BAY CROSSING REACH OF THE
BAY DIVISION PIPELINES NOS. 1 AND 2
(HETCH HETCHY AQUEDUCT)
Newark
Alameda County
California

HAER CA-366
HAER CA-366

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD
BAY CROSSING REACH OF THE BAY DIVISION PIPELINES NOS. 1 AND 2 (HETCH HETCHY AQUEDUCT)
HAER No. CA-366

Location: Newark, Alameda County, California
USGS Newark, Mountain View, Palo Alto Topographic Quadrangle Maps; Township 5S, Range 2W, Section(s) 19 Meridian: Mt. Diablo
UTM Coordinates at eastern terminus (Newark Valve Lot): 10; 583527; 4152974
UTM Coordinates at western terminus (Ravenswood Valve Lot): 10; 576812; 4148808

Present Owner: San Francisco Public Utilities Commission (SFPUC)

Present Use: The Bay Crossing Reach of the Bay Division Pipelines (BDPL) Nos. 1 and 2 describes the 26,300' segment of the Hetch Hetchy Aqueduct that crosses San Francisco Bay. The Aqueduct serves as a potable water transmission and distribution system serving 2.6 million customers along the pipeline route in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne Counties, making the SFPUC the third largest municipal utility in California.

Significance: The Bay Crossing Reach features some of the most complex and critical engineering components in the entire Hetch Hetchy Aqueduct system. In general, the Aqueduct is significant at the state level as it illustrates a pivotal shift in potable water collection and distribution in the San Francisco Bay region from reliance on local private water companies to a reliable, but distant, municipal water supply. In addition, the system utilized multiple innovative engineering structures to efficiently deliver water to the metropolitan region primarily by gravity flow. The scale of the water system had few peers at the national level during the same period as only the Metropolitan System in Boston and the Catskill supply system in New York were larger.[1] The Bay Crossing Reach utilized a unique combination of a pipeline bridge, wooden trestles, submarine pipe, valve houses, and a large concrete caisson to transmit water under and over San Francisco Bay, all while retaining sufficient hydrostatic pressure of the water line generated by gravity alone. By utilizing a complex array of structures to eliminate the need for a costly pumping station, the Bay Crossing Reach engineers, such as John

[1] Michael M. O'Shaughnessy, "The Hetch Hetchy Water Supply of the City of San Francisco.," *American Water Works Association* 9, no. 5 (1922): 743.

Ripley Freeman and Michael M. O'Shaughnessy, conveyed their mastery in the planning and design of an efficient municipal water delivery system. Consequently, these individuals were also recognized nationally for their accomplishments.

Historians: Kirk Ranzetta, Ph.D., Project Manager and Senior Architectural Historian, URS Corporation; Leesa Gratreak, M.S., Architectural Historian, URS Corporation; Patience Stuart, M.S., Architectural Historian, URS Corporation

Project Information: As a part of the Water System Improvement Program, the San Francisco Public Utilities Commission (SFPUC) is implementing the Bay Division Pipeline Reliability Upgrade Project (Project). The Project involves decommissioning the Bay Crossing Reach of the Bay Division Pipelines (BDPL) Numbers (Nos.) 1 and 2, a significant portion of the existing historic Hetch Hetchy aqueduct system between the Newark Valve House on the east side of San Francisco Bay and the Ravenswood Valve House on the west side of the Bay. As a whole, BDPL Nos. 1 & 2 were identified as a linear historic district and evaluated as eligible for the National Register of Historic Places and the California Register of Historic Resources.[2] The Project updates the 21-mile Bay Division pipelines segment of the Hetch Hetchy Aqueduct to improve seismic and delivery reliability. Under the California Environmental Quality Act (CEQA), the City and County of San Francisco determined that the decommissioning of the Bay Crossing Reach would constitute a significant adverse impact on several historic resources. Mitigation for this impact required the SFPUC to compile Historic American Engineering Record (HAER) documentation for the Bay Crossing Reach, including large format photography and a historical report.

Part I. Historical Information

A. Physical History

1. Date of Construction: Construction of BDPL No. 1 began in 1923 with the pipeline placed into service in 1926. Construction of BDPL No.2 began in 1934 with water delivery commencing in 1936.

2. Architect/Engineer: The City of San Francisco retained the noted hydraulic engineer John Ripley Freeman to consult on the overall design of the system. The implementation of his overarching plans, which included the Bay Crossing Reach, fell to an engineering team supervised by San Francisco City Engineer, Michael M.

[2] ENTRIX/Ward JV, *Bay Division Pipeline Reliability Upgrade Project: Historical Resources Section 106 Report*, prepared for the San Francisco Public Utilities Commission, 2008, 5-2.

O'Shaughnessy. They included Chief Assistant Engineer Nelson. A. Eckart, Hydraulic Engineer R. P. McIntosh as the designing engineer for structures, Leslie W. Stocker as the engineer for submerged pipe, electrical engineer P.J. Ost, surveyor J.H. Best, and Carl R. Rankin, resident engineer during construction for the Hetch Hetchy, Bay Division segment.[3] The engineers noted above, with the exception of R. P. McIntosh were associated with the construction of both BDPL No. 1 and No. 2.

3. Builder/Contractor/Supplier: Relying on San Francisco's industrial capacity, the City utilized local manufacturers for the majority of the BDPL components. The pipe used for BDPL No. 1 and BDPL No. 2 was manufactured by the Western Pipe and Steel Co. of California.[4] The City awarded the Healy-Tibbetts Construction Company the contract for constructing the pipeline, the bridge piers, and the large caisson.[5] In contemporary accounts, the United States Steel Products Company (USSPC) is credited with the fabrication, delivery, and placement of the bridge spans, but a plaque on the easternmost bridge truss confirms that a subsidiary of USSPC, American Bridge Company (ABC), constructed the spans.[6] Although acquired by USSPC in 1902, ABC continued to place plaques on bridges it built with the legacy company's name well into the twentieth century. The Union Machine Company cast the gate valves used in the Newark and Ravenswood Valve Houses for BDPL No. 1. The Chapman Valve Manufacturing Company cast the screw-top gate valves used for BDPL No. 2 in the Newark Valve House, the Caisson, and all of the submarine pipes located in the Dumbarton Valve House. Most of these gate valves for BDPL No. 2 also exhibit Pelton Water Wheel Patent plates. The Barrett Water Works supplied the primer and enamel for the 42" submarine pipe installed in 1925. It is unclear what type of finish was applied to the two 52" submarine pipes in 1934. For BDPL No. 2, the Cement Wrapped Pipe Co. supplied the concrete protective wrap.[7]

4. Original Plans and Construction: City of San Francisco Engineer O'Shaughnessy led the completion of the engineering drawings for BDPL Nos. 1 and 2 of the Hetch Hetchy Aqueduct. Key structures within the Reach include the pipelines, trestles, concrete anchor blocks, 32 span Pratt truss bridge, caisson (thrust pier), and 3 valve houses. BDPL No. 1 was constructed primarily with 60"-diameter riveted steel pipe. BDPL No. 2 was constructed immediately north of BDPL No. 1 and was constructed of primarily 66"-diameter, welded-steel, concrete-wrapped pipe. Within the Bay Crossing Reach, these pipes were either buried in a trench, elevated on wood trestles, or carried

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[3] "San Francisco Bay Crossing of Hetch Hetchy Aqueduct," *Engineering News Record* 96 (1926): 434. Entrix/Ward JV, 4-13. "San Francisco's Water Supply: An Historical Review," *Engineering News Record* 113 (1934): 132.
[4] SFPUC Photographic Archives, San Francisco, CA (1924-1936).
[5] Michael M. O'Shaughnessy, "Award of H.H.W.S Contract No. 90-B, Bay Crossing Pipe Line," City and County of San Francisco Department of Public Works, SFPUC Archives, San Francisco, CA (1923-1924).
[6] "San Francisco Bay Crossing," 434.
[7] "Wrapping a Cement Coating on 66-In. Steel Pipe," *Engineering News Record* 107(1931): 811.

upon a pipe bridge formed by 32 Pratt truss spans over the Bay. In addition to riveted steel pipe, the Bay Crossing also utilizes 2,750' of submarine pipe laid in the bottom of the Bay, and 400' of submarine pipe laid beneath Newark Slough. The SFPUC archives, located in San Francisco, California currently contain the original plans for BDPL Nos. 1 and 2. These plans include details of the pipe bridge, pipelines, and caisson.

5. Alterations and Additions: The City of San Francisco implemented the Bay Division segment of the Hetch Hetchy Aqueduct in four distinct phases between 1923 and 1973: BDPL No. 1 (1926), BDPL No. 2 (1934), BDPL No. 3 (1956), and BDPL No. 4 (1973).[8] The first two phases were clearly considered together during the system's early planning stages and BDPL Nos. 1 and 2 shared the same right-of-way. Population growth and the need for system reliability and redundancy led to the construction of the latter two pipelines in the south San Francisco Bay region starting in the 1950s.[9] BDPL Nos. 3 and 4 diverge from Nos. 1 and 2 at the Irvington Tunnel Portal in Alameda County, continue south around San Francisco Bay and then north up the Peninsula to rejoin Nos.1 and 2 near the Pulgas Tunnel Portal in San Mateo County. These four pipeline systems have been modified over time to address pipeline maintenance needs, installation of new valves for new service lines, and seismic reliability. Examples of these changes within the Bay Crossing Reach include the occasional replacement of framing members for the wood trusses and painting of the bridge spans and exposed metal pipe to prevent surficial rust. The most substantial changes occurred in 2011 with the commencement of the Bay Division Pipeline Reliability Upgrade Project, which involves construction of a new BDPL No. 5 that will replace BDPL Nos. 1 and 2 across San Francisco Bay between the Newark Valve House and Ravenswood Valve House. Scheduled for completion in the 2015, BDPL No. 5 will consist of a new pipeline crossing under San Francisco Bay. The Bay Crossing Reach of BDPL Nos. 1 and 2 will be decommissioned when BDPL No. 5 is placed into service.

