

**WAIKELE CANAL BRIDGE AND HIGHWAY OVERPASS
(Waikele Stream Bridge and OR&L Bridge)
Farrington Highway and Waikele Stream
Waipahu
Honolulu County
Hawaii**

HAER No. HI-100

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

**HISTORIC AMERICAN ENGINEERING RECORD
U.S. Department of the Interior
National Park Service
Oakland, California**

HISTORIC AMERICAN ENGINEERING RECORD

WAIKELE CANAL BRIDGE AND HIGHWAY OVERPASS (Waikele Stream Bridge and OR&L Bridge)

HAER No. HI-100

- Location:** Farrington Highway and Waikele Stream
Waipahu
City and County of Honolulu, Hawaii

U.S.G.S. topographic map, Waipahu Quadrangle 1998 (7.5 minute series)
Universal Transverse Mercator Coordinates NAD 83:
04.602570.2364850
- Present Owner:** State of Hawaii
- Present Use:** Vehicular Bridge
- Significance:** The Waikele Canal Bridge and Highway Overpass above the former railroad right-of-way of the Oahu Railway & Land Co. (hereafter called the OR&L Bridge) are significant for their contribution to the development of an effective road transportation system on Oahu, as part of the Farrington Highway segment of Oahu's belt road system. The bridges facilitated passage along Farrington Highway, which speeded travel by providing an alternative and shorter route to the nineteenth-century government road through the town of Waipahu.
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- Project Information:** This report is part of the documentation for properties identified as adversely affected by the Honolulu High Capacity Transit Corridor Project (HHCTCP) in the City and County of Honolulu. This documentation was required under Stipulation V.C. (1, 2) of the HHCTCP Programmatic Agreement, which was signed by the U.S. Department of Transportation's Federal Transit Administration, the Hawaii State Historic Preservation Officer, the United States Navy, and the Advisory Council on Historic Preservation. After consultation with the City and County of Honolulu, the National Park Service, Pacific West Regional Office, in a letter dated June 29, 2011, stipulated the details of the required documentation efforts, including HAER documentation for these and other bridges affected by the HHCTCP. Archival photographs were taken by David Franzen, Franzen Photography, Kailua, HI. The field work was conducted in May 2012 and the initial report prepared in June 2012. The report was finalized in October 2012.

Part I. Historical Information:

A. Physical History:

1. **Date of construction:** 1939¹
2. **Engineer:** William R. Bartels, bridge engineer for the Hawaii Territorial Highway Department, designed the Waikele Canal Bridge. The designer of the OR&L Bridge is unknown. Bartels received his education and training in Germany and immigrated to Hawaii in 1932 when he commenced working with the Highway Department; he continued his career there until his retirement in 1958.² During that period, he was a prolific and versatile designer, responsible for large and sophisticated bridge construction projects in Hawaii, including many tee-beam and rigid-frame concrete bridges. Bartels' name appears on original drawings of the Waikele Canal Bridge as the designer. These drawings were completed in March 1938, drawn by C.F. Wagner and T. Ting, but designed and checked by Bartels. Louis S. Cain, the Territorial Highway Engineer at the time, approved the drawings.
3. **Builder/ Contractor/ Supplier:** E. E. Black, Contractor³
4. **Original plans and construction:**

Both bridges were built in 1939 in conjunction with the construction of the Waikele Canal. Both bridges carry Farrington Highway, which passes over the Waikele Canal and the adjacent OR&L railway right of way about 128' to the east of the canal. In this area, Farrington Highway was built on an earthen incline that raises it above the height of railcars formerly traveling on the OR&L tracks. This incline continues to the edge of the Waikele Canal and for a short distance on the west side of the canal.

The Waikele Canal Bridge is a three-span, reinforced-concrete tee-beam bridge⁴ carrying two lanes of traffic (now both lanes are east-bound) over the Waikele Canal. The total length of the bridge is about 122' and its deck is about 50' above the floor of the concrete-lined streambed. The bridge has concrete parapets and end stanchions that were typical for the time of its construction in Hawaii. The thickly built parapets have cross-shaped voids. The end stanchions are also thickly built and squat, and are curved (arc) in plan with stepped edges. The underside of the bridge has four longitudinal beams with partial-arch closed spandrels where the bearings contact the top of the four supporting piers. The bridge appears as built, except for the addition of modern steel guardrails to the approaches at each end that cover original year date and name inscriptions (Waikele Canal) on the end stanchions.

The OR&L Bridge is classified as a concrete tee-beam bridge in the National Bridge Inventory Database.⁵ However, the original construction drawings for this bridge were not located at the State Department of Transportation files to confirm the pattern of reinforcing steel within its girders (which typically distinguishes tee-beam from other

¹ "Three Major Improvements Are Dedicated at Waipahu," *Honolulu Star Bulletin*, October 30, 1939. p. 16.

² "TH Honors 4 Veteran Employees," *Honolulu Advertiser*, July 1, 1958. Article at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biography section under: Bartels.

³ Superintendent of Public Works. *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1940* (Honolulu: Pacific Herald Publishing Co.) 1941. p. 22

⁴ National Bridge Inventory Database, Waikele Canal Bridge, on website: nationalbridges.com, accessed May 23, 2012.

⁵ National Bridge Inventory Database, OR&L Bridge, on website: nationalbridges.com, accessed May 23, 2012.

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concrete girder bridge types). This bridge has single span of 42'.⁶ Except for shorter lengths, its parapets and stanchions are the same as those on the Waikele Canal Bridge. The underside of the OR&L Bridge has four longitudinal beams.

