii, were generally constructed by prison labor and were part of the up-grading of the Hawaii belt roads that had begun in King Kalakaua's reign (1874-1892). After annexation in 1898, the practice of letting contracts to professional builders was used more widely in the islands.

Several masonry arches remain along the Mamalahoa Highway on the island of Hawaii, and on the Hana Highway on Maui. These routes were once the primary transportation arteries in their regions. The Mamalahoa and Hana Highways are characterized by narrow, winding lanes and innumerable streams and gulches. The Mamalahoa Highway was by-passed by the construction of a new belt road in the 1930s, leaving intact a high concentration of historic bridges. The numerous single-lane bridges of the Hana district have been preserved due to the lack of development along this remote region of Maui.

Unlike timber, or later concrete and steel bridges, masonry-arch bridges utilized locally available construction materials. However, construction of stone bridges, which employed arch building technology imported from the United States and Europe, required skilled labor which was scarce in the islands. The Hawaiians were skilled in laying stone and had a long tradition of dry masonry-rubble construction, a technique utilized for *heiau* (temples), house platforms, walls, and agricultural terraces. Unfortunately by the mid-1800s, the decimation of the native population by disease resulted in a chronic shortage of labor. After 1885 imported labor, particularly Portuguese and Japanese masons, oversaw the construction of masonry arch bridges.

Important builders involved in the construction of masonry arch bridges include Louis M. Whitehouse and John H. Wilson. Whitehouse was one of Hawaii's most prolific early contractors. In partnership with Wilson (who later served six terms as Mayor of Honolulu), he built the first section of the Nuuanu-Pali Road on Oahu, part of the Belt Road on the island of Hawaii, and several masonry arch bridges, including the Mamalahoa-Pukihae, Mamalahoa - Laupahoehoe and Nuuanu Avenue arch bridges. With another partner named Hawxhurst, he built the 1903 Waiakea and Wailuku River steel bridges in Hilo (both since replaced).

Masonry arch bridges are generally eligible under National Register Criterion A and C. Masonry arch bridges are eligible under Criterion C as notable examples of the use of vernacular building materials and the artisanship of local craftsmen. The local basalts which compose the lava-rock used in bridge construction are unique to Hawaii and the islands of the Pacific; thus these masonry arch bridges may be the only representatives of this type in the United States.

ELIGIBILITY REQUIREMENTS

The bridge must retain its integrity of location. Since masonry arch bridges were constructed as permanent structures, all extant examples are in their original location. The setting of the bridge must remain relatively unchanged; by-passing the original transportation artery with a new highway does not necessarily exclude a property if the bridge’s immediate surroundings retain its historic qualities.

The design of the bridge, particularly the arch sub-structure and the spandrel walls, must also retain its integrity. Alterations that may be considered acceptable include those that occurred early in the bridge’s history (i.e. within the period of significance) and in such a way that the alterations are reversible without diminishing the significant historic characteristics of the original bridge (by widening or lengthening the bridge by the construction of an adjacent concrete culvert, for example).

The bridge's original materials, particularly the basalt or brick used in the arch ring and vault, must not be adversely affected by alterations or additions. The quality of the original workmanship must remain apparent, with substantial evidence of artisan's labor and skill. The bridges must retain a high degree of historic feeling and their associations must be apparent to the informed or casual observer.

HIGH PRESERVATION VALUE REQUIREMENTS

Specific considerations for high preservation value under Criterion A include:

1. **Bridges that contributed in a *meaningful* way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or been significantly integral to the development of an effective transportation system,** such as the Hana Highway on Maui or the Mamalahoa Highway on the Island of Hawaii. The most significant early road and bridge building projects in the islands were located at important crossings or associated with belt road construction efforts. The narrow, winding belt roads cut across the innumerable streams and precipitous gulches along the coastline of the major islands and provided access to previously isolated communities.

2. **Early and/or prominent product of the Republic of Hawaii (1893-1898) or the early territorial governments (1898-1904).** Masonry arch bridges are the oldest and only remaining bridges from these important early periods and are very rare.

3. **Bridges associated with major historical events or natural disasters.** Due to its unique location in the center of the Pacific Basin, Hawaii is susceptible to tsunami (seismic sea wave) inundation from nearly every direction. Earthquakes generated in the Aleutian Islands, South America, and Japan have swept large, destructive ocean waves onto Hawaiian shores with a great loss of life and property. Several bridges have survived these onslaughts of nature.

4. **Bridges associated with the primary economic endeavor of the islands - sugar production (c. 1850-1950).** Sugar production facilitated changes in the pattern of land ownership in the islands, created a viable-trade-oriented economy and radically altered the demographics of the islands through the importation of wage-earning labor. The infrastructure required to support this massive economic endeavor - primarily for irrigation, cultivation, and transportation of sugar cane - changed the face of the islands forever. Many of the bridges constructed along belt roads were intended to aid in the overland transport of raw cane to the mills for processing, as well as to provide reasonable access for workers to the sugar lands.

Specific considerations for high preservation value under Criterion C include:

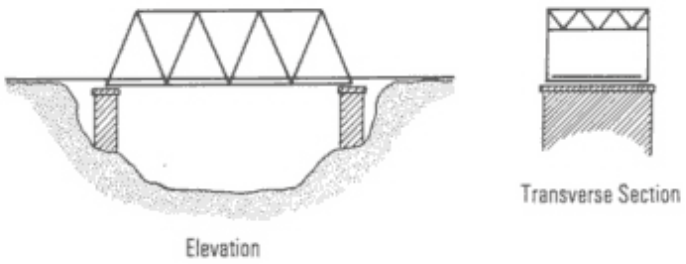
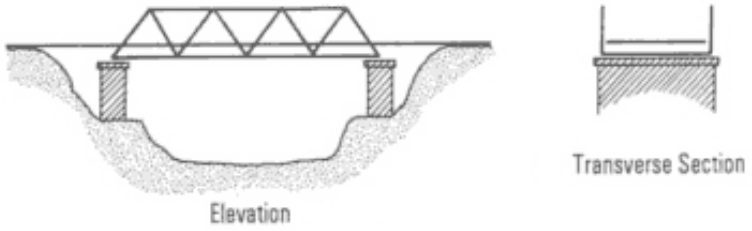
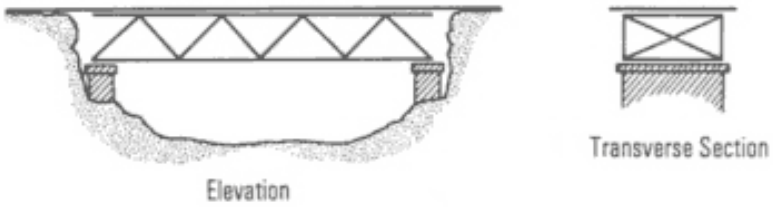
1. **Rare survivor of a once common type.** The construction of masonry arch bridges was initially promoted for their permanence and many examples were constructed throughout the islands. However, the important transportation routes these bridges were generally constructed along were among the first to be up-graded for modern traffic needs. Consequently, the majority of these bridges were replaced with modern structures.

2. **Example of vernacular materials or craftsmanship.** Masonry arch bridges are notable for their use of vernacular building materials and the high quality of craftsmanship by local artisans. The local basalts which compose the lava-rock used in bridge construction are unique to Hawaii and the islands of the Pacific; these masonry arch bridges may be the only examples of this type in the United States.

3. **Exceptional work by an important engineer, architect, or builder.** This survey has identified several individuals (and their companies) who were very important to the construction of masonry arch bridges in Hawaii.