B. Historic Context

1. Early Water Conveyance Systems in the San Francisco Bay Region: Early towns and cities in northern California relied on a combination of local private and public water systems to serve their water supply needs. In the early period, Euro American settlers in Northern California harnessed water from local rivers, creeks, and streams by creating impoundments and water delivery systems for drinking water and agricultural uses. The more sophisticated early municipal water systems were designed for large urban areas, primarily in the Los Angeles and San Francisco areas where population increases caused water suppliers to look beyond municipal boundaries for water. Despite sharing common themes and technologies, California communities brought water to their

[8] Entrix/Ward JV, 4-15.
[9] Warren D. Hanson, *San Francisco Water and Power: A History of the Municipal Water Department and Hetch Hetchy System* (San Francisco, CA: City and County of San Francisco, 2005), 41.

residents using a number of different conveyance systems.[10] During this period, water suppliers utilized four basic types of conduit: open canals, flumes, tunnels, and pipelines. Systems that traversed diverse terrain often used several different types of conduit depending upon the respective engineering challenges, particularly in mountainous areas.[11]

The initial impetus for San Francisco's search for municipal drinking water began with initial Spanish explorations in 1769, when Don Gaspar de Portolá and Jose Francisco Ortega reconnoitered the Peninsula and discovered San Francisco Bay.[12] With the founding of Presidio Pueblo (a military town) and the Mission San Francisco by Juan Batista de Anza in 1776, water became a critical component of long term Euro-American settlement.[13] Contrary to many of Spain's earlier colonies in what became the United States of America, indigenous populations had not established or developed this area, and therefore no previous water conveyance systems were in place.[14] Mission San Francisco was primarily served by a small stream called the *ojo de agua* and no steps were taken to develop water conveyance further until after Spanish rule ceased over California and Yerba Buena in 1821.[15] With increased freedom came more established trade and settlement. This increasing commercial activity prompted Mexico to open up Mission lands to settlement under the Secularization Act of 1833.[16]

With the discovery of gold in 1848, prospectors flooded the streets of San Francisco as the City became a significant embarkation point and an important center for suppliers. The City's expansion also prompted the need for a secure and reliable water supply. A limited amount of gold mining occurred in the late eighteenth and early nineteenth centuries, but it was the 1848 discovery of gold at Sutter's Mill on the American River that transformed gold production into California's largest industry.[17] Some saw this as an opportunity to establish entrepreneurships that would supply water to people in the area. The earliest recorded water salesman in San Francisco, Juan Miguel Aguirre, opened his business in 1849. By 1851, a competitor, the Sausalito Water and Steam Tug Company, was barging water in across the bay by tank steamer from springs on the Marin shore. The operation utilized 65 water carts to supply San Francisco households.[18]

In 1856, A.W. Von Schmidt franchised the San Francisco City Water Works, also known as the Bensley Company, and by 1858 was bringing water to the area from Lobos Creek.

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[10] JRP Historical Consulting Services/California DOT, *Water Conveyance Systems in California: Historic Context Development and Evaluation Practices* (Sacramento, CA: California Department of Transportation, 2000): Preface.
[11] Ibid.
[12] Hanson, 2.
[13] Hanson, 2.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] JRP, 31.
[18] Hanson, 3.

Also in 1858, the first local distribution pipelines were laid in the City.[19] In 1858, George H. Ensign obtained a water charter from the California Legislature and organized the Spring Valley Water Works (SVWW), using the same spring that Juan Aguirre initially exploited during the Gold Rush days, and also laid down additional local piping.[20] Schmidt was the first to search for more permanent, high capacity sources and in 1856 he began seeking out waters in San Mateo County.[21]

In 1865, SVWW finished building the first of its major distributing reservoirs in San Francisco, the Laguna Honda Reservoir on Seventh Avenue at an elevation of 373'. Water from Pilarcitos Creek, just north of Half Moon Bay, was delivered by flume and pipeline to Laguna Honda by gravity flow.[22]

Two other early significant water conveyance projects included the establishment of the Upper Crystal Springs Dam and Reservoir (1876) and the Lower Crystal Springs Dam and Reservoir (1888). The Crystal Springs facility was fully gravity fed and the dam was formed of interlocking concrete blocks formed and poured in place.[23] This series of projects in the San Andreas area formed a crucial component of the Hetch Hetchy water system as it became the main storage facility of San Francisco's water supplies fed from Hetch Hetchy Reservoir and other local watersheds. SVWW continued to develop additional reservoirs to serve increasing demand until it was taken over by San Francisco on March 3, 1930.[24]

In addition to the increasing population of San Francisco, a series of fires in 1850-52 and the fear of additional fires left residents uneasy about the security of their water supply. In addition, the overly lucrative and monopolistic commercial water industry left rate payers eager for a municipally-run system that could decrease or at least moderate rate increases.[25] In 1875, a special study committee headed by City Engineer T.R. Scowden recommended that San Francisco buy a reservoir on the border of Alameda and Santa Clara Counties to begin developing a municipal water supply (Hanson 2005: 13). The City did not act quickly enough and SVWW purchased the land with the goal of building the Calaveras Reservoir. SVWW did not develop the reservoir until 1913, when the Spring Valley Water Company (SVWC) purchased the SVWW.[26]

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[19] Hanson, 4. JRP, 70.
[20] Hanson, 5
[21] Ibid.
[22] Ibid.
[23] Hanson, 10-11.
[24] Hanson, 11.
[25] Hanson, 49.
[26] Hanson, 13.

The Calaveras Reservoir dam was completed by the SVWC in 1925, at a height of 230' at the crest, and a capacity of 31.55 billion gallons of water.[27] "The lower portion is built up by hydraulic fill method and the upper part with a rolled clay core supported on either side by loosely dumped material containing a large proportion of rock. The dam is 1,200' long and 1,500' wide at the base."[28] Through the SVWC's water system, water from the Calaveras Reservoir was delivered to neighboring East Bay customers and then to San Francisco through the Niles Canyon Aqueduct and submarine pipelines under San Francisco Bay to the Peninsula distribution system. These submarine pipes consisted of four lines of lap-welded steel flexible joined pipe. Two of the lines were laid in 1888 and two we laid in 1900.[29] This older network of submarine pipes was decommissioned when the present system was completed in 1934.

Due to the size and importance of the SVWC to the early development of San Francisco, the City engaged in "intermittent negotiations" with the private water company to acquire its holdings over a nearly 50 year period that ended in the final acquisition in January 1930. Despite keen political interest, bond measures presented during elections in 1910, 1915, 1921, and 1927 all failed to reach the two-thirds majority required to pass.[30] Finally, during the May 1, 1928 election, a $41,000,000 bond measure reached the two thirds majority threshold and by 1930, the City formally purchased the utility, assumed its operations, and established the San Francisco Water Department, the City's first municipal water works.[31] The purchase included the transfer of a large amount of existing infrastructure as well as riparian water rights and rights-of-way necessary to protect, divert, and use their water supplies and facilities.[32] This included an elaborate system of a dozen reservoirs and auxiliary tanks, pumping stations, and 1,191 miles of pipeline of various diameters all tucked out of view under the City streets.[33]

2. Looking to Hetch Hetchy: From Local to Distant Water Sources: Towards the late nineteenth century, many large cities in the West actively sought a more secure source of water for their residents. Portland, Oregon, for instance, worked closely with President Benjamin Harrison's administration to create the Bull Run Reserve in 1892. This successfully conserved the upper watershed of the Bull Run River for drinking water. By 1899, Seattle, Washington had acquired ownership of most of the Cedar River watershed for its drinking water supply. Los Angeles, California acquired property throughout the Owens Valley and by 1912 had completed the first Los Angeles Aqueduct.

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[27] Ibid.
[28] Ibid.
[29] Michael M. O'Shaughnessy, "Pipelines of the Hetch Hetchy Aqueduct," *Engineering News Record* 104 (1930): 405.
[30] Michael M. O'Shaughnessy, "San Francisco Water Supply Progress," *American Water Works Association* 22, no. 1 (1930): 29.
[31] O'Shaughnessy, "San Francisco Water Supply Progress," 29. Hanson, 15.
[32] Hanson, 14.
[33] Hanson, 15.

Motivated by population growth, fires, and chronic seasonal shortages, San Francisco pursued a similar goal. The feasibility of drawing Tuolumne River water from the Hetch Hetchy Valley in the Sierra Nevada was first investigated in 1879 by the State Geologist of California as water developers recognized the limitations of local water resources on the Peninsula. This was closely followed by an additional study that appeared in the *U.S. Geological Survey Annual Report 1899-1900* that recommended Tuolumne River waters from the Hetch Hetchy Valley as a viable municipal water source for San Francisco.[34]

From 1900-01, Mayor James Phelan took additional steps to find a clean, reliable source of water, directing City Engineer Carl E. Grunsky to study 14 possible water sources. Of those, Grunsky found the Tuolumne River system in the Hetch Hetchy Valley to be the superior choice.[35] The Tuolumne source had superior water quality, the largest amount of available water, a large site most suitable for a reservoir, lack of restriction from legal land claims, and the possibility of hydroelectric power generation at the site.[36] Fearful that the City could again lose the opportunity to act due to competing SVWW interests, the Mayor and City engineers quietly used their own money to send engineer J. B. Lippincott into the Sierra Nevada to conduct survey work.[37] The Mayor personally filed the initial water rights at Hetch Hetchy Valley and Lake Eleanor and turned them over to the City in 1903. However, politically charged opposition by environmental groups caused the City to formally abandon the Hetch Hetchy Aqueduct project in 1902.[38] The effort to save Hetch Hetchy Valley from change was led by many prominent environmental advocates, including noted naturalist John Muir, the founder and first president of the Sierra Club.

Public opinion about a possible Hetch Hetchy Aqueduct abruptly shifted soon after the decision to abandon the project as a result of the earthquake of 1906. The destruction left in the aftermath of the earthquake was caused largely by fires that burned for three days after the disaster due to lack of water for firefighting. Firefighters had to battle the flames with dynamite to create fire breaks rather than water because the quake had severed many of the City water mains. Although local leaders had been seeking permission to dam the Tuolumne River and create a municipally-owned water source for several years prior to the earthquake, the sight of the City reduced to charred rubble provided the momentum needed to get the Hetch Hetchy Aqueduct approved.[39] Amid a lengthy public debate that centered on the cost and environmental impacts, the U.S

[34] O'Shaughnessy, "The Hetch Hetchy Water Supply," 746. Hanson, 20.
[35] Hanson, 21.
[36] Hanson, 21.
[37] Hanson, 21.
[38] Hanson, 21.
[39] Entrix/Ward JV, 4-11.