Construction of the bridges involved emplacement of an incline of earthen fill about 1,200' long that raises Farrington Highway about 40' in elevation over that distance, from lower ground on the east to higher grade on the west. Before the bridges' construction, the existing steep terrain and the railroad tracks were obstacles that the bridge designer had to address. The solution provided a gentler slope to Farrington Highway and allowed it to clear the tops of rail cars, which then ran on the OR&L tracks.

5. **Alterations and additions:** Steel guardrails were added to the end stanchions of both bridges at an unknown date. A less noticeable alteration, also undated, was the addition of concrete paving that slopes up to the bridges' walkways, which covered the bullseye reflectors originally in the traffic-facing curbs. (See Description section for more information.)

The bridges are both included in the National Bridge Inventory Database. Waikele Canal Bridge has a National Bridge Inventory Structure Number of 003090001400108, and the OR&L Bridge is numbered 003090001400114.

B. Historical Context:

During the Republic of Hawaii period (1894-1898), and especially after annexation of Hawaii by the United States in 1898, political and business leaders recognized that the creation of improved belt roads with modern bridges around the perimeter of each island was of great importance to linking each island's communities, and to their economic growth.⁷ Funding the needed highway and bridge construction was always a challenge in each period of Hawaii's history. Starting in 1925 the Territory of Hawaii was able to obtain Federal highway funds to assist with the goal of completing and improving the islands' belt roads.

The Waikele Canal Bridge was constructed as part of the Territorial Highway Department's extension of Waianae Road in 1938-39 under Federal Aid Project (F.A.P.) No. 4-C, which was subtitled "Waipahu Cutoff." (For additional information on F.A.P. 4-C, and on the naming of Farrington Highway, see HAER No. HI-99, Honouliuli Bridge.) All the highway and bridge construction for F.A.P. 4-C was completed in 1939. Before this project the only road through the area, between Ewa Junction in the east and Waianae Road in the west, was Waipahu Road. This Kingdom-era roadway, originally called "Government Road," linked Waianae Road with Kamehameha Highway (the main belt road) at Ewa Junction. Waipahu Road (now Waipahu Street) follows a winding route through the former plantation village of Waipahu, running generally east-west, with a bend to the south of the now-demolished Oahu Sugar Company mill.

The 1939 Waipahu Cutoff highway alignment, in the area near the mill, is located $\frac{1}{4}$ to $\frac{1}{2}$ mile *makai* (common Hawaiian term denoting: toward the sea) of Waipahu Street. The new highway provided a more direct route, one that eliminated the need to travel along Waipahu Street's

⁶ Territorial Highway Department, Hawaii Highway Planning Survey. Bridge Inventory for the Island of Oahu. Prepared in Cooperation with the U.S. Department of Commerce, Bureau of Public Roads. September 1950.

⁷ Heritage Center, School of Architecture, University of Hawaii at Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation (Draft prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. pp. I-27 to I-29.

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twisting course through the built-up village of Waipahu. Farrington Highway created a bypass around Waipahu and greatly improved Oahu's belt road system in this part of the island.

The OR&L Bridge was not a part of F.A.P. 4-C. Original drawings show that it was located along the 1.1 miles of Farrington Highway that were not included in that Federal project, but were part of a Federal Aid Grade Hazard (F.A.G.H.) Project 4-C. F.A.G.H.-funded projects were for the "elimination of hazards to life at railroad grade crossings" and were used for any grade crossings within the Federal highway system.⁸ Such F.A.G.H. projects did not require any matching funds from the Territorial government.⁹

Several sources noted different costs for the highway work in this area. Newspaper articles stated the expected cost of the Waipahu Cutoff project as \$250,000 in 1937.¹⁰ This total was to be partly funded by Territorial appropriation and with a larger amount of Federal funds, since the cost of railroad grade crossing elimination was an "outright grant" from the Federal government and did not have to be matched by the Territory.¹¹ The articles also noted: "All curves in the road between [Ewa and Waianae Junctions] will be eliminated;"¹² and that "motorists will miss Waipahu entirely when using the cutoff and traffic will be speeded up by elimination of travel through the narrow and winding streets of that community."¹³ Before the bids were due from contractors, the expected cost of the project (including the amount for the flood control canal that rerouted Waikele Stream) was put at \$399,700 and the work expected to begin in July 1938.¹⁴ The Superintendent of Public Works report noted the total cost of the F.A.P. and F.A.G.H. 4-C projects, plus the related Kunia Road project (F.A.P. 16-B) at the western end of Waipahu Road, was \$381,238.18.¹⁵ The amounts for the Canal Bridge and OR&L bridge were not broken out in any cost estimates or final figures for highway and bridge construction in the Waipahu area, although the canal itself was estimated to cost \$65,000.¹⁶

The parapet and stanchion design of the OR&L Bridge is identical to the Waikele Canal Bridge and other contemporary Territorial bridges. This suggests that the OR&L Bridge was either designed by the Territorial Highway Department, or the drawings were done by some other engineers based on standard plans, from either the Territorial or federal highways departments.