4. **Bridges of exceptional aesthetic merit.** Masonry arch bridges, such as the Mamalahoa-Pukihae Bridge, stand out by virtue of individual design or because of the quality of craftsmanship displayed in their construction.

METAL BRIDGES

Through Truss[13]	
Pony Truss[14]	
Deck Truss[15]	
Pratt Truss (Diagonal)[16]	
Warren Truss[17]	
Howe Trusses[18]	

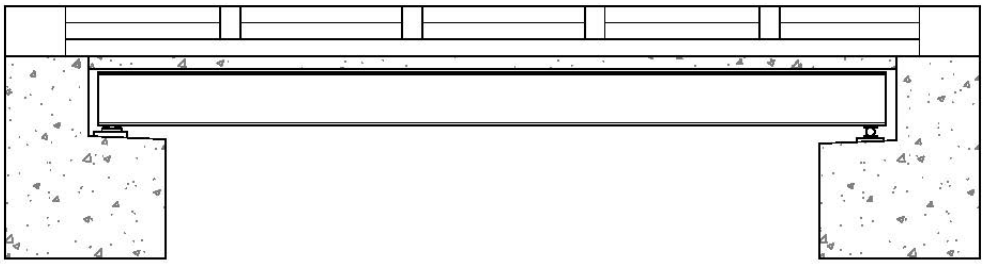
[13] "Bridge Types," Historic Bridge Foundation, http://historicbridgefoundation.com/?page_id=8 (accessed January 30, 2013).
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.
[18] Ibid.

DESCRIPTION

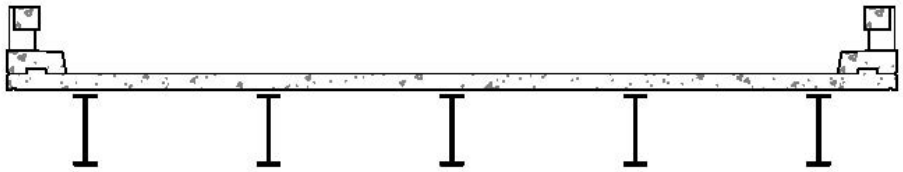
Although metal bridge construction was prevalent in Hawaii around the turn of the century, only steel stringer bridges continued to be built through the first half of the twentieth century. Due to the extremely corrosive nature of the marine environment in Hawaii, there are only a handful of metal bridges that remain. These extant metal bridges are of three basic types: steel and wrought iron trusses, steel stringer bridges, and steel trestle railroad bridges.

Steel and Iron Trusses: Steel and wrought iron trusses were commonly utilized in Hawaii until 1904, when the territorial government advocated the construction of more durable concrete bridges. Metal trusses were fabricated by British and American manufacturers and shipped to the islands to be erected by local contractors. Consequently, truss types were similar to those found in the United Kingdom and the United States (Pratt, Warren and Howe types). The Pratt trusses are distinguished by thick vertical members acting in compression and thin diagonal members in tension. This design reduced the length of the compression members to prevent them from bending or buckling. The Warren design is basically triangular with the diagonals alternately in compression and tension. A *through truss* carries its traffic load level with the bottom chords of the truss. A *pony truss* is a through truss with no lateral bracing between the top chords.

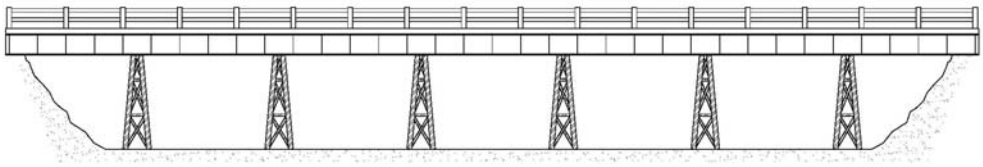
In 1884, ten metal truss bridges were shipped to Hawaii by the Pacific Bridge Company, with offices in Portland and San Francisco, for erection in the Hilo district on the island of Hawaii. The islands' largest and most expensive nineteenth-century metal truss bridge was erected at the mouth of the Wailua River on Kauai in 1890. The bridge was manufactured by Alex Findlay & Co. of Motherwell, Scotland. In 1919, one Warren truss segment of this bridge was utilized to construct the Opaekaa Stream Bridge #1 on Kauai. The Opaekaa Stream Bridge #1, listed on the NRHP in 1983, is the only remaining iron truss bridge of British manufacture in the United States. Only two twentieth-century trusses remain in the state: the 1932 Karsten Thot Bridge, a Warren truss erected in Wahiawa, Oahu; and a Pratt truss segment from the 1924 Wailuku River Railroad Bridge which was scavenged for reuse in the Kolekole Highway Bridge after the 1946 *tsunami* in Hilo. The 1912 Hanalei Bridge, a twentieth-century Pratt truss that crosses the Hanalei River on Kauai, was rehabilitated in 2003 in accordance with the Secretary of the Interior's Standards for Rehabilitation; this bridge remains on the NRHP as a contributing resource of the Kauai Belt Road.

Steel Stringer Elevation[19]	

[19] Drawing provided by MKE Associates LLC, 2013.

Steel Stringer Section[20]	

Steel Stringer: Steel stringers were constructed in Hawaii primarily for industrial and railroad bridges. Ornamentation, if any, is usually limited to the pattern of the railings. The two extant examples from the period of significance were constructed over railroad lines in Maui and Kauai. One is the Lihue Mill Bridge on Kaumualii Highway in Lihue, Kauai and the other is the Waiale Drive Bridge on Kaahumanu Avenue in Wailuku, Maui. Both bridges were constructed with U.S. Works Program Grade Crossing funding, which provided federal money without the usual match requirement, to build bridges separating railroad and road grades. The use of steel, uncommon in Hawaii due to the extreme marine environment, may reflect the requirements of the U.S. Grade Crossing Program. Since very little steel is used for bridge construction in Hawaii, this may be considered an unusual structural type. It should be noted that there are numerous steel stringer bridges that feature wood plank decks and wood railings. These bridges are addressed as timber bridges since their appearance to the general public is wood.

Steel Trestle Bridge[21]	

Steel Trestle Railroad Bridges: Fourteen steel trestle railroad bridges were constructed in 1911 for the Hilo Railroad Company. Five of these (Hakalau, Nanue, Kapue, Paheehee, and Umauma) were reconstructed as territorial highway bridges between 1951 and 1953, the remaining nine were salvaged for use in the reconstruction. The reconstructed steel trestle structures are topped with a concrete and asphalt highway deck. During their conversion, the bridges were widened for highway use by the addition of members from other railroad bridges. The simple horizontal concrete railings were added during the 1951-53 renovations.

SIGNIFICANCE

The period of significance for metal truss and stringer bridges begins in 1912, when the earliest remaining example was erected, and ends in 1957. The period of significance for steel trestle railroad bridges begins in 1911, when they were first constructed, and ends in 1953, after their conversion to highway bridges. Metal bridges are eligible under Criterion A if they contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or been significantly integral to the development of an effective transportation system. Metal truss bridges in Hawaii are significant as representative examples of the expanding capital investment and control that American manufacturers had gained over their British and German rivals as a consequence of the U.S. annexation of the islands in 1898. The steel stringer bridges are significant for their association with the railroads of the sugar industry. They were built with U.S. Works Program Grade Crossing funding which provided federal money, without the usual match requirement, to build bridges

[20] Ibid.
[21] Ibid.

separating railroad and road grades. The erection of metal truss and stringer bridges was a deliberate effort by the territorial government to construct permanent public works improvements requiring the latest technology.