Congress passed the Raker Act of 1913 that authorized the damming of the Tuolumne River.[40]

Despite federal support, funding for the aqueduct was delayed. In 1918, Michael O'Shaughnessy lobbied the Mayor of San Francisco to address the issue of a water shortage in the City and personally sent him a letter stating:

> *In view of the present water shortage and the critical conditions that may result unless immediate steps are taken to provide an additional water supply for San Francisco, it is recommended that you urge upon the [Spring Valley] Water Company the acceptance of the following plan, and that a strenuous effort be made by the City Administration for immediately financing the said plan: The City of [sic] San Francisco to build the westerly end of its Hetch Hetchy Aqueduct so that the waters of Calaveras Reservoir may be carried in it to Crystal Spring Reservoir and San Francisco.*[41]

O'Shaughnessy, the San Francisco City Engineer for 20 years (1912-32), was the most prominent supporter of the Hetch Hetchy Aqueduct. Historian Warren Hanson has asserted that O'Shaughnessy's prescient vision shaped what would become one of the most important water systems devised in the west during the period. He notes that:

> *System design evolved over time as O'Shaughnessy considered the best way to secure San Francisco's water supply for the next 100 years. Hydraulics, durability and capacity for expansion drove O'Shaughnessy's decisions. He located facilities to maintain the hydraulic grade line for a gravity-flow system rather than pumping water across California, built tunnels instead of pipelines where possible for their capacity, longevity and ease of maintenance, and strengthened dam foundations to support additional storage in the future.*[42]

The City, working from plans originally developed for the Hetch Hetchy Aqueduct by nationally renowned hydraulic engineer John Freeman, called for constructing the O'Shaughnessy Dam at Hetch Hetchy Valley. The plans also included an aqueduct extending westward approximately 150 miles to the Crystal Springs Reservoir on the San Francisco Peninsula. Mountains, valleys, and waterways along the aqueduct route required a range of engineering structures. An extensive network of tunnels, for instance, was constructed through the Coast Range, Diablan Ranges, as well as the Pulgas Ridge. The Sunol Valley necessitated the construction of a siphon to maintain adequate hydrostatic pressure and the San Francisco Bay crossing utilized submarine pipes and a pipe bridge.

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[40] Ibid.
[41] Michael M. O'Shaughnessy, "Letter to Mayor, Honorable James Rolph, Jr. about the proposed agreement between San Francisco and Spring Valley Water supplying water from Calaveras Reservoir to Crystal Springs," Hetch Hetchy Water System Engineering Files, SFPUC Archives, June 17, 1918.
[42] Hanson, 31.

The complexity of the overall system required significant outlays of public funding. Although the 1913 Raker Act authorized $45 million to construct the Hetch Hetchy Aqueduct, by the time the City of San Francisco was prepared to build the first Bay Division Pipeline (BDPL No. 1) in 1922, funds were already too depleted.[43] To secure adequate financing for construction and to minimize delays in construction, the City approached the SVWC and negotiated a leasing agreement with the company for temporary use of BDPL No. 1. The SVWC advanced four annual payments of $250,000 each, as pre-paid rent for its use of the pipeline.[44] This agreement allowed SVWC to use BDPL No. 1 to convey water from the Calaveras Reservoir across the San Francisco Bay to the City while the municipally-owned system was still being constructed and prevent interim water shortages. To deliver this water, SVWC "enlarged the Sunol Aqueduct in 1924… and also built Niles Regulating Reservoir and Niles/Irvington Pipeline and Pump Station to boost Calaveras Dam and Sunol Filter Bed water into BDPL No. 1."[45]

Amid the SVWC's efforts to improve its system throughout the San Francisco Bay Area, the City completed the $6 million Hetch Hetchy Aqueduct between the Irvington Tunnel Portal in Fremont, Alameda County and the Pulgas Tunnel Portal in Redwood City, San Mateo County in 1926.[46] Named the "Bay Division" segment of the Aqueduct, it included approximately 21 miles of pipeline. The route selected for BDPL No. 1 included a crossing of San Francisco Bay at Dumbarton Straight that reduced the distance by 20 miles that another SVWC-proposed route would have used to the south around the Bay. The approximately 5 mile segment of BDPL No. 1 that crossed the wetlands, Newark Slough, and the Bay came to be known as the "Bay Crossing Reach".

In addition to granting the SVWC a lease for BDPL No. 1 in 1922, the City also negotiated an option to buy the SVWC and its assets for integration with the Hetch Hetchy system once it was completed. The City did not exercise this option until 1930 when it acquired the company's assets for $39.96 million.[47] With the assumption of the company's infrastructure and operations, the City created the San Francisco Water Department under the Board of Public Works. By 1932, a New Charter placed the Water Department under the San Francisco Public Utilities Commission (SFPUC).[48]

3. Bay Division Segment of the Hetch Hetchy Aqueduct: Construction and Capacity: The construction of BDPL No. 1 required crossing the soft marshes on either side of San Francisco Bay, the deep navigable channel of the Bay, and the navigable Newark Slough. A team of engineers led by City of San Francisco Engineer

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[43] Hanson, 40.
[44] Ibid.
[45] URS, *Calaveras Dam Alternatives Assessment*, prepared for the San Francisco Public Utilities Commission (2004), np.
[46] Michael M. O'Shaughnessy, "The Bay Crossing Division of San Francisco's Hetch Hetchy Aqueduct," Hetch Hetchy Water System Engineering Files, SFPUC Archives, April 1927, 1.
[47] Hanson, 11-14.
[48] Hanson, 52.

Michael M. O'Shaughnessy, with Nelson A. Eckart as principal assistant, collaborated on the project (Anon. 1926: 434). Other members of the team included R. P. McIntosh as the designing engineer for structures and Leslie Stocker as the engineer for submerged pipe. The resident engineer during construction for the Bay Division was C.R. Rankin.

Most of the companies that supplied structural components to the Bay Crossing Reach were located close to the project area in San Francisco's industrial waterfront. The Western Pipe and Steel Company of San Francisco, for instance, manufactured the pipe. The Healy-Tibbits Construction Company orchestrated the installation of the submerged pipe across the Bay, in addition to erecting the concrete piers for the pipe bridge and the large concrete caisson that received the submerged pipe on the west side of the Bay. Healy-Tibbets was a contractor on several other large projects in San Francisco that included completing the anchorage and approaches for the Oakland Bay Bridge constructed in the 1930s.[49]

The United States Steel Products Company and its subsidiary the American Bridge Company, constructed the pipe bridge. The company assembled the individual spans on land and then delivered them via barge to Dumbarton Strait.[50] The Union Machine Company manufactured the gate valves for BDPL No. 1 installed in the Newark and Ravenswood Valve Houses.

Submarine sections of the pipeline included 2,750' of pipe in the San Francisco Bay built below the surface to avoid conflict with navigation channels and 400' of pipe under the Newark Slough. Submarine pipe was not used for the entire length of the Bay crossing because a pipe bridge and large pier were preferred for "reasons of ultimate economy."[51] At the time of construction, the distance traveled and diameter of the submarine pipe was comparable only to New York City's Narrows Siphon No. 2 that carried New York City's water system between Staten Island and Brooklyn (NY) near the present day Verrazano Narrows Bridge.[52]

Initially referring to the crossing as the "Dumbarton line", O'Shaughnessy described the construction of the Bay Crossing Reach by noting:

> *The sections over the marshes east and west of the bay, about 3.6 miles in length, are supported on pile trestles, and the section over the comparatively shallow water and the tide flats between Dumbarton Strait channel and the west shore of the bay is laid on a steel bridge …. This is a steel, seven panel, Pratt truss bridge of 36 spans, each 105 feet long. The clear width inside of the truss is about 20 feet, providing space* for *two 6 ft. 4 inch*

[49] Oakland Bay Bridge, Historic American Engineering Record, No. CA-32.
[50] "San Francisco Bay Crossing of Hetch Hetchy Aqueduct," 434.
[51] "San Francisco Bay Crossing of Hetch Hetchy Aqueduct," 434.
[52] O'Shaughnessy, "Pipelines of the Hetch Hetchy Aqueduct," 405.

> *steel pipes …. The submarine pipe lines at Newark Slough and Dumbarton Strait are cast iron, 42 inches in inside diameter, 2 inches thick, with flexible joints of the ball and socket type at intervals of 12 feet. The Dumbarton line is nearly 70 feet below the water at the navigable channel. It is buried from 3 to 20 feet deep under the bottom of the bay.*[53]

In order to obtain the most efficient route to the Crystal Springs Reservoir, the City of San Francisco purchased right-of-way through Alameda and San Mateo counties. While the pipeline corridor largely traversed agricultural lands in Alameda County, the nascent growth of North Fair Oaks, Menlo Park, Atherton, and Redwood City created some challenges. Beginning in the early 1920s and prior to the construction of the pipelines, several subdivisions, such as Dumbarton Oaks and North Fair Oaks, were platted in San Mateo County. In these subdivisions, the right-of-way sliced diagonally across the grid-street pattern. Later subdivisions, such as Newbridge Park, platted after construction of the pipelines, incorporated the right-of-way into their overall community design.[54]

During the first year in operation, BDPL No. 1 conveyed an average of nearly 35 million gallons per day to the City's local reservoirs.[55] Designed by the Hetch Hetchy planners and engineers to accommodate growth in consumption, the aqueduct anticipated the eventual addition of more pipelines and other facilities. The system designers, for instance, ensured that the entire system of conveyance tunnels leading from the Hetch Hetchy Valley through the mountains could accommodate a capacity of 400 million gallons per day to provide adequate water flow for future additions to the system.[56] The City also acquired pipeline right-of-way up to 80' wide to ensure sufficient space for the installation of additional conduits.[57]

Initially, BDPL No. 1 received water from the San Francisco Water Department's aqueduct from Sunol, by way of Niles. Water flowed by gravity to the Bay-Pulgas pumping plant at Ravenswood near the west shore of the Bay and was then pumped to the Pulgas Tunnel, from which it then flowed by gravity to the Crystal Springs Reservoir. When the Hetch Hetchy Aqueduct was completed, the system was fully gravity fed and the pumping station no longer needed.[58] The Bay-Pulgas pumping plant and the SVWC's four submarine pipes across the Bay were subsequently removed. Pier posts located in the mud flats on the east and west side of the Bay and trestle remnants indicate the location the SVWCs pipelines. Older pipe segments are still found scattered

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[53] Michael M. O'Shaughnessy, "Bay Crossing Division of the Hetch Hetchy Aqueduct: A Brief Description," Hetch Hetchy Water System Engineering Files, SFPUC Archives, February 3, 1927, 4-5.
[54] Sanborn Fire Insurance Company Map #39, Redwood City, California, 1932.
[55] O'Shaughnessy, "The Bay Crossing Division of San Francisco's Hetch Hetchy Aqueduct," 3.
[56] Entrix/Ward JV, 4-15.
[57] O'Shaughnessy, "Bay Crossing Division of the Hetch Hetchy Aqueduct: A Brief Description," 3.
[58] Ibid, 2.

on the east side of the Bay near the Dumbarton Valve House. One pipe segment is still used as a culvert for an access road leading to the valve house.