Waipahu

"The town of Waipahu is a child of Oahu Sugar [Company]."¹⁷ The Oahu Sugar Company (OSC) plantation and mill began as a development project of Benjamin F. Dillingham, who had leased land from James Campbell. Dillingham partnered with J. Hackfeld and Company (Paul Isenberg) and with Mark Robinson (who provided land for the mill site) to form the company, which was incorporated in March 1897. The original "Government Road" traversing Waipahu

⁸ Federal Works Agency, "Title 23, Chapter 1 – Public Roads Administration," in *1939 Supplement to the Code of Federal Regulations of the United State of America* (Washington DC: Government Printing Office) 1940. p. 1335.

⁹ "Cain Outlines Territory–U.S. Highway Plan," *Honolulu Star Bulletin*, June 29, 1937. p. 1.

¹⁰ Ibid. and "New Highways Will Be Built," *Honolulu Star Bulletin*, December 18, 1937. p. 3.

¹¹ "U.S. Earmarks \$975,000 for Hawaii Roads," *Honolulu Star Bulletin*, December 31, 1937. p. 1.

¹² "New Highways Will Be Built," *Honolulu Star Bulletin*, December 18, 1937. p. 3.

¹³ "Waipahu Road Job Bids Are Due June 9th," *Honolulu Star Bulletin*, May 25, 1938. p. 1.

¹⁴ Ibid.

¹⁵ Superintendent of Public Works, *Report to the Governor of the Territory of Hawaii for the Year Ending June 30, 1940* (Honolulu: Pacific Herald Publishing Co.) 1941. p. 22.

¹⁶ "Waipahu Road Job Bids Are Due June 9th," *Honolulu Star Bulletin*, May 25, 1938. p. 1.

¹⁷ Michael Mauricio, *Waipahu, Its People and Heritage* (Waipahu, HI: Waipahu Community Foundation) 1997. p. 59.

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was a much straighter line, but the first OSC manager, August Ahrens, requested rerouting of the road to run south of the mill, which would avoid many crossings of the road by the plantation's rail lines. A land exchange was arranged and Waipahu Road (now Street) basically follows that 1897 alignment through the town.¹⁸

Oahu Sugar's first harvest was in 1900. That year the plantation had enough workers to harvest and mill 7,900 tons of raw sugar. In the following years, the population grew with the plantation, which besides laborers, required tradesmen, supervisors, and engineers. These workers and their families grew the town of Waipahu around the OSC mill. By the late 1920s, Waipahu was sprawled along Waipahu Road to the east and west of the mill, and a business district had formed south of the mill, with its center at Waipahu Depot Road. Primary residential areas were located *mauka* (common Hawaiian term denoting: inland) of the mill (Japanese Camp) and to the east along Waipahu Road. By the 1930s, Waipahu "included second and third generations. They had grown up on the plantation and considered Waipahu their home."¹⁹ In 1940 the town had a population of 6,900.

Growth exploded in the 1960s when the population went from 8,353 in 1960 to 22,798 in 1970. This period saw a corresponding increase in building along Farrington Highway. In 1966 the section of the H-1 Freeway *mauka* of Waipahu between Kunia Road and Makakilo was opened, providing another bypass around the town. Growth in Waipahu continued; the population in 1980 was over 29,000.

Oahu Railway & Land Co.

The Oahu Railway & Land Company (OR&L Co.) was a narrow-gauge railway system established in 1889 by Benjamin F. Dillingham. The trains primarily hauled supplies to and raw sugar from his and others' sugar plantations, but also carried passengers. The railroad system reached from the base yard in Honolulu to Ewa Station by May 1890. The Waipahu Station was located along the main route, where Waipahu Depot Road crossed the OR&L Co. tracks, about ½ mile south of the OSC mill. This station was about ½ mile southeast of the site of the future Waikele Canal Bridge. Additional stretches of OR&L Co. track were laid from Ewa around Kaena Point, and along the north shore to Kahuku; in 1906, a branch line was extended from Waipahu to Wahiawa. In 1921, the line from Honolulu to Waipahu was expanded by the addition of a second set of tracks.²⁰

The branch line to Wahiawa extended northwest from the OR&L Co. main line, at a point just west of the Waipahu Station. This branch line ran about ½ mile before crossing a bridge over the Waikele Stream. In 1939, this section of the branch line to Wahiawa was the portion spanned by the Highway Overpass (OR&L Bridge) that carried Farrington Highway over the railroad tracks. This branch line consisted of two tracks at the point where the Highway Overpass (OR&L Bridge) crosses it.

OR&L Co. railroad operations remained a principal mode of travel and transport across Oahu through the 1920s. Pineapple and sugar freight before World War II consistently provided good income for the company. Passenger traffic on the OR&L Co. lines was more sporadic during this period as ridership fluctuated downward through the depression years of the 1930s, and

¹⁸ Spencer Mason Architects, Waipahu Street Widening Project, Potentially Historic Properties (Prepared for Austin, Tsutsumi & Associates, Inc.) 1990. pp. 1-3.

¹⁹ Lani Nedbalek, *Waipahu, A Brief History* (Mililani, HI: Wonder View Press) 1984. p. 27.

²⁰ Jim Chiddix & MacKinnon Simpson, *Next Stop Honolulu! Oahu Railway & Land Company, 1889-1971* (Honolulu: Sugar Cane Press) 2004. pp. 342 & 344.

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passenger trains were scheduled less frequently. The company ordered its last steam locomotives in 1926.²¹

Private ownership of automobiles and territorial roadway improvements further contributed to the decline in OR&L Co. passenger service. Previously busy railway stations became “whistle stops”, and OR&L Co. converted many of its passenger cars into freight cars. Even with declining passenger numbers and service cuts during the 1930s, OR&L Co. maintained some passenger service; they offered special charters (such as photography excursions around Kaena Point), and operated a fleet of gasoline-powered passenger motorcars with daily service on the mainline, which was cheaper to operate than a steam locomotive.