The remaining metal truss and stringer bridges are eligible under Criterion C as rare survivors of a once common bridge type and as representative examples of the work of important engineers and builders. These include: Joseph H. Moragne of the Kauai Department of Public Works, who oversaw the construction of the Hanalei River Pratt Truss in 1912 (replaced in 2003). James L. Young was responsible for building the Karsten Thot Warren truss over the North Fork of the Kaukonahua Stream in Wahiawa, Oahu in 1932. Young, the founder of J. L. Young Engineering Company, was "in the literal sense of the phrase, a builder of Hawaii."[22] Young was trained as a civil engineer and an architect. He designed and constructed the first two reinforced-concrete fireproof buildings in Honolulu, the Pantheon Block and the laboratory building at the Bishop Museum. Between 1922 and 1925, Young built over forty-one buildings in Honolulu, including Palama Settlement, the Library of Hawaii (Hawaii State Library), and the "new library building at the University of Hawaii" (George Hall).[23] He also constructed buildings on many military bases, including Fort Shafter, Fort Ruger, Fort Kamehameha and Schofield Barracks. The most significant steel stringer bridges were designed by William Bartels, chief designer for the Territorial Highways Department, in 1936. Bartels arrived in Hawaii from Germany in 1932, working as a bridge engineer for the Territory until his retirement in 1952. He was responsible for the largest and most sophisticated bridge construction projects in Hawaii during this time.

The converted steel trestle and girder railroad bridges have National Register significance under criterion A, B, C, and D. The railroad line played a major role in the development of the Hilo and the Hamakua Coast by providing transportation to the harbor for the island's sugar production. The Hilo Railroad Company was founded by Benjamin Franklin Dillingham and figures significant in the history of the Hawaiian Islands. The railroad and its numerous bridges together have been called the "greatest engineering feat in Hawaii."[24] Another commentator noted that the completion of the railroad marked nothing less than "an era in the development of the Islands."[25] In addition, the converted railroad bridges are the remains of the only standard gauge rail line erected in the islands and can tell us much about early twentieth century steel manufacturing. The bridges represent the Work of a Master: John Mason Young, designer of the original railroad line and bridges; as well as William R. Bartels, of the Territorial Highways Department, who engineered their conversion from railroad to highway use in the 1950s.

ELIGIBILITY REQUIREMENTS

Metal truss, stringer and trestle bridges must retain their integrity of location. However, relocation of the structure within the period of significance is interpreted as part of the history of the bridge. The design of the bridge, particularly the superstructure and connections, must also retain its integrity. Alterations may be considered acceptable if they were completed early in the bridge's history (within the period of significance) and they are reversible without diminishing the significant historic characteristics of the original bridge (e.g. the addition of a completely independent additional truss to support the weakened original structure or widening with members salvaged from identical spans). The setting of the bridge must remain relatively unchanged; by-passing or realignment of the original transportation artery does not necessarily exclude a property if the bridge's immediate surroundings retain its historic qualities. The bridge's original materials must not be obscured by alterations or additions. The quality of the original workmanship must remain apparent, particularly from a technical rather than aesthetic standpoint, with substantial evidence of the builder's labor and skill. The bridges must retain a high degree of historic feeling and their associations must be apparent to the informed or casual observer.

[22] George F. Nellist, "The Story of Hawaii and Its Builders," *Honolulu Star-Bulletin*, 1925, 911-12.
[23] Ibid.
[24] *Paradise of the Pacific,* December 1924, 14.
[25] Thomas Thrum, *Hawaiian Almanac and Annual* (Honolulu: Hawaiian Gazette Company, 1914), 142.

HIGH PRESERVATION VALUE REQUIREMENTS

Specific considerations for eligibility under Criterion A include:

1. **Bridges that contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or were significantly integral to the development of an effective transportation system, such as a belt road or homestead road**. The most significant early road and bridge building projects in the islands were associated with belt road construction. Many early metal truss bridges were imported to the islands to accommodate the construction of the belt roads, such as those at Hanalei and Wailua on Kauai. Homestead roads made possible the settlement and development of the rural areas in which they are located.

2. **Early and/or prominent product of private enterprise.** The converted highway bridges are among the few remaining examples of bridges constructed by private enterprise. The Hilo Railroad Company (which later became the Hawaii Consolidated Railroad) was a significant economic force on the Island of Hawaii during the early twentieth-century.

3. **Representative of a significant engineering endeavor**. The railroad construction project was a daring engineering feat that crossed numerous gorges and streams with large steel bridges at the valley mouths and required massive earth cuts (and tunneling) for completion of the comparatively straight road bed. This was in direct contrast to the more conservative government policy of winding roads and small concrete or timber bridges in the backs of valleys or down sharp grades to sea level.

4. **Bridges associated with the primary economic endeavor of the islands (c. 1850 -1950) - sugar production.** Sugar production changed the pattern of land ownership in the islands, created a viable-trade-oriented economy and radically altered the demographics of the islands through the importation of wage-earning labor. The infrastructure required to support this massive economic endeavor - primarily for irrigation, transportation, and cultivation of sugar cane - changed the face of the islands forever. Many of the metal bridges were constructed to aid in the overland transport of raw cane to the mills for processing, such as the steel railroad trestles erected along the Hamakua coast of the island of Hawaii, as well as to provide reasonable access for workers to the sugar lands.

5. **Bridges associated with major historical events or natural disasters.** Due to its unique location in the center of the Pacific Basin, Hawaii is susceptible to *tsunami* (seismic sea wave) inundation from nearly every direction. Earthquakes generated in the Aleutian Islands, South America and Japan have swept large, destructive ocean waves onto Hawaiian shores with a great loss of life and property. The railroad bridges were damaged and/or partially destroyed but survived the devastating tsunami of 1946. This disaster forced the closure of the rail line and resulted in the acquisition of these bridges by the Territorial Highways Department.

Specific considerations for eligibility under Criterion B include:

1. **Bridges associated with the lives of persons significant in our past.** The steel trestles railroad bridges were an integral part of the Hilo Railroad Company founded in 1899 by entrepreneur Benjamin F. Dillingham; Lorrin Thurston, the Minister to Washington during the Republic of Hawaii and a former Interior Minister under the monarchy; and Mark Robinson, the former Queen Liliuokalani's Minister of Foreign Affairs.

Specific considerations for eligibility under Criterion C include:

2. **Rare survivor of a once common type.** The construction of metal truss and stringer bridges was initially promoted for their permanence and many examples were constructed throughout the islands. The use of steel for bridges was phased out after the territorial government advocated the construction of durable, low-maintenance concrete bridges in 1904. The few remaining metal truss and stringer bridges are rare surviving examples of this once common bridge type.

3. **Example of a rare structural type.** The steel trestle bridges are the remains of the only standard gauge rail line erected in the islands. In addition, they are a rare example of steel construction, since the majority of other railroad trestles were constructed of wood.

4. **Exceptional work by an important engineer, architect, or builder.** Important engineer/designers include Joseph Moragne of the County of Kauai Engineer's Office and William R. Bartels, Chief Designer for the Territorial Highway Department. The original railroad bridges were designed by John Mason Young in 1910-1911. Important local builders of steel truss and stringer bridges include Honolulu Iron Works, Hawaiian Contracting Company and John L. Young. The steel trestle railroad bridges were erected by W.W. Beers, a New York engineer. Important steel fabricators include Hamilton and Chambers of New York, U. S. Steel Products, and the American Bridge Company.