4. BDPL No. 2 Construction: The Hetch Hetchy plans originally called for two Bay Division pipelines, and design and construction provisions were made for a second parallel pipe.[59] In October 1924, San Francisco voters approved an additional $10 million to complete the Coast Range Tunnel and Bay Crossing to meet the intended capacity for Hetch Hetchy water delivery. Construction on BDPL No. 2 did not start until the summer of 1934, a few months after completion of the Coast Range Tunnel. Subsequent bonds issued in 1933 covered additional construction costs for the Hetch Hetchy system, including $12.1 million to cover the combined construction costs of BDPL No. 2, Crystal Springs Pipeline, and distribution system reservoirs and improvements. BDPL No. 2 was installed immediately parallel to BDPL No. 1. BDPL No. 2 featured a slightly larger pipe that ranged in diameter from 62 to 66" in diameter. It was placed on the similarly styled trestles and the same pipe bridge as BDPL No. 1. For the most part, the same team of City engineers designed and oversaw construction of BDPL No. 2. Constructed for a total of $4 million, BDPL No. 2 was completed in 1936 and more than doubled the amount of Hetch Hetchy water supplied to Crystal Springs Reservoir.

During this phase of construction, to fully integrate BDPL No. 2 with the existing BDPL No. 1, additional pipes and gate valves were installed at the Newark Valve House. The Dumbarton Valve House was also constructed and outfitted with several gate valves. The Bay Caisson, left partially constructed during the construction of BDPL No.1, was completed and outfitted with gate valves as well. The Chapman Valve Manufacturing Company cast the gate valves for BDPL No. 2 in the Newark and Dumbarton Valve Houses as well as the Caisson. These valves also exhibit Pelton Water Wheel Company patent plates.

5. Project Completion: With the completion of the Coast Range Tunnel in early 1934, the first Hetch Hetchy water flowed into the Crystal Springs Reservoir on October 24, 1934. A ceremony was held at the ceremonial release of the water that included local politicians, the SFPUC President Lewis Byington, as well as Secretary of the Interior Harold Ickes and members of the public. The event was broadcast nationwide over the Columbia Broadcasting System (CBS).[60] President Roosevelt's comments on the event, delivered by Secretary of the Interior Harold L. Ickes, noted that he "was particularly pleased with the project as a demonstration of what can be accomplished by the federal government and a municipality when they work together to make use of a valuable

[59] Michael M. O'Shaughnessy, *Hetch Hetchy: Its Origin and History* (San Francisco: Recorder Printing and Publishing Company, 1934), 132.
[60] Hanson, 42.

natural resource for the welfare of the people."[61] One noteworthy absence at the ceremony was Michael M. O'Shaughnessy, who passed away only a few days earlier. Even though water was flowing through BDPL No. 1 in time for the ceremony, BDPL No. 2 would not be completed until 1936.

Upon completion of the project in 1936, Nelson A. Eckart, General Manager and Chief Engineer for the SFPUC, wrote that the benefits of the Hetch Hetchy line were being quickly realized. The system improved the sanitary, chemical, and physical characteristics of the water supply, minimized seasonal fluctuations, created a source of revenue through the system's hydroelectric power plants, and had significant operating benefits. The fact that the system was entirely gravity-fed proved to be the most important of these operating benefits as it obviated the need for the Pulgas and Belmont booster pumping stations thus saving nearly $93,000 in annual operating costs.[62] The engineering solutions employed in the Bay Crossing Reach were integral to maintaining sufficient hydrostatic pressure through the entire Bay Division Pipeline system, thus making it a significant segment of the Hetch Hetchy Aqueduct.

Part II. Structural/Design Information

A. General Statement:

1. Character: The various components of the Bay Crossing Reach convey how the system developed and operated over time. The Bay Crossing Reach consists of two, 3.6 mile long pipelines, three submarine pipelines, three valve houses, a concrete caisson, concrete anchor blocks, wooden trestles, valve vaults, water meters, and gate valves, as well as a bridge consisting of 32 Pratt truss spans. While maintenance has occurred throughout the system over time, the principal components have not been substantially modified since construction of BDPL No. 2 from 1934-36.

Overall, the Bay Crossing Reach effectively communicates its function through the presence of visually imposing structures that largely lie above the ground. The pipelines traverse vacant land and marshes, but also extend under local roads, waterways, railroad lines, and parking lots, thus creating a sense of linear continuity.

2. Condition of Fabric: The Bay Crossing Reach still serves its intended purpose to this day although several components of the system are in constant need of repair and maintenance. The historic fabric of the system currently exhibits surficial pipeline rust, leaks at pipe joints, rusting bridge components, and flooded valve holds. In addition, sheet piles have been installed at the Newark Slough Crossing near an anchor block to

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[61] "Hetch Hetchy Water Flows into Bay City," *The Oregonian*, October 29, 1934.
[62] Nelson A. Eckart, "Benefits Accruing from the Hetch Hetchy Project, San Francisco Water Supply," *American Water Works Association* 28, no. 9 (1936): 1226.

stop erosion from the slough. The valve buildings exhibit typical wear from nearly 90 years of use with no major impacts to their condition. Some the buildings are marred by graffiti.

B. General Description: A key component of the Bay Division Segment of the Hetch Hetchy Aqueduct, the Bay Crossing Reach, consists of several distinct components. From east to west, these include the Newark Valve House, the BDPL Nos. 1 & 2, concrete anchor blocks, the east trestle segment, the Newark Slough crossing, the central trestle segment, the Dumbarton Valve House, the San Francisco Bay crossing located at natural narrowing called Dumbarton Straight consisting of three submerged pipelines, a large caisson (thrust block), elevated pipe bridge, the west trestle segment, and the Ravenswood Valve House. Descriptions of each component are provided below from east to west. The function and interaction of the components in the complete system and as well as physical descriptions are discussed separately.

C. Main Components:

1. Newark Valve House: The Newark Valve House, constructed 1924-1926, was designed to house a series of gate valves for the Bay Crossing Reach. The valves played a critical role in the ability to shut off and/or divert flows into either pipeline in case of emergency or a need for system repair. The valve house is situated on low lying land immediately east of the marshes along the eastern side of San Francisco Bay and just south of the Southern Pacific Railroad. A pair of culverts with the dates 1924 and 1935 embossed in their concrete lintel lie just outside the north fence line of the valve house. The valve lot also includes several subterranean vaults.

Erected directly over BDPL Nos. 1 and 2, the one-story, T-shaped plan building features weatherboard cladding that terminates at vertical cornerboards. Asphalt shingles sheath the building's shallow-pitched gable roof. The open eaves exhibit exposed rafter tails. The windows consist of two-over-two light, double-hung sashes covered with protective metal screens. The fenestration includes one window slightly off-center on the north façade; one window centered under a gable on the east side; one off-center window on the west façade, paired with the single metal door ; and two windows on the south façade, one centered under a gable and one centered along the face of a secondary wall. Other than the replacement of the original door with a metal security door, the building features few modifications since its original construction.

The interior consists of a T-shaped space unencumbered by interior walls. The exterior walls are left exposed with the wood framing and roof painted white to maximize the reflection of natural light. The interior circulation consists of a series of cement floors and access wells with metal catwalks that permit maintenance to the various gate valves and pipelines. The Union Machine Company supplied the gate valves for BDPL No. 1,

while the Chapman Valve Manufacturing Company cast the gate valves for BDPL No. 2. The Union Machine Company gate valves not only exhibit the company's name embossed in the valve but also a date stamp of "1924". Interestingly, the gate valves for BDPL No. 2 exhibit Pelton Water Wheel Company patent plates.

Constructed during a period of system expansion and improvement, the Newark Valve House demonstrates how San Francisco increased capacity to meet growing demand in the city and elsewhere around the San Francisco Bay region. Interestingly, the Newark Valve house exhibited a design unlike other valve houses that were constructed during the same period along the Bay Division segment of the Hetch Hetchy system. The architectural features and massing typify domestic architectural detailing and deviate significantly from the stucco-covered designs utilized at the Irvington Tunnel Portal, Driscoll Road Venturi Meter House, and Redwood City Valve House. Overall, the Newark Valve House retains much of its historic integrity.[63]

2. Bay Division Pipelines Nos. 1 & 2: BDPL Nos. 1 and 2 run parallel and are located in multiple communities in Alameda and San Mateo Counties, including Fremont, Newark, East Palo Alto, Menlo Park, and Redwood City. The Bay Crossing Reach lies primarily between Newark to the east and East Palo Alto to the west. The pipeline elevation at the Reach varies from just above sea level to approximately 110' below sea level (at the bottom of the Bay's navigable channel at Dumbarton Straight.

For much of their length within the reach, BDPL Nos. 1 and 2 consist of a 60" diameter riveted-steel pipeline (BDPL No. 1) and a 66" diameter welded-steel, concrete-wrapped pipelines (BDPL No. 2). The plate thicknesses for BDPL No. 1 were 5/16", 3/8", and 7/16".[64] The range in thicknesses was directly related to the differential pressures applied to various segments of pipe with the pipes that experienced the greatest stresses receiving thicker plating. The pipes of BDPL No. 1 and No. 2 were originally coated with bituminous enamel with exposed segments of BDPL No. 1 receiving an additional coat of aluminum paint to reduce the heat absorption when the pipe was empty.[65] Due to its larger capacity, BDPL No. 2 features a ½" plate thickness.

At the Dumbarton Valve House, the water flows of the two pipelines are diverted through a series of Chapman Valve Manufacturing Company cast screw top gate valves into three smaller, submarine pipelines that cross under the Bay to the concrete Bay Caisson – a concrete thrust pier at the end of the pipe bridge. The three submarine crossings consist of a 42"-diameter cast-iron ball-and-socket flexible joint pipe and two, 54"-diameter, concrete-wrapped steel-flanged pipe. Divided into twelve foot segments,

[63] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1e, Newark Valve House, prepared for the SFPUC, February 2007.
[64] O'Shaughnessy, "Pipelines of the Hetch Hetchy Aqueduct," 405.
[65] Ibid.

the submarine pipes required a 2" plate thickness due to the internal and external pressures. The submarine pipes extend 405' across the Newark Slough and 2760' across San Francisco Bay to the Bay Caisson.

In the Bay Caisson, the flows are converted back into two larger diameter pipelines through the gate valves. For the 6,600' combined length of the pipe bridge and the west trestle, BDPL No. 1 measures 60" in diameter. BDPL No. 2 measures 76" in diameter on the pipe bridge only. From the west end of the bridge to the Ravenswood Valve House it measures 66".[66] The differences in pipe diameter relate directly to the management of water flows as well as thrust. The Bay Crossing Reach also includes a segment of curved pipe situated in the center trestle area on the east side of the Bay. The curve was necessary in order to locate the system within the right-of-way that could be acquired by the City.

3. East, Center, and West Trestles: To traverse the wetlands on the east and west sides of San Francisco Bay, BDPL Nos. 1 & 2 were elevated above the marshy ground on wood trestles constructed in the 1920s and 1930s. The trestles extend from just west of the Newark Valve House on the east side of the San Francisco Bay to the Ravenswood Valve House on the west side of the San Francisco Bay and are identified as the East, Center and West Trestles. These trestle segments are separated by the Newark Slough and San Francisco Bay where the two pipelines are submerged. The East Trestle extends from the Newark Valve House west to the Newark Slough, a distance of about 10,200'. The Center Trestle extends from the Newark Slough west to the Dumbarton Valve House, a distance of about 6,300' with an alignment that includes two curves. The West Trestle extends from the steel pipe bridge west to the Ravenswood Valve House, a distance of about 2,700'.