World War II reversed this decline, as OR&L Co. "went into a heightened schedule of moving men and material. Trains ran 24 hours a day, sometimes with five-minute headways. Many old passenger cars which – in the late '30s – had had the seats ripped out...were soon reconfigured with crude benches to carry people again."²²

After the war, OR&L Co.'s freight and passenger business once again dropped when automobiles and trucks began to supply Oahu's transportation needs more frequently. A tsunami struck Oahu on April 1, 1946, and damaged OR&L Co.'s mainline, forcing north shore plantations to use trucks for deliveries into Honolulu. When these and other plantations realized that truck shipping was efficient, it became the preferred method of delivery. OR&L Co. freight tonnage decreased even further. Operations of the common carrier service on the OR&L Co. mainline ceased on December 31, 1947, and most of the mainline track was removed. Sections of OR&L Co. track between Pearl Harbor and (Naval Magazine) Lualualei were turned over to the Navy. OR&L Co. maintained a small rail line at the Honolulu waterfront that served pineapple canneries, a meat packing plant, and the wharfs. In 1962, the packing plant started using trucks for transportation, and subsequently about 8¾ miles of track were abandoned. The pineapple canneries remained connected to the wharfs by rail lines until 1971, when the OR&L Co. operation ended.

Waikele Canal

The Waikele Canal was a City and County of Honolulu project, built in conjunction with the construction of the Waikele Canal Bridge and the OR&L Bridge, which were Territorial projects. The canal was built to stop the flooding of businesses that frequently occurred during heavy rains near Waipahu Depot Road, about ¼ mile east of the bridge. In this area, Waikele Stream, which drains a very large area *mauka* of Waipahu, formerly emptied into Kapakahi Stream at a sharp bend that turned the water south toward Pearl Harbor. The need for flood control here was expressed by Waipahu community leaders and the Honolulu Board of Supervisors in 1937; at that time, it was recommended that any funds left over from the Kapalama flood control project be set aside for the Waipahu project and also a project in Waialua.²³ The canal was dredged south to Pearl Harbor from a point in Waikele Stream about ¼ mile upstream from this flood point. The canal ran near (west of) the existing OR&L Co. Wahiawa branch line for a short distance. The Waikele Canal Bridge was built to span this canal and the Highway Overpass (OR&L Bridge) was built to span the OR&L Co. tracks.

²¹ Jim Chiddix and MacKinnon Simpson, *Next Stop Honolulu, Oahu Railway & Land Company 1889-1971*. (Honolulu: Sugar Cane Press). 2004. p. 185.

²² *Ibid.* p. 199.

²³ "New Waianae Hookup, Plan," *Honolulu Star Bulletin*, June 29, 1937. p. 7.

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Spoils from the canal were used to build the incline that carries Farrington Highway up to the OR&L Bridge and the Waikele Canal Bridge.²⁴ The construction of the incline was covered under F.A.G.H. 4-C funding. The dredged canal diverted Waikele Stream directly into Pearl Harbor, eliminating the flooding that had periodically occurred at the Waipahu Depot Road area.

After the canal was dredged and water flowing down Waikele Stream was diverted into it, the segment of the stream that formerly ran to Kapakahi Stream at Waipahu Depot Road was abandoned and went dry. This left the canal as the only outlet of Waikele Stream to Pearl Harbor and caused it to eventually be referred to as Waikele Stream.²⁵

The Waikele Canal was opened in October 1939 and quickly proved its worth diverting water coming down Waikele Stream and preventing flooding of the business district. On the 21st and 22nd of that month it "withstood the acid test when 11.07 inches of rain fell in Waipahu."²⁶ The official dedication was held on October 29, 1939 when acting Mayor David Y. K. Akana presented the flood control canal to the community in a ceremony that was conducted on the Waikele Canal Bridge.²⁷

Tee Beam Bridges

Concrete tee-beam bridges are the most common type of remaining pre-World War II bridges in the state of Hawaii.²⁸ They are a part of the evolution of reinforced-concrete deck bridge technology in Hawaii that began with the first slab bridges around 1908. Often county-designed, these early slab bridges frequently consisted of concrete decks replacing older type superstructures on their original abutments, which were often lava rock and mortar.

Design of reinforced-concrete deck bridges progressed rapidly during the first decades of the 20th century. Many of the earliest concrete bridges had been built in the arched form of the Hawaiian kingdom's lava-rock ones. The strength of concrete girder and tee-beam types, and their lower cost, led to their use in locations with short spans, rather than the concrete arched types.

Although the earliest tee-beam bridges in Hawaii date from about 1912, after about 1925 the tee-beam bridge became the preferred choice for bridge construction by the Territorial Highway Department. The pattern of reinforcing steel within their girders was the feature that most distinguished them from other concrete girder bridges. The pattern of reinforcing steel in the girders and deck structurally joins the two.²⁹ This allows the two components to work together, so that tee-beam bridges can efficiently carry a greater load. This relatively small change over standard girder construction provided an increased carrying capacity, and the tee-beam quickly came into wide use, with examples constructed into the 1950s.

Tee-beam bridges in Hawaii generally had parapets with voids, below a reinforced-concrete rail cap. "Several standard rail patterns [were] used by the Territorial Highway Department, either

²⁴ Michael Mauricio, *Waipahu, Its People and Heritage* 1997. p. 11. Also, State of Hawaii, Department of Transportation, Highways Division, Design Branch, F.A.P. No. 4-C, Drawing 4449.8, Revised June 19, 1939.