5. **Bridges of exceptional aesthetic merit.** The steel trestle railroad bridges are spectacularly sited along the ocean at the mouths of steep, verdant valleys. The height of the bridges over the stream bed and quality of craftsmanship displayed in their steel construction contributes to their aesthetic value.

Specific considerations for eligibility under Criterion D include:

1. **Bridges that have yielded, or may yield, information important in prehistory or history.** Analysis of metal bridges may potentially yield information about early twentieth-century steel manufacture and construction. The steel trestle bridges may yield information regarding the only standard gauge railway in the islands.

CONCRETE ARCH BRIDGES

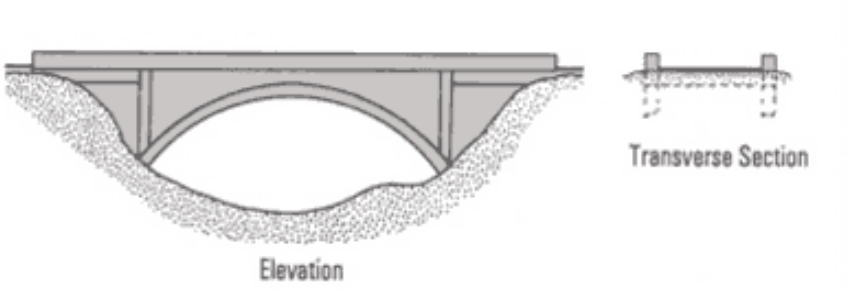
DESCRIPTION

Concrete arches constructed in Hawaii are of two basic types: *solid*- and *open*-spandrels. The solid spandrel type is generally *arch deck* bridges, in which the traffic deck sits upon the arch. These were generally constructed in two periods in Hawaii: the early solid-spandrel arch bridges date from c.1904 to 1915, and the later solid-spandrel arch bridges date from c.1916-1929. There are two types of open spandrel arch bridge construction: the most common is the arch deck open-spandrel, first constructed on Maui in 1911; the second type is the Rainbow or Marsh arch, a *through-arch* constructed during the 1920s and 1930s, in which the traffic deck is suspended from the bottom or lateral chord of the arch.

The first reinforced-concrete bridge in America was built in 1889, but the material remained in an experimental phase until the early 1900s. Reinforced-concrete arch bridges were built in Hawaii after 1904, when the territorial government made it their policy to erect strong, low-maintenance bridges. Concrete could be produced locally from crushed coral or stone aggregate and lime produced by burning the coral reefs. Other materials like cement and reinforcing steel were imported.

South Hilo Road Supervisor Norman K. Lyman voiced public opposition to the Territorial DPW policy of building concrete arch culverts. He was quoted in the *Hilo Tribune* as saying that he "would rather have a stone bridge than a concrete culvert as the former would give employment to more voters, whereas the cement and other materials required for concrete work was all imported from the [west] coast."[26] The newspaper bolstered his argument by pointing out that "stone is plentiful near Hilo and just the kind for bridges and culverts."[27]

This conservative policy was not adopted. In fact, the last known mention of stone arch culverts or bridges is in a 1903 letter of Assistant Superintendent of Public Works, Merton Campbell, with regard to the Mamalahoa-Pukihae Bridge in Hilo. While stone was cheap and locally available, construction of stone arches was labor intensive and seemed to have died quickly with the advent of concrete. This corresponds to developments in the U.S. mainland where concrete had largely replaced masonry by the turn of the century. Further confirmation that concrete was the prevailing bridge material of the era is apparent in the decision made by the Loan Fund Commission, set up in 1911 to oversee a special construction fund established by the Legislature. The commission announced that "Steel was unanimously discarded. Concrete will be used as far as funds permit, the absence of repairs offsetting the large first cost, but it is possible that wood may be used on some spans over forty feet, if funds get low."[28]

Closed Spandrel Arch[29]	

[26] *Hilo Tribune*, November 14, 1905, 2.
[27] Ibid.
[28] *Hilo Tribune*, January 16, 1912, 2.
[29] "Bridge Types," Historic Bridge Foundation.

The various types of concrete arch bridges are described as follows:

Closed (Solid-Spandrel) Concrete Arch Bridges: Reinforced-concrete solid-spandrel arch bridges were constructed in two periods in Hawaii. The earliest all-concrete bridges were built in 1904-1906 to standardized plans as a result of territorial policy, although extant examples of solid-spandrel arches of this type date from as late as 1912 (Mamalahoa-Pahoehoe Bridge on the Hawaii Belt Road). Since the first concrete arches echoed the design and form of earlier masonry arch bridges, these utilize concrete, a new material, in a fairly conservative manner from an engineering perspective. Nonetheless, reinforced-concrete was a material requiring skilled designers and builders.

These first reinforced-concrete arch bridges were constructed in lieu of masonry arches, generally in residential areas over small or intermittent streams bisecting major transportation arteries. The arches of these early bridges are circular and earth-filled. The rise of the arch is typically eight feet and the span approximately thirty-two feet. The parapets are of reinforced cast concrete, approximately four to six inches thick and three feet high, with a peaked concrete rail cap. The bridges are quite narrow, usually twelve or thirteen feet. Important examples of early concrete arch bridges include a series of concrete arch bridges in Hilo and Pepeekeo, such as the Mamalahoa-Kapue Bridge with its fifty-six foot span, and the Mamalahoa-Puuokalepa Bridge.

Concrete, previously used for the arch ring of masonry bridges or the capping of parapets, was used for bridge construction after the territorial government made construction of strong, low-maintenance bridges its stated policy shortly after annexation. Previously bridges had been built of timber, stone or metal, but the new Superintendent of Public Works (SPW), C.S. Holloway, strongly recommended concrete arches for small spans. His assistant, J.H. Howland, sent prints of several of these types of bridges to Hawaii Road Engineer G.H. Gere to encourage the Hawaii Road Boards to adopt this type of bridge.

> *I strongly recommend that concrete arches be built wherever the span is not too great and that particular attention be paid to the foundations for the piers and abutments, so that whatever work is undertaken, will be of a permanent nature and capable of standing heavy pressures due to excessive flow of water during the rainy season...I would avoid as far as possible the construction of steel bridges, especially on the windward sides of the Islands and near the sea. Bridges of wooden construction will last much longer and require less maintenance. Several of the steel bridges are in exceedingly bad condition*.[30]

According to the 1905 report of the Assistant SPW, the foundations of all bridges and culverts, were to be "constructed that they are good for all time."[31] The report went on to state that:

> *Wherever practicable, bridges have… been built of concrete, and where the span was too great so as to make the cost excessive, timber bridges (treated with creosote) have been designed preferably to steel structures which we have found...to be the most expensive to maintain and keep in repair*.[32]

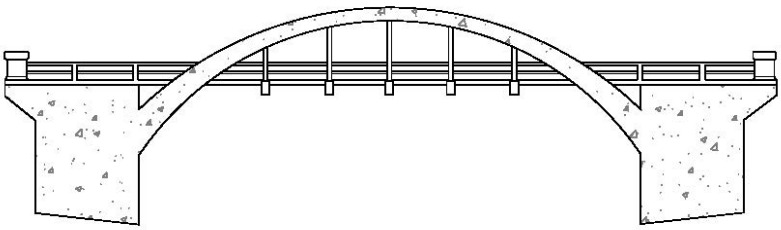
Between 1904 and 1906, contracts were let for the construction of at least six concrete arches, including those in Ewa and Waianae (both on Oahu), Mamalahoa-Puuokalepa and Mamalahoa-Waiaama, and the Chong Drive-Waipahoehoe Avenue Bridge on the Saddle Road in Hilo on the island of Hawaii. Holloway was correct in his assessment of their longevity, in that, all but one of these original concrete arches still stands today. The construction of solid-spandrel concrete arches was the first step towards modern transportation infrastructure;

---

[30] *Hilo Tribune,* March 19, 1904, 4.
[31] *Fifth Annual Report of the Superintendent of Public Works to the Governor of the Territory of Hawaii for the Year Ending June 30, 1905*, Hawaii (Territory), Department of Public Works (Honolulu: Honolulu Publishing Co., Ltd., 1905), 72.
[32] Ibid.

the development of open-spandrel arches pushed the engineering limits of the new material and construction technology.