The trestles' structure primarily consists of redwood, all heart structural lumber, or creosote coated timbers. In addition to supporting the pipelines, the trestles also support a pair of wood plank walkways on each pipeline that allow access for routine inspections. Intermittent wooden pedestrian plank walkways constructed perpendicular to and over the pipelines allow for access to each side of the pipelines. These trestles are supported on bents that form repetitive construction components throughout the trestle segments. Replaced on an as-needed basis since the 1920s and 1930s, the newer bents were constructed with similar materials and in a manner consistent with original designs.[67]

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[66] O'Shaughnessy, "The Bay Crossing Division of San Francisco's Hetch Hetchy Aqueduct," np.
[67] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1h East, Center, and West Trestles, prepared for SFPUC, February 2007.

There are four different types of support bents, referred to in 1934 as Type A, B, C, and E. The bents have wooden saddles to carry the weight of the pipelines. Some of the bents have been replaced with concrete columns, but many retain their timbers.

Bent Types A and B are similar in construction, differing primarily in their use. Type A bents were used for straight portions of the trestle, while Type B bents were used for portions with curves. Commonly, the bents were spaced every 19.8 to 20.5' along the length of the trestle. Their structure consists of two battered piles driven into the ground (1:5 angle for Bent Type A and 1:4 angle for Bent Type B), topped with two 12x12" (nominal dimension) caps. The piles are dapped with a 1" notch to connect with the lower cap and secured with drift pins connecting the cap and the top of the pile. The upper 12x12" horizontal cap is placed on top of the lower horizontal cap, using two 12x12" posts and one 6x12" post. This assembly provides a series of supports for the saddles that hold the respective pipes. The height of the posts was likely adjusted in the field during construction to maintain a steady elevation for the pipe centerline. A 10x12" saddle was placed on top of the top cap. The saddle has a curved notch in it to conform to the rounded section of the pipelines. Two 3x8" cross braces support the structure. Four steel angles bolted to the top cap limit the longitudinal movement of the saddle. Two 8x10" girts placed on the outside edges of the top cap support the exterior wood plank walkways that run on either side of the pipe.[68]

Bent Type C was utilized where the pipe traversed open water, either approaching the crossings, or in the particularly wet marshy segments along the overall pipeline. Generally spaced every 20.5' along the length of the pipe, Bent Type C is designed similarly to A and B in that the saddle can slide atop the cap. The 1:8 battered piles were driven and cut off at the target elevation. The cap was dapped and placed on the piles using drift pins, and the saddle and girts were placed on top of the cap.[69]

Bent Type E was generally used for every 15th bent for the east, center, and west trestles that carry BDPL No. 2 to provide extra longitudinal capacity and stiffness. BDPL No. 1 does not feature any Type E bents. Each bent utilizes 4 or 6 (depending on location conditions) 14"-diameter creosoted piles with a batter of 1:2. Similarly to the other bent types, the piles are topped by a wood cap and saddle. The components are secured by 1" bolts.[70]

As a system of support over the marshy east and west sides of San Francisco Bay, the wood trestles illustrate the challenges that San Francisco's Water Bureau faced as design and construction of the Bay Division segment of the Hetch Hetchy water distribution

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[68] OPAC Consulting Engineers, Inc., *Technical Memorandum: BDPL 1 and 2 Dumbarton Crossing Decommissioning Options*, produced for SFPUC, San Francisco, November 2005.
[69] Michael M. O'Shaughnessy, "Award of H.H.W.S. Contract No. 90-B, Bay Crossing Pipe Line," City and County of San Francisco Department of Public Works, Hetch Hetchy Water System Engineering Files, SFPUC Archives, May 18, 1923.
[70] OPAC, np.

system progressed during the 1920s and 1930s. Illustrating the budgetary constraints of the project, the project engineers viewed the trestles as a less costly option to burying and/or submerging the pipeline through the marsh. Despite failures of similar structures elsewhere in the Bay area during the 1906 earthquake, engineers nonetheless found the trestles to be more cost efficient and reliable than other options.[71]

4. Concrete Anchor Blocks: A total of seventeen strategically placed anchor blocks, also called "thrust blocks," ensure pipeline stability at critical points where the pipeline decreases or increases in diameter, changes direction, or changes elevation The anchor blocks are located at the beginning and end of the east trestle (shortly to the west of the Newark Valve House, on the east and west sides of the Newark Slough, along the curved pipe of the center trestle, on the east and west sides of the Dumbarton Valve House, at the pipe bridge landing on the west side of the Bay, in the middle of the west trestle and immediately east of the Ravenswood Valve House. .

Installed between 1924-26 and 1934-36 during with the construction of BDPL Nos. 1 & 2 respectively, the concrete anchor blocks play a pivotal role in stabilizing the pipeline at critical junctures where hydrostatic pressure could destabilize the structures. The anchor blocks are an essential operational component of the water distribution system and are an example of how the engineers navigated the design challenges imposed by dramatic changes in elevation as well as corridor directional swings.[72]

The poured concrete anchor blocks are trapezoidal in shape and hollow in the center where the pipeline passes through the structure. Mostly situated on land, some of the anchor blocks for the submerged pipelines are situated in the Bay's tidal zone and are occasionally inundated. The structures range in size depending upon their design function and the amount of force they are designed to counteract. The anchor blocks were typically constructed of reinforced concrete poured into wooden forms. Visible reminders of these construction techniques remain evident in the horizontal wood plank form lines created during the original concrete pouring. Those concrete anchor blocks lying above the waterline and that are visible all retain their historic integrity and original construction materials.[73]**5. Newark Slough Crossing:** The Newark Slough is located in the Don Edwards National Wildlife Refuge and surrounded by salt evaporation ponds and saltwater marsh. The pipeline crossing lies between the Center Trestle and East Trestle under Newark Slough. In order to keep the Newark Slough navigable, the U.S. Army Corps of Engineers required the project engineers to place the BDPLs below the Slough in a 400' submarine crossing. At the Slough crossing, the pipe diameters for BDPL Nos. 1 and 2 decrease as the pipes cross the waterway. This increased velocity necessitated the construction of large concrete anchor blocks on either side of the

[71] Ranzetta, HR-1h.
[72] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1f, Concrete Anchor Blocks, prepared for SFPUC, February 2007.
[73] Ibid.

crossing to compensate for the strain of hydrostatic pressure being exerted on the pipeline. The 42" submarine pipe for BDPL No. 1, identical to the pipes used for the Bay crossing, was lowered into place using a series of winches turned in synchronicity by individual workers in February 1925.[74] A presumably similar system was used for BDPL No. 2. Additional smaller submarine anchors were utilized within the slough to ensure the pipes remained in place.

6. Dumbarton Valve House: The Dumbarton Valve House is situated on east shore of the Dumbarton Strait of San Francisco Bay at the east end of the submarine pipe crossing and west end of the Center Trestle. The building was constructed in the 1930s to subdivide the flows from BDPL Nos. 1 & 2 into three smaller diameter submarine pipes for the Bay crossing, as discussed below. BDPL Nos. 1 & 2 enter the valve house from the northeast and exit the valve house as three submarine pipes on the southwest.[75]

This distinctive Dumbarton Valve House rests atop a high, poured concrete foundation designed to avoid water infiltration caused by tidal changes as well as storms on the Bay. The building, sheathed in vertically applied corrugated metal, features a unique massing consisting of a northwest-southeast spine with two extensions on the northeast and three extensions to the southwest. Large anchor blocks, similar to those described above for the Newark Slough Crossing, are located on the northeast and southwest sides of the valve house.[76] Within the valve house, all the pipes are supported by pile-supported concrete footings.[77] Housing a number of gate valves and meters, the Dumbarton Valve House played an essential role in the delivery of water across San Francisco Bay as it provided a way to adjust water flows and pressure and maintain gravity flow while also allowing for system flexibility and shutdown of either or both pipes in case of failure.

The building has a nearly symmetrical fenestration, except for a door located on the northwest façade that is not echoed on the southeast façade. The fenestration pattern is as follows: five windows facing northwest, along with one door, all off-center; two windows on the northeast façade, along with two doors that exit out the northeast wing of the structure directly on to BDPL Nos. 1 & 2 (immediately where they enter the valve house); five windows facing southeast, all of which are off-center; one window on the southwest façade with two doors that lead directly to the submarine pipes (immediately where they exit the valve house). The window on the southwest façade is the only window not boarded up. It features twelve fixed lights.

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[74] SFPUC Photographic Archives, Negative #9592, February 19, 1925.
[75] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1g, Dumbarton Valve House, prepared for SFPUC, February 2007.
[76] Ibid. Ranzetta, HR-1f.
[77] OPAC, 22.

While the metal sheathing of the Dumbarton Valve House appears to be a later replacement and several windows have been boarded over, the building still communicates its historic function and association through its clear visual and structural connection with BDPL Nos. 1 and 2.[78] There is no additional architectural detail around the short, boxed eaves or windows and the original roof has been replaced with asphalt shingles with metal ridge flashing. The interior consists of concrete and metal grate floors, catwalks and subterranean holds that allow for pipe maintenance and access to the gate valves that control flows from BDPL Nos. 1 and 2 into the three submarine pipes. All of the screw top gate valves were cast by the Chapman Valve Manufacturing Company and exhibit Pelton Water Wheel Company patent plates. To maximize interior lighting, the building's wood wall and roof framing remain exposed and painted white to maximize the reflection of natural light.

7. San Francisco Bay Crossing Submarine Pipelines: The San Francisco Bay Crossing is located at a narrow part of the Bay known as the Dumbarton Straight. The crossing begins immediately west of the Dumbarton Valve House, from which the three submarine pipes extend directly into the Bay. These three submarine pipes measure 42", 54", and 54" in diameter, with the 42" pipe being the southernmost of the three. All of the submarine pipes are cast iron, exhibit 2" thick metal plate, and have flexible joints at intervals of 12'. The 42" – diameter pipe features a ball-and-socket type joint while the two, 54"- diameter pipes consist of concrete-wrapped steel-flanged pipe. Divided into twelve foot segments, the submarine pipes required a 2" plate thickness due to the internal and external pressures applied to the pipes. The 42" submarine pipeline was protected with Barrett Water Works Primer and Enamel.[79] This is the same style of pipeline used in the Newark Slough. It is unknown if the same primer and enamel were applied to BDPL No. 2.