²⁵ U.S. Geological Survey, Topographic Map, Waipahu, HI. Scale 1:24,000. 1998.

²⁶ "Three Projects Dedicated," *Honolulu Advertiser*, October 30, 1939. p. 1.

²⁷ "Three Major Improvements Are Dedicated at Waipahu," *Honolulu Star Bulletin*, October 30, 1939. p. 16.

²⁸ Heritage Center, School of Architecture, UH Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation (Draft prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. p. I-72.

²⁹ Parsons Brinkerhoff and Engineering and Industrial Heritage, A Context for Historic Bridge Types, NCHRP Project 25-25, Task 15 (Prepared for the National Cooperative Highway Research Program) October 2005. p. 3-88.

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'Greek-cross,' arched, or simple rectangular voids."³⁰ Earlier masonry (lava rock or concrete) bridges typically had solid railings.

Part II. Structural/ Design Information:

A. General Statement:

1. **Character:** Waikele Canal Bridge and the OR&L Bridge exemplify typical reinforced-concrete bridges constructed in Hawaii during the 1930s and 1940s. The parapet design with cross-shaped voids and the curved-plan end stanchion configuration were also typical of this type and period of bridge.

The Waikele Canal Bridge is also visually remarkable for its great height above Waikele Stream (approximately 50') and for its overall length (about 122'). These dimensions, combined with the slender supporting piers, and with the graceful closed spandrel form of the girders, present an unusually airy appearance for a reinforced-concrete bridge.

2. **Condition of Fabric:** Good.

B. Description:

Waikele Canal Bridge

The Waikele Canal Bridge carries the two eastbound lanes of Farrington Highway on an asphalt-surfaced roadway approximately 24' wide. The two sides of the roadway have 3'-0" wide concrete walkways set about 6" higher than the roadway, which form curbs. The concrete parapets and end stanchions of the bridge are typical construction for bridges built on Oahu from the late 1930s through the mid 1940s.

The two concrete parapets are 2'-10" tall, measured from the walkway surface, and are 119'-5" long between end stanchions, with narrow expansion joints between parapets and stanchions. Along the length of each parapet are four expansion joints on a variable spacing of either 24'-5", 24'-0", or 22'-6". The parapets have top railings 1'-0" wide and 7" high with 1" x 1½" stepped corners. Below the railing is a series of vertical concrete balustrades 6" wide and 6" thick that are typically spaced at 1'-7" on centers. The sections of each parapet that are between the balustrades are slightly thinner (4" thick) and each section was molded with a cross-shaped void. These voids are typical of concrete bridge design in Hawaii during the 1930s and 1940s and are commonly referred to as a Greek-cross shape.³¹ Each cross void is 1'-3" high and 8" wide. The base of each parapet, running its length, is 7" high and 10" thick.

The concrete end stanchions are 3'-3" high from the walkway surface, 1'-9" thick, and about 5' long. In plan, they form an arc of a circle spanning about 45 degrees. The stanchion end facing the parapet abuts it squarely and the stanchion curves out away from the roadway, presenting a curving face to the traffic lanes. Each stanchion has 1½" stepped corners, with a top surface that is 1'-3" wide. Along its outer (road-face) curving circumference each measures 5'-5" in length, and along the inner curve, 4'-2" in length. Each stanchion has been altered by an added steel W-beam guardrail. These rails extend along the edges of the roadway at the bridge approaches. Typically, concrete bridges of this type and period have date and name inscriptions on their end stanchions. Although the guardrail covers the inscriptions from casual

³⁰ Heritage Center, School of Architecture, UH Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation (Draft prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. p. I-72.

³¹ Ibid., p. I-30.

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view, the inscriptions can be seen behind them. "Waikele Canal" is on the northeast and southwest stanchions. On the northwest and southeast stanchions, the date "1939" is visible behind the guardrails. The incised block letters of the inscriptions are about 3" high.

At the northeast and southwest ends of each of the two 6"-high walkway curbs are 8"-wide phosphor bronze plates set flush with the concrete walkway surface. These plates covered the tops of 6"-diameter "bullseye reflectors" that were originally presented to oncoming traffic by being set into the face of these two curbs.³² Added concrete paving covers the face of the curbs, so it is not known if the reflectors are still extant under the plate.

The underside of the bridge is board-formed concrete, with four longitudinal girders supported at two points, making three spans across the 122'-0" distance between abutments. The center span is 50'-0" and each flanking span is 36'-0". Each reinforced concrete longitudinal girder is formed with a spandrel at its support points. Each girder is 1'-6" thick, 3'-0" high at its midpoints between supports, and is 6'-0" high at the spandrels. At their support point spandrels, the girders are joined by 1'-0" thick transverse beams.

The supports for the girders are 1'-6" square, reinforced-concrete columns, about 28' high, which extend down from the spandrel support points to reinforced-concrete piers in the canal bed that are about 16' high. These piers consist of four legs, one under each column, joined at their tops by a horizontal concrete beam 3'-0" square. The center two legs of each pier are 3'-0" square and the outer leg of each pier is battered on its upstream- or downstream-facing side, with width ranging from 6'-6" at its base to 5'-0" at its top, where it joins the horizontal beam. In addition, these *mauka*- and *makai*-facing sides of the outer legs have angled surfaces, pointing upstream and down.