The second period of reinforced-concrete solid-spandrel arch construction occurred, between 1916 and 1929, simultaneously with the development of the technologically innovative open-spandrel arch. Later solid-spandrel arch bridges achieved greater spans and further refinement of detail and ornamentation, particularly at parapets and end rails, than earlier examples. Art-deco styling and neo-classical detailing, such as scrolled volutes, embossed diamond-shaped panels, resulted in the construction of the most ornate bridges in the state. These later solid-spandrel arches were intended to be significant civic statements reflecting Hawaii's aspirations for beautiful and urbane public works projects. The World's Colombian Exposition in Chicago in 1893 served as the inspiration for the City Beautiful movement and the ensuing neo-classical revival in the United States. The City Beautiful movement reached its height on the U.S. mainland between 1900 and 1910, but affected Hawaii somewhat later. This movement is characterized by an attempt to create beautiful and functional cities. Aesthetic principles such as beauty, order, system, and harmony found physical realization in urban design. Architecture and public works projects, such as road and sewer systems, became civic statements which strengthened the identification of Hawaii to the U.S. mainland. The improved physical environment would persuade urban dwellers, many of them recent immigrants to Hawaii from Asia, to become imbued with civic patriotism and better disposed toward community needs.

Open Spandrel Arch[33]	
Rainbow Arch Bridge[34]	

Open-Spandrel Concrete Arch Bridges were technologically innovative and are considered to be engineering break-throughs. Open-spandrel bridges do not contain fill material and deck loads are carried to the arch ribs by spandrel columns. The first open-spandrel bridges were constructed along the Mamalahoa Highway at Honolii on the Island of Hawaii and along the Hana Highway at Koukouai (Kaukauai) on Maui in 1911. The open-spandrel bridge, with its technical innovations, was capable of spanning hundreds of feet. Island engineers had multiplied their arch-spanning capacity by a factor of ten and refined the casting of concrete to create slimmer, lighter-

[33] Parsons Brinckerhoff, "A Context For Common Historic Bridge Types," 3-68.
[34] Drawing provided by MKE Associates LLC, 2013.

looking structures. They retain their historic associations and feeling due to their rural location, ornamental nature and now uncommon structural type.

Rainbow Arch Bridges, also known as "Marsh Arches" after their designer and patentee - James B. Marsh, are a sub-set of the open-spandrel arch type. This distinctive form of reinforced through-arch bridge construction was also used extensively in portions of the mid-west from 1912 (the patent date) through the early 1930s. Many Marsh arch bridges were constructed in Hawaii at important crossings over major rivers in populated regions. However, only two examples remain: 1) A double-span arch with reinforced-concrete top lateral bracing was constructed over the Anahulu Stream in Haleiwa on Oahu in 1921, and 2) A single-span, pony through-deck arch, was erected over the Wailuku River in Hilo on the island of Hawaii in 1938. Marsh arches were capable of spanning several hundred feet, however the prohibitive cost of large single-spans resulted in the construction of several individual or multiple span arches.

SIGNIFICANCE

The period of significance for reinforced-concrete arch bridges begins in 1904, when the first example was constructed, and ends in 1938 when the last concrete arch bridge was constructed. Concrete arch bridges are eligible under Criterion A if they contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or have been significantly integral to the development of an effective transportation system. The construction of reinforced-concrete bridges in place of timber and metal bridges is representative of the commitment of the territorial and county governments to implement permanent public works improvements. The construction of these bridges required the mobilization of skilled labor and significant public funds. Many of these bridges were often extremely prominent, both in style and location, and made a significant "civic statement" regarding the technical and aesthetic sophistication of the communities in which they were built. In addition, some of these bridges have survived significant historic preservation battles between the concerned citizenry and governmental transportation agencies or private developers.

Reinforced-concrete arch bridges are eligible under Criterion C as the earliest examples of concrete bridge construction in the state. They also represent a span of engineering innovation and a visual timeline of construction technology. Concrete arch bridges often evidence a high degree of detailing and workmanship and are examples of exceptional work by important local builders. The few remaining examples are rare survivors of this once common bridge type. Reinforced-concrete arch bridges also serve as examples of exceptional work by an important engineer, architect, or builder. Prominent designers include: William H. Chun, En Leong Wung, both of County of Hawaii Engineer's Office; and William R. Bartels, chief designer for the Territorial Highways Department. The builders of these important early structures include: Louis M. Whitehouse, Peter and Charles Arioli, Hisato Isemoto, and Moses Akiona.

EILIGIBILITY REQUIREMENTS

Since reinforced-concrete arch bridges were constructed as permanent structures, the bridge must retain its integrity of location in order to be considered eligible. The design of the bridge, particularly the arch sub-structure, the spandrel walls and parapets, must also retain its integrity; although alterations early in the bridge's history (i.e. within the period of significance) and in such a way that the alterations are reversible without diminishing the significant historic characteristics of the original bridge (by widening or lengthening the bridge by the construction of an adjacent concrete culvert, for example) are acceptable. The setting of the bridge must remain relatively unchanged; by-passing the original transportation artery with a new highway does not necessarily exclude a property if the bridge's immediate surroundings retain its historic qualities. The bridge's original materials must not be adversely affected by alterations or additions. The quality of the original workmanship must remain apparent, with substantial evidence of the artisan's labor and skill. The bridge must retain a high degree of historic feeling, and its associations must be apparent to the informed or casual observer.

HIGH PRESERVATION VALUE REQUIREMENTS

Specific considerations for eligibility under Criterion A include:

1. **Early and/or prominent product of the Territory of Hawaii.** Bridges constructed as permanent public works improvements by the territorial government required the latest technology and mobilization of skilled labor.

2. **Bridges associated with the primary economic endeavor of the islands (c. 1850 -1950) - sugar production.** Sugar production facilitated changes in the pattern of land ownership in the islands, created a viable-trade-oriented economy and radically altered the demographics of the islands through the importation of wage-earning labor. The infrastructure required to support this massive economic endeavor - primarily for irrigation, transportation, and cultivation of sugar cane - changed the face of the islands forever. Many of the bridges constructed along belt roads were intended to aid in the overland transport of raw cane to the mills for processing, as well as to provide reasonable access for workers to the sugar lands.

3. **Bridges constructed as a civic statement in urban centers, such as Honolulu and Hilo.** The construction of the Panama Canal in 1915 coincided with changing social conditions in Hawaii. Honolulu was eager for the expected economic growth through shipping, trade, and tourism. These prospects mobilized community leaders to increase promotion for Hawaii, improve transportation, and further the identification between Hawaiian communities and American cities. Arched bridges in particular make a dramatic statement.

Specific considerations for eligibility under Criterion C include:

1. **Earliest use of a material.** Solid-spandrel concrete arch bridges were among the first use of this material in Hawaii. Since the first concrete arches echoed the design and form of earlier masonry arch bridges, these utilize a new material, concrete, in a fairly conservative manner from an engineering perspective. The development of open-spandrel arches pushed the engineering limits of the new material and construction technology.