The submarine pipelines within the Bay crossing, at their deepest point, lie nearly 70' below the water level at the navigable channel. To further secure the pipelines, project engineers buried the submarine pipe from 3' to 20' under the sediment of the bottom of the Bay.[80] The length of the submarine crossing is 2,750'. The cost of utilizing the submarine pipelines totaled about $200 per foot for a single line as a number of carefully orchestrated steps had to occur to ensure the pipes were properly laid on the bottom of the Bay. This included dredging the pipeline route, using barged pipe cranes to lower the pipeline segments and deep water divers to ensure the pipes were properly positioned and sealed. The cost of the elevated pipe segments on the pipe bridges and trestles was far less at $30 per foot.[81] Due to their high cost, the submarine pipes were only utilized at the Bay shipping channel where the pipe had to be laid in deep waters to avoid

[78] Ranzetta, HR-1g.
[79] O'Shaughnessy, "Bay Crossing Division of the Hetch Hetchy Aqueduct," 5.
[80] Ibid.
[81] "San Francisco Bay Crossing," 434.

conflict with ships. Where marine navigation was not an issue, such as where the pipes cross the marshy area on the west side of the bay, the pipes were elevated on steel bridge spans or on wooden trestles.

8. Bay Caisson: According to O'Shaughnessy, "The most difficult feature of the entire division from the standpoints of both design and construction was the great end pier at which the submarine pipe connects to the pipe on the bridge. This pier is in the form of a hollow, concrete open caisson having an outside diameter of 80 feet."[82] The Bay Caisson is at sea level near the middle of the pipeline crossing in San Francisco Bay, approximately 3,700' from the west shore near East Palo Alto. It is approached via a service road that extends from Rutgers Street to the BDPL pipe bridge and then via a narrow 3,900' walkway on the pipe bridge that extends from the western Bay shoreline to the Caisson.[83] The Bay Caisson is also referred to as the "end pier" of this pipe bridge in addition to a "thrust pier". Prior to its construction, project engineers created a scale model of the Bay Caisson to ensure that the complex piping and concrete structure could satisfy the system's engineering requirements.[84]

Erected in 1926 on 715 vertical and battered timber piles to support its massive weight, this structure accommodates the transition of the submarine pipelines under the Bay back to surface elevation. In order to counteract the significant amount of force exerted by the change in elevation by Hetch Hetchy water, the Bay Caisson was erected of 4,900 cubic yards of concrete. While the walls were lightly reinforced, the submarine pipes that entered the Caisson from the east were encased in a large block of reinforced concrete lying at the base of the structure. The caisson was originally designed to house four submarine pipes when it was originally constructed, however, only a single 42" diameter submarine pipe was attached when the caisson was built in 1925-1926. Clearly anticipating the system's expansion, the caisson's upper structure was left unfinished so that any future connections could be made unencumbered by any building constraints. The metal framed and sheathed control room would not be completed until the addition of BDPL No. 2 and two additional 54" diameter submarine pipes in 1936. Engineers chose to utilize the larger diameter pipes to eliminate the need for a fourth submarine pipe. The upper space of the Caisson consists of one large room and a hold below. The upper space houses a series of Chapman Valve Manufacturing Company gate valves with Pelton Water Wheel Company patent plates to manage flows and allow for shutoffs for maintenance or in an emergency. The metal beam framing of the structure lies exposed and is painted a silvery white to maximize the reflection of interior light. The roof sheathing consists of glass so that the interior is illuminated entirely by natural light. The

[82] O'Shaughnessy, "The Bay Crossing Division of San Francisco's Hetch Hetchy Aqueduct," 2.
[83] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1i Bay Caisson, prepared for SFPUC, February 2007.
[84] SFPUC Photographic Archives, Negative # D-2375, D-2376, September 11, 1934.

hold meanwhile, allows for easy access to the network of submarine and terrestrial pipe connections.

The Caisson is a 98' tall concrete and metal-framed structure. Five of the six facades of the metal top to the Caisson are identical with small, centered fixed light windows that have protective metal screens. The sixth side features a door with a window aligned above it. This structure is the only one within the Bay Crossing Reach that expresses a modest allusion to stylistic intent. The chevrons visible on the window grates, stylized pilasters at the building corners, and the three corbelled concrete bands near the building's roofline convey an Art Moderne stylistic composition. Additional detailing at the base of the structure includes a stylized concrete band with vertical fluting.

A simple metal safety railing wraps around the structure and defines a narrow walkway that circumnavigates the structure. The Caisson sits on a very high foundation with a splayed base that allows the structure to stay above the Bay's rising and falling tides. Several drainage pipes for expelling water, caused by seepage into the Caisson are visible from the east façade of the foundation. The roof exhibits a low parapet and six-sided, pyramidal center apex. The exterior of the Caisson appears unaltered since the historic period. The interior contains a series of gate valves; specially designed manual valves that allow the utility to control water flows. Just as importantly, the Caisson's interior spaces also include a panel of gauges that monitor water pressure in all of the pipes.

The Caisson's construction technique represents a significant engineering achievement and was highlighted in the *Engineering News Record* in 1926:

> *The plan of construction adopted to avoid danger of spreading the surrounding caisson cylinders was first to drive the wooden piles in the area on which the concrete was to be placed and then to begin the construction of the caisson in which the pier was to be built. The caisson was constructed by first putting down 21 steel cylinders 80 feet long and 9 ½ feet in diameter, which were in themselves small caissons within which excavation could be made and the concrete placed. The steel cylinders were equally spaced on the circumference of a circle 72 feet in diameter. When the concrete within these steel cylinders was in place, constituting a ring of small piers, the steel cylinders were pulled and a double line of steel sheetpiling giving a wall 3 feet thick, the space afterwards filled with concrete, thus enclosing the area on which the main pier was to be built.*[85]

The publication then goes on to describe the construction of the Caisson in great detail, including the substructure of wooden supports that formed the framework for the foundation:

> *A total of 715 wooden piles were used in the foundation including 64 batter piles driven on a 1 to 2 slope to carry part of the hydrostatic thrust, and the nine driven in each steel cylinder.*

[85] "San Francisco Bay Crossing," 434-435.

> *Under the center of the pier the pile centers were 2 ½' apart in one direction and 3' in the other. The chief concern with the piles was to get them down into the firm yellow clay, not only to increase their bearing power but also to strengthen them against the lateral thrust…These piles extended an average depth of about 40 ft. below the concrete level and were driven with a No. 2 steam hammer having a 5,000-lb ram.*[86]

The cylinders used in the construction were made of steel sheets from 9" to 12" thick and were driven approximately 70' into mud, sand, and gravel by a 9,600-lb drop hammer. On the bottom of each cylinder was a 5 ½' extension or shoe of 9" steel, left unbolted and kept in place when the cylinder was pulled to assure firm contact with the stiff clay at the bottom.[87] The cylinders were of additional note because of the system used to test their strength:

> *The test was made by jacking from the head of one pile to a horizontal beam placed between two others and observing the deflection of the beam…In this test the piles satisfactorily resisted practically twice the maximum load they will have to resist under operating conditions. The test was considered notable in that it was conducted nearly 30 ft. below tide level without the use of compressed air.*[88]

Inside the steel cylinders, a series of precast hollow shells 6' thick and 78' x 78' in plan received poured concrete from barges. To resist potential bending movements during pouring activities, the engineers designed heavy steel reinforcement. The cores were filled with concrete up to low tide level, where they were cut off after serving their construction purpose. On opposite faces of each of these piers, a portion of projecting vertical sheetpile was used to complete the Caisson wall. After the steel cylinders were removed, a double wall of steel sheetpiling between the precast piers was driven into place. The area between these walls was excavated and later filled with tremie concrete. After that was complete, a 1' layer of crushed rock and subsequent 10' layer of concrete was poured inside the Caisson, which was completed during a continuous, three-day pour. The precision and workmanship of the structure was conveyed by the complete lack of seepage and complete dryness of the inside of the structure during construction.[89]

9. Bay Division Pipeline Bridge: The BDPL bridge lies on an east/west axis and remains accessible from the west shore of San Francisco Bay. It is accessed by a 2-mile-long service road approaching from the southeast via Rutgers Street in Menlo Park.[90]

Constructed in 1923, the BDPL Bridge extends from the concrete Caisson to the west shore of San Francisco Bay near Ravenswood, California. A bridge plaque, situated on

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[86] "San Francisco Bay Crossing," 435.
[87] "San Francisco Bay Crossing," 435.
[88] Ibid.
[89] "San Francisco Bay Crossing," 436.
[90] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1j Bay Division Pipeline (BDPL) Bridge, prepared for SFPUC, February 2007.

the last span and visible from the Caisson, notes the date of 1923. Roughly 3,700', the 32 -span bridge consists of reinforced concrete piers supporting 7-panel steel Pratt trusses. Fabricated in the San Francisco shipyards by the United States Steel Products Company and its subsidiary American Bridge Company, each 105' truss was barged down the Bay from the companies' manufacturing plant in 1924-1925 and lifted onto a set of concrete piers. Each pier contains two reinforced-concrete columns, which rest on timber piles and are connected by three reinforced-concrete beams.[91]

To ensure that the bridge was firmly anchored to the Caisson, over three feet of the bridge was embedded in the concrete of the Caisson. The concrete was poured directly against the end floor beam of the bridge and around the end posts. On the bottom chords of the bridge, three layers of felt saturates in hot air-blown asphalt provide a small expansion joint gap. This allowed the end posts and bottom chords of the bridge freedom to deflect under the action of both the vertical gravity loads and the reversing horizontal loads caused by temperature and hydrostatic thrust loads on the Caisson pier (serving the function of the end thrust pier for the bridge).[92]

The Pratt truss spans consist of A-7 steel members that are connected with riveted gussets. Each of the six vertical members of the truss exhibits a diagonal brace. Supports of individual truss spans consist of alternating fixed bearings and expansion bearings. The bearing ends alternate from span to span so that each pier supports either two fixed bearings or two expansion bearings. The spans carry BDPL No.1, a 60" diameter riveted steel pipeline, and BDPL No. 2, a 76" diameter welded steel pipeline. When originally built in 1923, the bridge carried only BDPL No. 1, though it was designed to hold an additional pipeline. BDPL No. 2 was added to the bridge in 1936. Rather than using a concrete or wood deck like a typical road bridge, the pipe bridge manufacturers installed wooden saddles that rested directly on the steel floor beams that were designed to carry the weight of the two pipelines.[93] Wood plank catwalks along both pipes allow for observation and routine maintenance of the pipelines and Caisson.[94]

The BDPL Bridge spans a shallow, unnavigable portion of San Francisco Bay and was less expensive than continuing the submerged pipeline from the Caisson to the west shore. The use of such a long bridge to span a waterway is uncommon for the era. Aside from maintenance, the pipe bridge retains much of its original fabric.[95]

10. Ravenswood Valve House: The Ravenswood Valve House represents the western terminus of the Bay Crossing Reach. The structure, constructed in 1924-1925, houses a series of gate valves for controlling flows for BDPL No. 1 by allowing workers to

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[91] Ibid.
[92] "San Francisco Bay Crossing," 436.
[93] Ranzetta, HR-1j.
[94] OPAC, 15.
[95] Ranzetta, HR-1j.

manually bypass or completely close the pipe for maintenance or emergency repairs.[96] BDPL No. 2 passes around the structure immediately to the south and then runs parallel to BDPL No.1.