The abutments of the bridge are board-formed concrete with integral wing walls, extending about 25' to 30' upstream and downstream of each abutment. The abutments are about 20' high and are set on the top lip of the sloping concrete lining of the canal.

OR&L Bridge

The OR&L Bridge is about 128' east of the Waikele Canal Bridge, and carries the same two eastbound lanes of Farrington Highway over the former Oahu Railway & Land Company railroad grade. The OR&L Bridge has the same width of asphalt-surfaced roadway, flanked by walkways and curbs as on the Waikele Canal Bridge. The parapets of the OR&L Bridge are 42'-0" long between end stanchions. Except for the parapet length and inscriptions on stanchions, the configuration of the parapets and stanchions of this bridge are identical to the Waikele Canal Bridge, as described in the section above. The stanchions of the OR&L Bridge have no inscriptions discernible behind the added guardrails.

The OR&L Bridge has phosphor bronze plates remaining in the curb near the northeast and southwest stanchions, like the Waikele Canal Bridge. These plates covered the tops of 6"-diameter "bullseye reflectors" that were originally presented to oncoming traffic by being set into the oncoming face of the curb.³³ Added concrete paving covers the face of the southwest curb, so it is not known if the reflector is still extant under the plate. A gap in the added paving at the northeast curb reveals the top of the reflector cavity with no reflector present.

³² State of Hawaii, Department of Transportation, Highways Division, Design Branch, [Waikele] Canal Bridge, F.A.P. No. 4-C, Drawing 4449.27. March 1938.

³³ Ibid.

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The underside of the OR&L Bridge is board-formed concrete with four longitudinal girders crossing the single 42' span. Each girder is about 1'-6" thick and 3'-0" high. Smaller transverse beams that are about 1' thick and 2' high join the girders. One transverse beam joins the three south girders about 12' from the east abutment, and another transverse beam joins the three north girders about 12' from the west abutment.

The abutments are board-formed concrete, about 20' high, with wing walls that extend about 40' to 50' in each direction from under the edges of the bridge.

C. Site Information:

Both bridges are located along an urban section of Farrington Highway about 1/3 mile west of Waipahu Depot Road. In Hawaii, roads and streams are not given Tax Map Key (TMK) designations. The Waikele Canal Bridge lies just north of TMK 9-4-011: 041 and of 9-4-011: 061, the two parcels that flank the canal on the *makai* side of this bridge. The OR&L Bridge is located just north of TMK 9-4-011: 103, which is a strip of land that formerly was the railroad spur right-of-way. The setting has changed greatly since the bridges' construction. Aerial photos show that as late as 1951, the area around the bridges' was much less densely built up, with only scattered buildings.³⁴ From the construction date until that time, the area was on the fringes of the Waipahu community.

Immediately to the north of the 1939 Waikele Canal Bridge is a two-lane, reinforced concrete bridge (built in 1963), that carries the westbound lanes of Farrington Highway across Waikele Canal. It is sited adjacent to the base of the (1939) earthen incline of the eastbound lanes. The northwest end stanchion of this bridge is inscribed "William A. Patterson Bridge."³⁵ (Patterson, 1899-1980, was the son of an overseer on Waipahu's Oahu Sugar Company plantation, and would later become the first president of United Airlines [from 1934 to 1966].)

Further north, beyond the William A. Patterson Bridge, are residences along Farrington Highway, then a set of two- and three-story apartment buildings along Aniani Place, whose layout follows the curve of Waikele Stream. North of the 1963 bridge, and north of the narrow strip of residential and commercial development along Farrington Highway, the area occupied by Waipahu Cultural Garden Park and Hawaii's Plantation Village remains mostly open land with scattered buildings, a pattern that recalls the original building density of the immediate area. Residences, a Hawaiian Telcom building, churches, and schools are south of the 1939 bridges. To the east is Waipahu's original business district, which started along Waipahu Street and Waipahu Depot Road, and in recent decades has expanded along Farrington Highway to the base of the earthen incline leading to the bridge. West of Waikele Road, Farrington Highway is lined with large commercial developments and a few low- to mid-rise multi-family residential buildings.

Part III. Sources of Information:

A. Primary Sources:

Architectural Drawings and Early Views

Original drawings of the Waikele Canal Bridge are electronic files (scans) located in the database at the Hawaii Department of Transportation, Highways Division, Design Branch: Project No. 4-C, Waianae Road (Farrington Highway) Waipahu Cutoff. Project ID No. 7101-

³⁴ Hawaii State Archives, Folder PPA-63-1, photo 1-16. September 6, 1951.

³⁵ "Waipahu Honors Its Own: UAL President Patterson," *Honolulu Star Bulletin*, March 29, 1963. p. 21.

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001, Project File O-10-12, dated 06/09/1938. Drawings of the Waikele Canal Bridge in the database of the Hawaii State Department of Transportation were created by the Territorial or State Department of Transportation and are considered in the public domain.

No detailed drawings of the OR&L Bridge could be located for this report. This bridge appears on roadway profile drawings in the above Waikele Canal Bridge files.

Historic Maps and Aerial Photos are located in the collection of the Hawaii State Archives. Aerial photos in the collection of the Hawaii State Archives were created under contract for the Hawaii Territorial/ State Land Use Bureau and are considered in the public domain. Some early photographs of the bridges and of canal dredging are located at the Hawaii State Archives in Annual Reports to the Governor, Territory of Hawaii, by the Superintendent of Public Works, years ending 1938 and 1940. These photos were created by the Territorial Department of Public Works or under contract for the department and are considered in the public domain.