2. **Rare survivor of a once common type.** The construction of concrete arch bridges was initially promoted for their permanence and many examples were constructed throughout the islands. However, the important transportation routes these bridges were generally constructed along were among the first to be up-graded for modern traffic needs. Consequently, the majority of these bridges were replaced with modern structures. The remaining rare survivors are often located on little used or by-passed roads.

3. **Exceptional work by an important engineer, architect, or builder.** Significant early designers include William H. Chun, En Leong Wung and William R. Bartels. Important builders include Louis M. Whitehouse, John H. Wilson, Peter Arioli, Hisato Isemoto, and Moses Akiona.

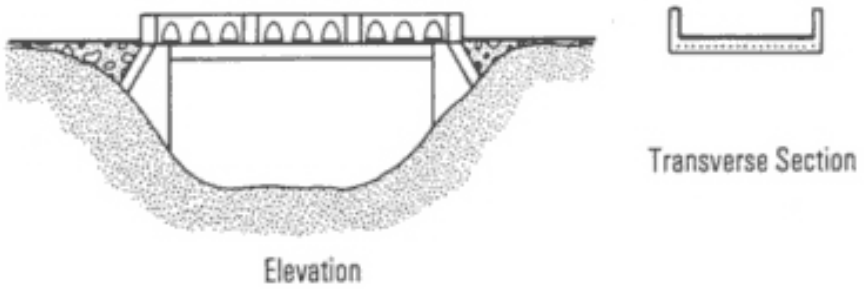
4. **Bridges of exceptional aesthetic merit.** Most arched bridges in the islands stand out by virtue of their design or because of the quality of craftsmanship displayed in their construction. The interrelationship of the bridge and its site may also have aesthetic value.

CONCRETE DECK BRIDGES

DESCRIPTION

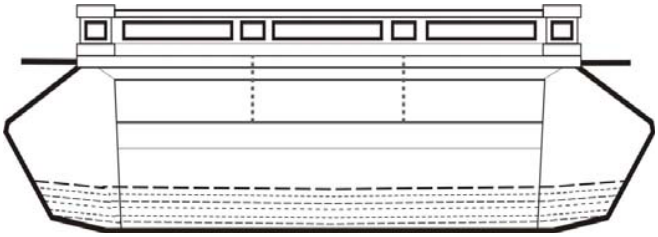
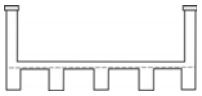
Concrete construction technology rapidly advanced in the early decades of the twentieth-century. Early twentieth century bridges built with county funds often consisted of new simple concrete decks built over the original nineteenth-century stone abutments. Slab bridges are known to have been used in Hawaii since about 1908. However, concrete girders and tee beam types came to dominate Hawaii's early twentieth-century bridge designs. As their strength and economy became apparent, concrete deck girders replaced concrete arches and open-spandrel arches for short spans. Like their contemporary flat slab bridges, early concrete girder bridges tend toward plain solid parapets and little or no ornamentation. Simple girder bridges were constructed as late as 1935 for short spans on secondary roads, since they did not have the load carrying capacity of the more recently developed concrete tee beam bridges.

This common bridge type built after 1945 is the subject of the program comment discussed in Chapter 1 under Regulatory Background, Federal Law.

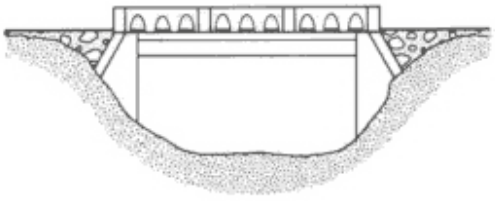
Flat Concrete Slab[35]	

Flat Slab: Simple reinforced-concrete slab bridges were an alternative to metal or timber stringer structures. Concrete flat slab bridges were constructed in Hawaii from 1908, when the oldest remaining example was built (Mokulehua Bridge on the Hana Highway), until approximately 1937, when moment-resisting concrete rigid-frame bridges became common. Early flat slab bridges built with county funds often consisted of new simple concrete decks built over the original nineteenth century stone abutments. The slabs were cast on site, with formwork built by local carpenters. The plain appearance of this functional design was augmented by a variety of railings, which ranged from solid parapets to open balustrades. These bridges typically had spans of twelve to sixteen feet. However, the 1911 Waioli Bridge was constructed with a maximum span of twenty-eight feet; a technological achievement that would not be surpassed until the Keaiwa Stream Bridge (replaced in 2001), in Kau on the island of Hawaii, was built in 1937 with a span of thirty-feet.

[35] "Bridge Types," Historic Bridge Foundation.

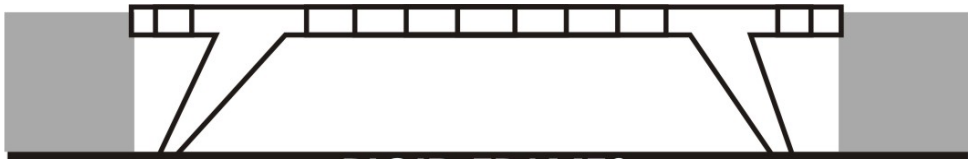
Concrete Girder elevation[36]	  Transverse Section

Concrete Girder: Another common early concrete bridge type utilized cast concrete girders in order to extend the length of the spans. As their strength and economy became apparent, concrete deck girders replaced concrete arches and open-spandrel arches for short spans. Many of these inexpensive bridges were built by the county governments c. 1911-1912 and numerous examples of this bridge type remain along the Hana Highway on Maui and the Mamalahoa Highway on the island of Hawaii. The most notable early concrete girder bridge is the 200 foot long Hanapepe Bridge built in 1911. Like their contemporary flat slab bridges, early concrete girder bridges tend toward plain solid parapets and little or no ornamentation. Simple girder bridges were constructed as late as 1935 for short spans on secondary roads, since they did not have the load carrying capacity of the more recently developed concrete tee beam bridges.

Concrete Girder (T-Beam)[37]	 Elevation  Transverse Section

Concrete Tee Beam: The concrete tee beam is the most common remaining type of pre-WWII bridges in the state of Hawaii. Although, the majority of concrete tee beam bridges were built by the Territorial Highways Department using local contractors after 1925, many early examples, dating from 1911-12, remain throughout the islands. These bridges are virtually indistinguishable from concrete girder bridges in appearance, differing only by the number of longitudinal beams and the pattern of steel reinforcing. Later tee beam bridges achieved remarkable spans and are among the longest and highest bridges in the state. This height and length was achieved by utilizing continuous tee beam sections. Continuity allowed for greater spans and the elimination of expansion joints in the deck. They typically feature one of the several standard rail patterns used by the Territorial Highway Department, either "Greek-cross," arched, or simple rectangular voids and a reinforced-concrete rail cap.

[36] Ibid.
[37] Ibid.

Concrete Rigid Frame[38]	

Concrete Rigid Frame: The most sophisticated of the pre-WWII bridges, from an engineering perspective, are those utilizing rigid-frame technologies. Concrete frame bridges are characterized by the construction of abutments and deck as one solid piece of concrete. This milestone design eliminated the need for steel bearings between deck and abutments and was more economical than plain slab construction. It also enabled the slab bridge to double or triple its previous span of 20 feet. Rigid-frame construction was a very economical and swift method for building bridges where costs had to be minimized. The earliest rigid-frame bridges were built in the United States between 1922 and 1930. However, this technology was not used in Hawaii until 1936, when William Bartels of the Territorial Highway Department developed the plans for the Wahiawa Bridge on Kauai and the Kaahumanu-Naniloa Overpass in Wailuku, Maui. These were followed the next year by the construction of two concrete rigid-frame bridges in the Kau District on the island of Hawaii and another on Oahu. Rigid-frame bridges are generally single-span structures and utilize the standard rail patterns of the Territorial Highways Department.