The one-story, barn-like structure features a concrete foundation and a wood frame covered with corrugated metal siding. BDPL No. 1 passes directly through the building, entering at the east elevation at slightly above ground level and exiting the west façade at the same elevation but then quickly descending below ground. Immediately before entering the east façade, BDPL No. 1 is restrained by a trapezoidal anchor block.[97] To the immediate west of the valve house is a manual Chapman Valve Manufacturing Company gate valve, which projects out of the ground approximately 6' and has a large valve handle wheel for operation.[98]

The structure's gable roof exhibits sheathing of corrugated metal in addition to paired rafter tails exposed under the north and south gable, but is otherwise devoid of detailing except for a louvered clerestory along the main ridgeline of the building. This clerestory provides ventilation at the peak of the roof and also allows some light into the structure. On the north façade, there are two windows to either side of a large wooden garage opening that is original to the structure. All of the windows are six-over-six light, metal casement windows. On the east façade, there are two windows (one on either side of the entry of BDPL No.1 into the building) and one door at the northeast corner of the building. On the south façade, there is one, off-center door and one window. On the west façade there are four windows; two located to the north side of BDPL No. 1 as it exits the building and two to the south. It is unclear whether the metal exterior siding is original to the building.[99]

The interior consists of one open space with the piping and valve gate located entirely above grade. The interior also contains a small, vertical board-sheathed privy. The Union Machine Company cast the gate valve located at Ravenswood. The valve is embossed with the company's name and a date of "1924".

D. General Site Description

The Bay Crossing Reach of the BDPL Nos. 1 and 2 of the Hetch Hetchy Aqueduct includes the portion of the SFPUC historic right-of-way for the BDPL Nos. 1 and 2 extending from the Newark Valve House on the east side of the Bay to the Ravenswood Valve House on the west side of the Bay.

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[96] Kirk E. Ranzetta, State of California Department of Parks and Recreation Primary Record for HR-1k Ravenswood Valve House, prepared for SFPUC, February 2007.
[97] Ranzetta, HR-1f.
[98] Ranzetta, HR-1j.
[99] Ranzetta, HR-1k.

Situated in Alameda and San Mateo counties, the setting of the Bay Crossing Reach consists of a variety of land uses, including industrial lands, open space, the Don Edwards National Wildlife Refuge, former salt ponds, unpaved access roads, and recreational trails. The right-of-way proceeds under roadways, railways, and navigable waterways, as well as over marshes and wetlands and the San Francisco Bay. In general, the land is flat and lies just above sea level with views to the east and west of the Coast Range and Santa Cruz Mountains respectively. The pipeline is visible for approximately 80 percent of this segment, with the remaining portions being underground or below the water surface of the Newark Slough and San Francisco Bay.

Part III. Sources of Information

A. Primary Sources

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_____. State of California Department of Parks and Recreation Primary record for HR-1d Newark Valve House. Prepared for San Francisco Public Utilities Commission SFPUC, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1e Newark Slough Crossing. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1f Concrete Anchor Blocks. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1g Dumbarton Valve House. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1h East, Center and West Trestles. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1i Bay Caisson. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1j Bay Division Pipeline (BDPL) Bridge. Prepared for San Francisco Public Utilities Commission, February 2007.

_____. State of California Department of Parks and Recreation Primary record for HR-1k Ravenswood Valve House. Prepared for San Francisco Public Utilities Commission, February 2007.

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Part IV: Project Information

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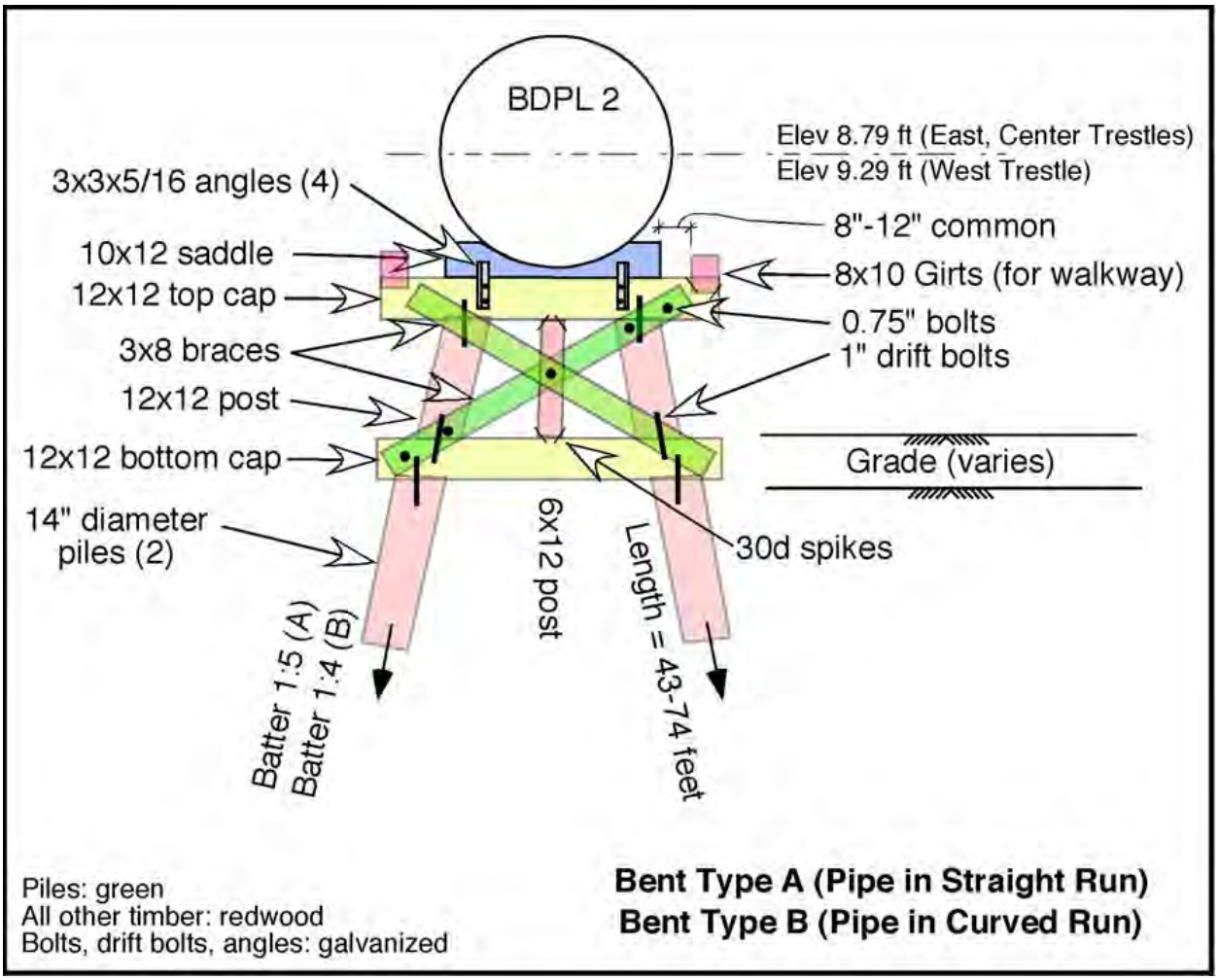
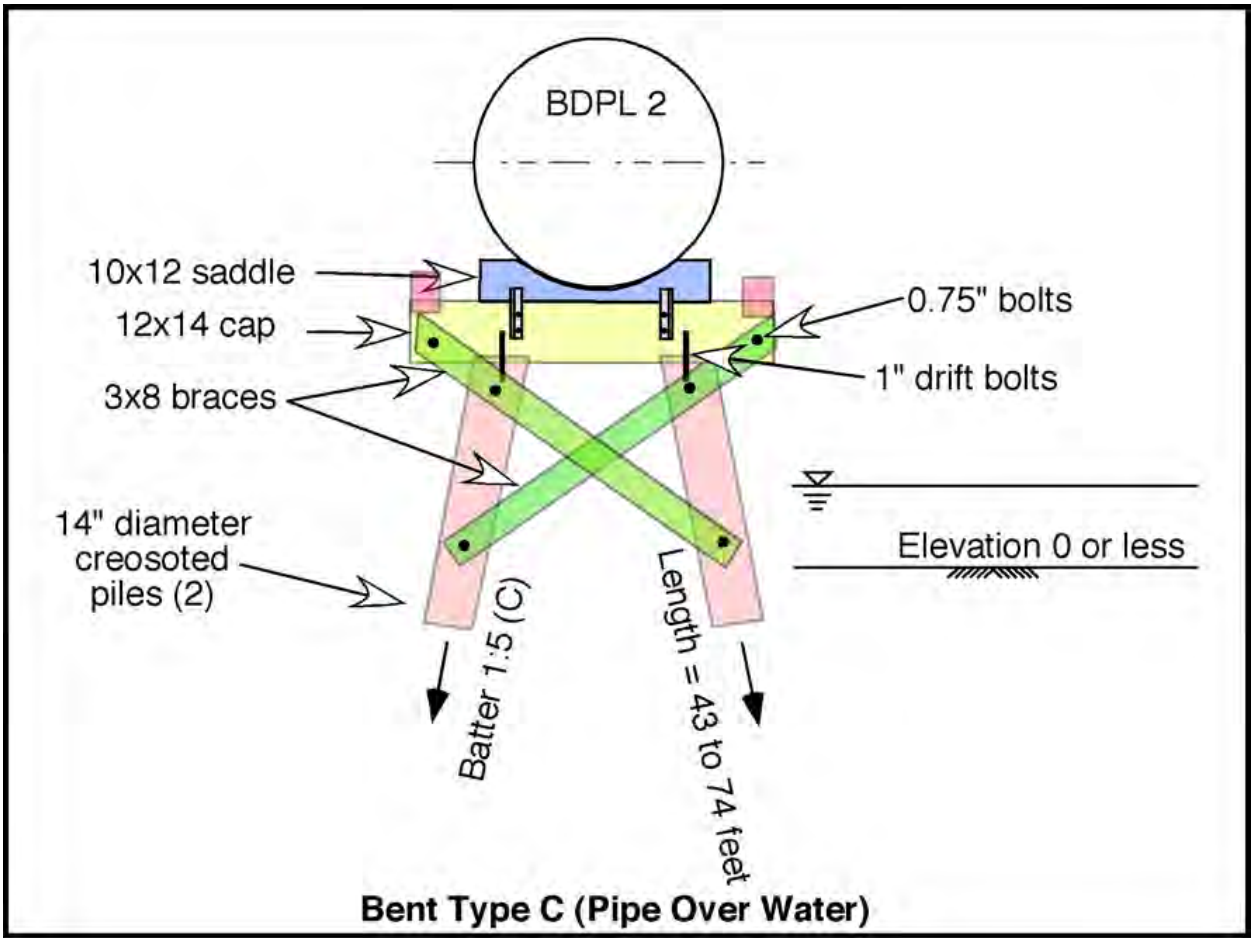
Appendix A