B. Secondary Sources:

Chiddix, Jim & MacKinnon Simpson. *Next Stop Honolulu! Oahu Railway & Land Company, 1889-1971*. Honolulu: Sugar Cane Press. 2004.

Federal Works Agency. "Title 23, Chapter 1 – Public Roads Administration," in *1939 Supplement to the Code of Federal Regulations of the United State of America*. Washington DC: Government Printing Office. 1940.

Heritage Center, School of Architecture, University of Hawaii at Manoa. *State of Hawaii, Historic Bridge Inventory and Evaluation*. Draft prepared for the State of Hawaii, Department of Transportation, Highways Division. May 2008.

Honolulu Advertiser

"Three Projects Dedicated," October 30, 1939. p. 1.

"TH Honors 4 Veteran Employees," July 1, 1958. Article at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biography section under: Bartels.

Honolulu Star Bulletin

"Farrington Highway To Be New Belt Road Name," February 11, 1935. p. 1.

"Cain Outlines Territory-U.S. Highway Plan," June 29, 1937. p. 1.

"New Waianae Hookup, Plan," Honolulu Star Bulletin, June 29, 1937. p. 7.

"New Highways Will Be Built," December 18, 1937. p. 3.

"U.S. Earmarks \$975,000 for Hawaii Roads," December 31, 1937. p. 1.

"Waipahu Road Jobs Bids Are Due June 9th," May 25, 1938. p. 1.

"Three Major Improvements Dedicated at Waipahu," October 30, 1939. p. 16.

"New 5½-Mile Section of H-1 Open Wednesday," Nov. 27, 1966. p. A1B.

Mauricio, Michael. *Waipahu, Its People and Heritage*. Waipahu, HI: Waipahu Community Foundation. 1997.

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- National Bridge Inventory Database. On website nationalbridges.com, accessed May 23, 2012.
- Nedbalek, Lani. *Waipahu, A Brief History*. Mililani, HI: Wonder View Press. 1984.
- Pagliaro, Penny. *Ewa Plantation: An Historical Survey 1890 to 1940*. [Honolulu: author.] 1987.
- Parsons Brinckerhoff and Engineering and Industrial Heritage. *A Context for Historic Bridge Types*, NCHRP Project 25-25, Task 15. Prepared for the National Cooperative Highway Research Program. October 2005.
- Spencer Mason Architects. *Waipahu Street Widening Project, Potentially Historic Properties*. Prepared for Austin, Tsutsumi & Associates, Inc. 1990.
- Superintendent of Public Works. *Report to the Governor, Territory of Hawaii, for the Year Ending June 30*. Honolulu: Various Publishers. Various Years.
- Territorial Highway Department, Hawaii Highway Planning Survey. *Bridge Inventory for the Island of Oahu*. Prepared in Cooperation with the U.S. Department of Commerce, Bureau of Public Roads. September 1950.
- Thompson, Bethany. *Historic Bridge Inventory, Island Of Oahu*. Prepared for the State of Hawaii, Department of Transportation, Highways Division. June 1983.
- U.S. Geological Service. *Topographic Maps*. Various quadrangles and dates.
- Yoklavich, Ann. *Ewa Plantation Company Industrial Center, HABS HI-384*. Historic American Buildings Survey, National Park Service, Department of the Interior. 2002.
- Yamamoto, Michael T., Nina Yuriko (Ota) Sylva, and Karen N. Yamamoto. *Waipahu, Recollections from a Sugar Plantation Community in Hawaii*. Albuquerque, NM: Michael T. Yamamoto. 2005.
- Newspaper articles on W.R. Bartels are available at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biography section under: Bartels. Various Dates.