SIGNIFICANCE

The period of significance for reinforced-concrete deck bridges begins in 1908, when the first example was constructed, and ends in 1968, the cut-off date for the survey. Concrete deck bridges are eligible under Criterion A if they contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or been significantly integral to the development of an effective transportation system. Concrete deck bridges are representative of important public works projects initiated by the territorial and county governments. They were generally constructed at important crossings along a major transportation route or belt road. Many of the later concrete deck bridges were constructed with federal work relief programs funds during the Depression era. The early flat slab and girder bridges are an excellent example of the early period of twentieth-century bridge design when new materials and design methods were being tried. Concrete flat slab and girder bridges are early examples of the progressive Territorial Highway System in Hawaii and among the first use of formal engineering expertise in bridge making by the new territorial government, shortly after the annexation of Hawaii by the United States. The road bridges played a major role in the development of each county's belt road plan by connecting previously isolated communities with a paved highway.

Reinforced-concrete deck bridges are eligible under Criterion C if they are the earliest, sole surviving, longest span, or most intact example of their type, or if they exhibit notable engineering or decorative details. They may also serve as examples of exceptional work by an important engineer, architect, or builder. Later concrete bridges, such as tee beams and rigid-frames, demonstrate the rapid advances in engineering technology in the early decades of the twentieth century.

Prominent designers include: Joseph H. Moragne of the Kauai DPW, who oversaw the construction of the early slab and girder bridges built in the Hanalei area of Kauai in 1911-12; and William Bartels, chief designer for the Territorial Highway Department (THD), who was responsible for the design of many later concrete bridges, such as tee beam and rigid-frames. Important builders include: George Ewhart, George Freitas, George Mahikona, and the Hawaiian Contracting Company. See information on these designers in Appendix B.

[38] Parsons Brinckerhoff, "A Context For Common Historic Bridge Types," 3-97.

ELIGIBILITY REQUIREMENTS

Since reinforced-concrete deck bridges were constructed as permanent structures, the bridge must retain its integrity of location. The design of the bridge, particularly the sub-structure, the spandrel walls and parapets, must also retain its integrity. Alterations may be considered acceptable if they were completed early in the bridge's history (i.e. within the period of significance) and in such a way that they are reversible without diminishing the significant historic characteristics of the original bridge. The setting of the bridge must remain relatively unchanged; by-passing the original transportation artery with a new highway does not necessarily exclude a property if the bridge's immediate surroundings retain its historic qualities. The bridge's original materials must not be adversely affected by alterations or additions. The quality of the original workmanship must remain apparent, particularly from a technical rather than aesthetic perspective, with substantial evidence of a builder's labor and skill. The bridges must retain a high degree of historic feeling and their associations must be apparent to the informed or casual observer.

HIGH PRESERVATION VALUE REQUIREMENTS

Concrete deck bridges are generally eligible under Criterion A and C. Specific considerations for eligibility under Criterion A include:

1. **Bridges contributing in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or been significantly integral to the development of an effective transportation system.** The most significant early road and bridge building projects in the islands were associated with belt road construction. Early concrete deck bridges were constructed along narrow, winding roads cut across innumerable streams and precipitous gulches along the coastline of the major islands. Later concrete bridges were built on new highways in an effort to straighten older roads and accommodate modern automobile traffic.

2. **Bridges associated with major historical events or natural disasters.** Due to its unique location in the center of the Pacific Basin, Hawaii is susceptible to *tsunami* (seismic sea wave) inundation from nearly every direction. Earthquakes generated in the Aleutian Islands, South America and Japan have swept large, destructive ocean waves onto Hawaiian shores with a great loss of life and property. The Hawaiian Islands have also suffered devastating hurricanes and the ravages of lava flows from central volcanic peaks.

3. **Bridges associated with the primary economic endeavor of the islands (c. 1850 -1950) - sugar production.** Sugar production facilitated changes in the pattern of land ownership in the islands, created a viable-trade-oriented economy and radically altered the demographics of the islands through the importation of wage-earning labor. The infrastructure required to support this massive economic endeavor - primarily for irrigation, transportation, and cultivation of sugar cane - changed the face of the islands forever. Many of the bridges constructed along belt roads were intended to aid in the overland transport of raw cane to the mills for processing, as well as to provide reasonable access for workers to the sugar lands.

Specific considerations for eligibility under Criterion C include the following:

Reinforced-concrete deck bridges are eligible under Criterion C if they are the earliest, sole surviving, longest span, or most intact example of their type, or if they exhibit notable engineering or decorative details. They may also serve as examples of exceptional work by an important engineer, architect, or builder.

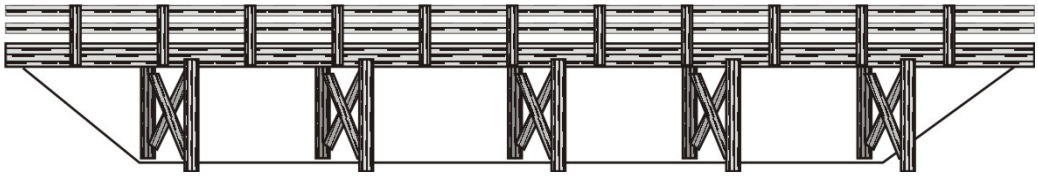
1. **Design utilizing new technology.** Rigid-frame construction and the use of continuity in girder design contributed to the increase length of spans for later concrete deck bridges.

2. **Exceptional work by an important engineer, architect, or builder.** Significant early designers include Joseph Moragne and William R. Bartels. Important builders include George Ewhart, George Freitas, George Mahikona, and the Hawaiian Contracting Company. Design of some portions of the early Interstate Highway system also received input from noted engineers and architects such as Law & Wilson, and Vladimir Ossipoff.

3. **Bridges of exceptional aesthetic merit.** Most early concrete deck girder bridges in the islands are strictly utilitarian structures. Occasionally, however, a structure stands out by virtue of its design or because of the quality of craftsmanship displayed in its construction. The interrelationship of the bridge and its site may also have aesthetic value.

4. **Bridges part of an historic district.** Many of these concrete deck bridges may not individually exhibit an exceptional aesthetic. However, strung together they may form a cohesive and aesthetically pleasing historic district, such as the Pali Highway.

TIMBER STRINGER BRIDGES

Timber Stringer[39]	

DESCRIPTION

Simple timber stringer spans constitute the only extant wood bridge type in Hawaii. Timber had been used for bridge construction since 1840 when the first bridges were built in the islands. Timber bridges were susceptible to washouts and decay, thus the earliest surviving bridge dates from 1924. The remaining examples of wood bridges are constructed of timber girders, often with masonry (basalt) pier footings and abutments, wood cribbing or trestles, and open horizontal wood board railings. Stringer spans usually measure twenty-five feet or less. Larger timber stringer bridges are generally located in the dryer areas over deep gulches and date from the immediate pre- and post-WWII period (c. 1937 to 1947). The failure of the Territorial Legislature to match federal funds led to a significant reduction in funds available for bridge construction by the end of the decade. Consequently, less expensive wood bridges were built. The older, smaller wood bridges were generally constructed on secondary roads. Very few of these timber bridges remain in the islands as a result of a deliberate policy by the THD and county DPWs to replace timber bridges with permanent, low-maintenance concrete structures.