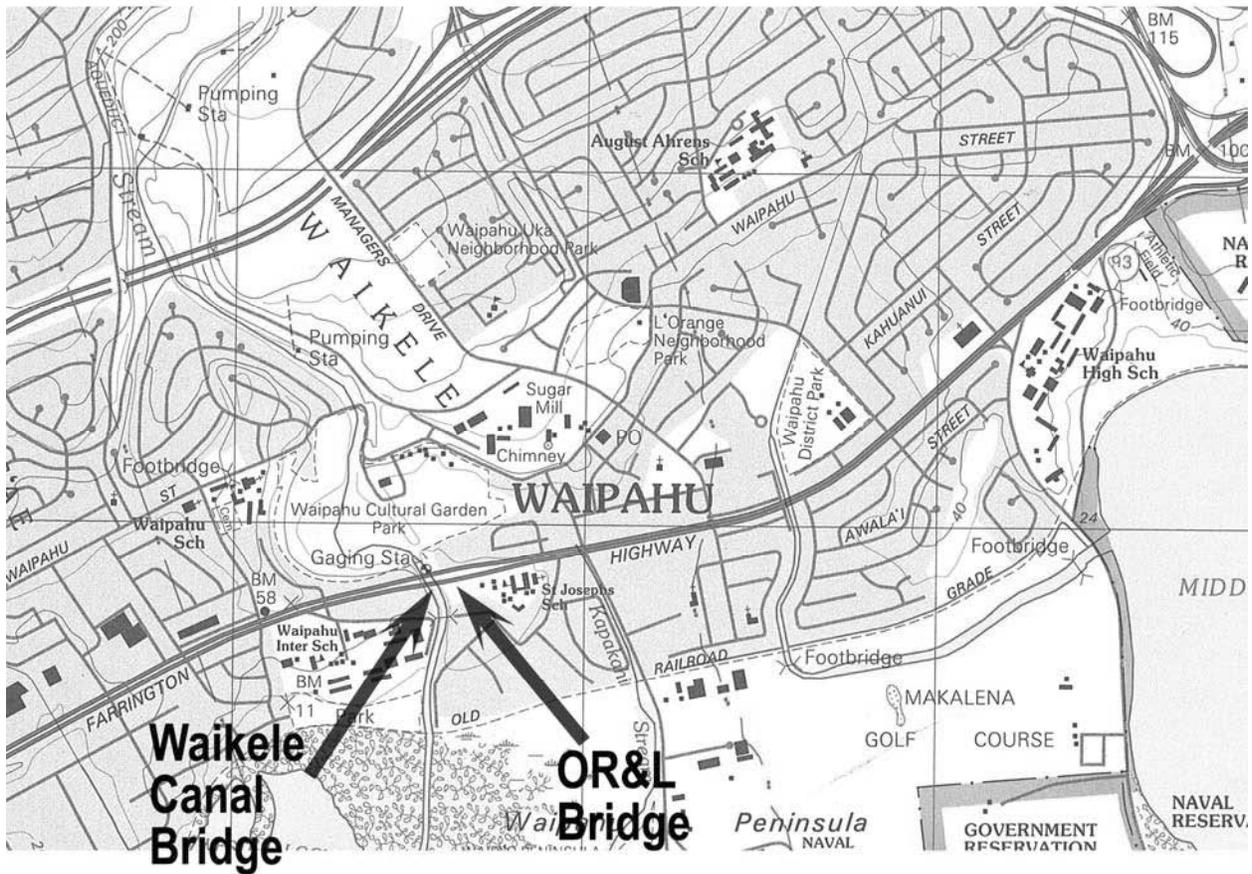
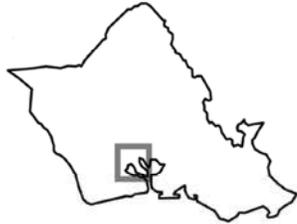
C. Likely Sources Not Yet Investigated:

National Archives and Records Administration files for the U.S. Department of Transportation, Federal Highways Administration and for predecessor agencies such as U.S. Department of Commerce, Bureau of Public Roads.

Additional information on the Waikele Canal flood control program might be located in the Hawaiian Sugar Planters' Plantation Archives collection at the University of Hawaii at Manoa, Hamilton Library Hawaiian Collection, within the material pertaining to Oahu Sugar Co.

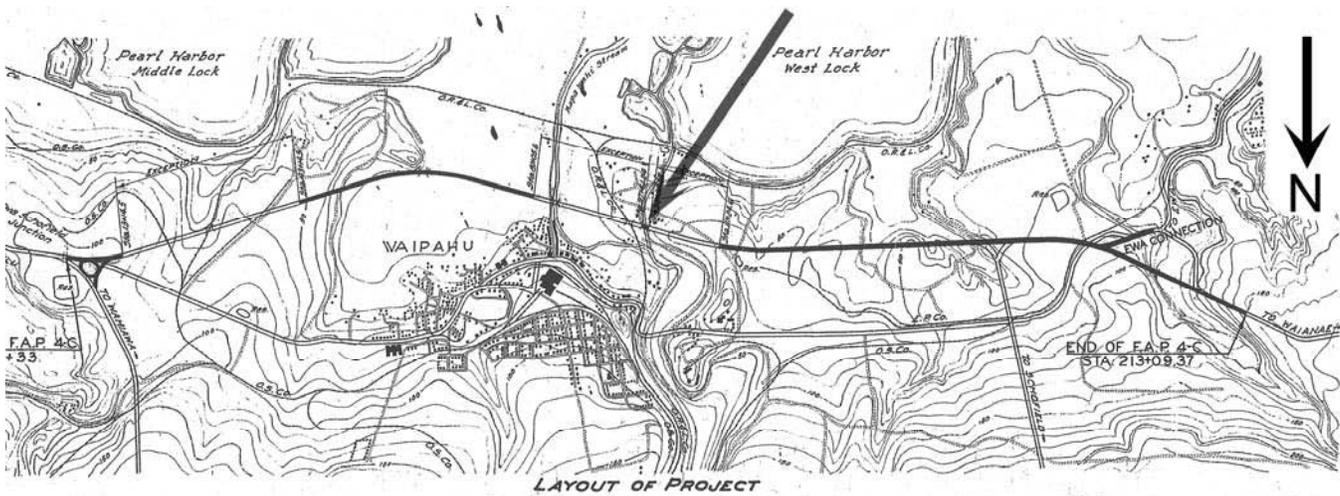
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Location Map



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Portion of the project map for Federal Aid Project 4-C, Waipahu Cutoff. The location of the Waikele Canal Bridge is shown by the added arrow. No scale. *Hawaii Department of Transportation, Highways Division, Design Branch, Project ID 7101-001, 06/09/1938.*



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Portion of aerial photo dated 1939-1941 showing the Waikele and OR&L Bridges shortly after construction (added arrows and labeling). No scale. *Hawaii State Archives, Folder PPA-39-2, photo M-4.30 (public domain).*



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Portion of 1954 topographic map showing the two bridges (added arrows and labeling). No scale. U.S. Geological Survey, Waipahu Quadrangle, 1:24,000, 1954.