SIGNIFICANCE

The period of significance for timber stringer bridges begins in 1924, when the first remaining example was constructed, and ends in 1949, when the last timber bridge was constructed. Timber bridges are eligible under Criterion A if they have contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or were significantly integral to the development of an effective transportation system. Timber stringer bridges are representative of public works efforts by the territorial and county governments for transportation infrastructure primarily located in rural homestead areas.

The majority of Hawaii's timber was (and still is) fir or pine imported from the Pacific Northwest, although early records show a preference for rare local tropical hardwoods. During the early twentieth-century, older timber bridges were periodically replaced with simple concrete spans in efforts to upgrade the highways. The relative impermanence of timber, compared to other bridge types, diminished the desirability of timber bridges. However, timber was frequently used for small bridges on little-traveled roads because this material was less expensive in the short run. Budget constraints impacted bridge construction beginning in 1937, when the Territory no longer matched incoming federal funds. Bridges built around this period were often of inexpensive timber with fairly short spans. Further, concrete and steel were in short supply due to the military construction boom as World War II approached. During this time, locally abundant masonry (“lava-rock”), which was not previously used on Federal Aid bridges, made an appearance in footings and abutments. Today, the governmental transportation agencies no longer construct timber bridges and, in fact, are reluctant to maintain existing ones. Consequently, the few remaining timber stringer bridges stand as rare survivors of this once common bridge type. Because these bridges have few character defining features, those timber bridges that feature superstructures re-constructed with concrete or steel girders at a later date do not meet integrity criteria.

[39] Ibid.

ELIGIBILITY REQUIREMENTS

Timber bridges must retain their integrity of location. The design of the bridge, particularly the wood sub-structure, must also retain its integrity. Alterations within the period of significance that do not diminish the significant historic characteristics of the original bridge (such as material replaced in-kind) are acceptable. The setting of the bridge must remain relatively unchanged. By-passing the original transportation artery with a new highway may not necessarily exclude a property if the bridge's immediate surroundings still retain their historic qualities. The bridge's original materials must not be adversely affected by alterations or additions. The quality of the original workmanship must remain apparent, particularly from a technical rather than aesthetic perspective. The bridges must retain a high degree of historic feeling and their historic associations must be apparent to the informed or casual observer.

HIGH PRESERVATION VALUE REQUIREMENTS

Specific considerations for eligibility under Criterion A include:

1. **Bridges that have contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or that have been significantly integral to the development of an effective transportation system.** The most significant early road and bridge building projects in the islands were associated with belt road construction. Timber stringer bridges were constructed along narrow, winding roads that cut across the streams and gulches of island coastlines. Later concrete bridges were built on new highways in an effort to straighten the older roads and accommodate modern automobile traffic.

Specific considerations for eligibility under Criterion C include:

1. **Rare survivor of a once common type.** A timber bridge may be considered of high preservation value if it is the earliest, sole surviving, longest span, most intact example of its type, or if it exhibits notable engineering or decorative details. The governmental transportation agencies no longer construct timber bridges and, in fact, are reluctant to maintain existing ones. Consequently, the majority of these bridges were replaced with modern structures. The remaining rare survivors are often located on little used or by-passed roads. They may also serve as examples of exceptional work by an important engineer, architect, or builder

2. **Exceptional work by an important engineer, architect, or builder.** The majority of remaining timber stringer bridges was designed by unknown engineers in the County Engineer's Office. However, several later, large timber bridges constructed during the Depression were designed by the THD chief engineer, William R. Bartels.

BRIDGE PARAPET/RAILING TYPES

SOLID PARAPET DESIGN	
Concrete Solid	 Farrington Highway, Hunehune Stream Bridge (1941) County of Honolulu: 003924001100001
Concrete Solid with Cap	 Hanapepe Bridge (1911) County of Kauai: 007190071119004

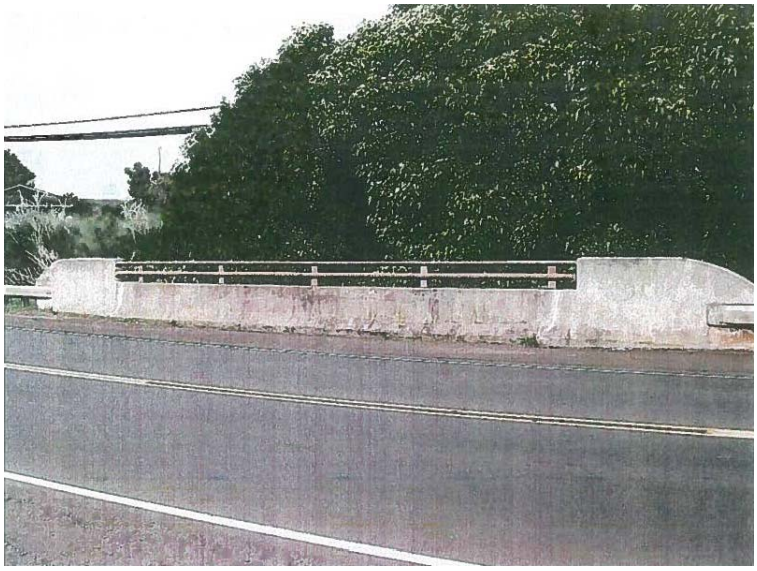
Concrete Solid Panel	 Hanamaulu Stream (Maalo Road) Bridge (1927) Kauai State: 007005830500004
Concrete Solid Panel with Cap	 Waikomo Stream (Koloa Road Bridge) (1928) County of Kauai: 007270100828001

Concrete Solid Decorative	 Ala Wai Canal County of Honolulu: 003083181400074
Masonry Rock	 Kawa Stream Bridge (1939) Oahu State: 003063001400065

Masonry Rock with Cap	 Nuuanu Stream Bridge County of Honolulu: 003083471400113

OPEN PARAPET DESIGN	
Concrete Open Horizontal	 Mana Bridge No. 1 (1900) County of Kauai: 007120061112002
Concrete Open Vertical	 Kapalaau Stream Bridge (1940) Oahu State: 003009300501414

Concrete Open Arched	 Waihohonu Stream Bridge (1934) Kauai State: 007000500302613
Concrete Open Greek Cross	 Waimea River (1940) Kauai State: 007000500301039

Concrete Open Decorative	 Puuhaoa No. 22 Bridge (1910) County of Maui: 009003600904386
Concrete and Metal	 Gulch (Kailua) Structure No. 50 (Sam Kalama) (1930) County of Maui: 009003650700070

Concrete and Metal Picket	 Palolo Stream Bridge County of Honolulu: 003083531400155
Concrete and Metal Decorative	 Kapalama Canal (1938) County of Honolulu: 003062081400134

Metal Horizontal	 Kula Kolea Pedestrian Overpass (1960) Oahu State: 003000630000234
Metal Picket	 Vineyard Blvd (Central Intermediate Pedestrian Overpass) (1957) Oahu State: 003098001400116

Metal Thrie Beam	 Anakaluahine Stream Bridge No.69 (1924) Maui State: 009000300303899
Metal Decorative	 Keolu Drive Bridge-Hele Drainage Channel (1957) County of Honolulu: 003427001100001

Wood	 Maili Stream Bridge (1900, replaced in kind in 1974) County of Hawaii: 001260001100003
No Railing/Parapet	 Opaekaa Bridge (1900) County of Kauai: 007420151142001