Historic Maps and Contemporary Drawings of Trestle Supports Used on the Bay Crossing Reach

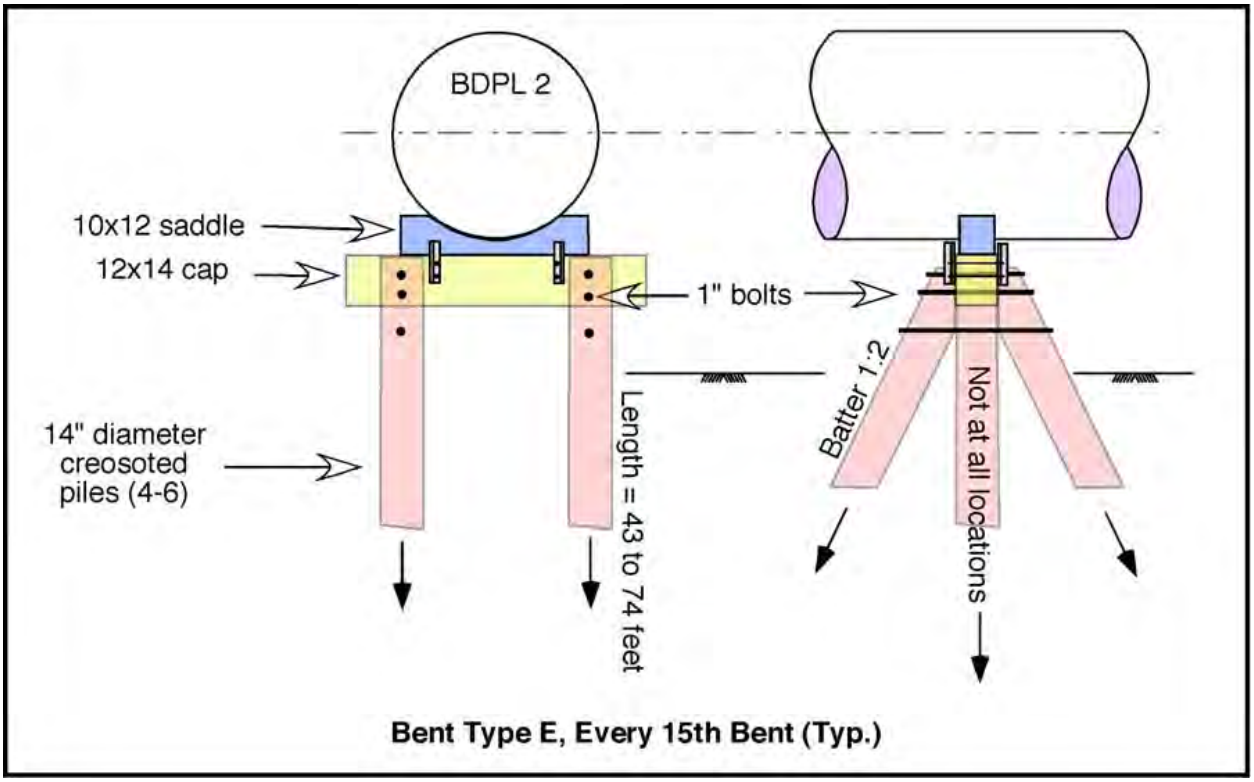
(Note: Historical maps have been redacted from this HAER submittal but are available upon request from the San Francisco Public Utilities Commission, 525 Golden Gate Avenue, San Francisco, CA 94102. A list of the removed images is included for reference.)



Drawing of wooden trestle pipeline supports for "Bent Type A" and "Bent Type B" found on BDPL No. 1 and 2 (OPAC 2005: 13).



Drawing of wooden trestle pipeline supports for "Bent Type C" found on BDPL No. 1 and 2 (OPAC 2005: 14).



Drawing of wooden trestle pipeline supports for "Bent Type E" (OPAC 2005: 15). Note: BDPL No. 1 does not contain any Type E supports.

List of Historic Maps and Contemporary Drawings Available at the
San Francisco Public Utilities Commission Archives

1. Elevation cross section and map showing the Bay Crossing Reach of the Bay Division Pipelines, SFPUC Archives, 1923.

2. Location of test piles driven in San Francisco Bay at Dumbarton Strait in anticipation of erecting the pipe bridge and Caisson. SFPUC Archives, 1923.

3. Historic engineering drawing of typical pipeline trench sections for BDPL No. 1. SFPUC Archives, 1923.

4. Historic engineering drawing of Bay Crossing Reach pipeline and its arrangement on bridge spans. SFPUC Archives, no date.

5. Historic engineering drawing for the Bay Crossing Reach pipeline bridge. SFPUC Archives, 1923.

6. Historic engineering drawing for the concrete piers of the Bay Crossing Reach pipeline bridge. SFPUC Archives, 1923.

7. Historic engineering section drawing of the 42 inch flexible joint cast iron pipe used for the submarine pipeline. SFPUC Archives, 1924.

8. Historic drawing showing cross sections of the Bay Crossing Reach "thrust pier" or Bay Caisson. *Engineering News Record*, March 18, 1926, p. 435.

Appendix B

Historic Photographs of the Bay Crossing Reach

(Note: Historical photographs have been redacted from this HAER submittal but are available upon request from the San Francisco Public Utilities Commission, 525 Golden Gate Avenue, San Francisco, CA 94102. A list of the removed images is included for reference.)

List of Historic Photographs Available at the
San Francisco Public Utilities Commission Archives

1. Historic photograph of hydraulic riveting for BDPL No. 1 at the Western Pipe and Steel Company manufacturing plant in San Francisco. SFPUC Archives, 1924.

2. Historic photograph of pipe bridge span being loaded onto a barge in the shipyards of San Francisco. SFPUC Archives, 1924.

3. Historic photograph showing the unloading of BDPL No. 1 pipe at the Redwood City wharf. SFPUC Archives, 1924.

4. Historic photograph showing the barges used as a floating concrete plant and storage for cement and rock. Sheet piles for a bridge pier are pictured in the center background. SFPUC Archives, 1924.

5. Historic photograph of the culvert constructed under the S.P.R.R. at Newark. Note the date stamp on the culvert's lintel. SFPUC Archives, 1924.

6. Historic photograph of the Newark Slough submarine pipe and concrete anchor block (east end). SFPUC Archives 1925.

7. Historic photograph showing the laying of the 42" submarine pipeline across Newark Slough, SFPUC Archives, 1925.

8. Historic photograph showing the construction of the Dumbarton Valve House. SFPUC Archives, 1935.

9. Historic photograph of the newly completed Dumbarton Valve House. SFPUC Archives, 1936.

10. Historic photograph showing the completed Bay Crossing Reach pipeline bridge. SFPUC Archives, 1926.

11. Historic photograph of engineering model used for the Bay Caisson. Note the four pipeline connections at the base. One of the connections remains unused. SFPUC Archives, 1934.

12. Historic photograph, detail of Bay Caisson engineering model interior illustrating gate valve locations and operations. SFPUC Archives 1934.

13. Historic photograph of metalwork beginning to be woven into the base of the Bay Caisson. SFPUC Archives, 1925.

14. Historic photograph of metalwork laid prior to the pouring of concrete for the Bay Caisson. Note the four submarine outlet pipes. This same image appeared in the 1926 *Engineering News Record* article that updated progress on the Bay crossing of the Hetch Hetchy Aqueduct. SFPUC Archives, 1925.

15. Historic photograph of hoisting operations related to the tapered pipe for BDPL No. 1. These modifications were made to BDPL during the construction of BDPL No. 2. Note the unfinished upper section of the caisson that lacks the present-day metal cap. It remained in an unfinished, but operational state between 1926 and 1935. SFPUC Archives 1935.

16. Historic photograph of the pipe bridge, gate valves, and Bay Caisson connections nearing completion. SFPUC Archives 1936.

17. Historic photograph showing the completed Bay Caisson. SFPUC Archives 1936.

18. Historic photograph illustrating the west approach to the pipe bridge and BDPL No. 1. SFPUC Archives, 1925.

19. Historic photograph taken during construction of BDPL No. 2 illustrating the wooden trestles used to cross the wetlands on the west side of San Francisco Bay prior to the installation of the pipeline. SFPUC Archives, 1934.

Appendix C

Supplemental Color Photographs of the Bay Crossing Reach

October 2013

Newark Valve House, view of west and south elevations, looking northeast, October, 2013. Kirk Ranzetta, URS photographer.

Newark Valve House, interior detail of gate valve, looking northwest, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Newark Valve House, pipe hold detail of tapered pipe and gate valve, looking northeast, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Newark Valve House, pipe hold detail of tapered pipe and valves, looking northeast, October 2013.
Kirk Ranzetta, URS photographer.

BDPL No. 1 railroad undercrossing with date stamp, Newark Valve House vicinity, October 2013. Kirk Ranzetta, URS photographer.

BDPL No. 2 railroad undercrossing, Newark Valve House vicinity, October 2013. Kirk Ranzetta, URS photographer.

BDPL No. 1 (foreground) and BDPL No. 2 (right) along the middle trestle, looking west, October 2013. Kirk Ranzetta, URS photographer.

View of pressure treated wood beneath Trestle, BDPL No. 2, looking east, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

BDPL No. 1., detail of riveted transverse and longitudinal plate joints. Note use of conical and button head rivets for transverse and longitudinal plate joints, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

BDPL No. 1., detail of riveted transverse and longitudinal plate joints along middle trestle, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Newark Slouth Crossing with BDPL No. 1 in foreground, looking east, October 2013. Kirk Ranzetta, URS photographer.

Newark Slouth Crossing, detail of anchor block and flexible pipe connection, looking north, October 2013. Kirk Ranzetta, URS photographer.

Dumbarton Valve House and BDPL No. 1, looking west, October 2013. Note the Bay Caisson in the right background. Kirk Ranzetta, URS photographer.

Dumbarton Valve House, detail of water pressure gauges, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Dumbarton Valve House, interior view of submarine pipeline gate valves and pipe holds, looking southwest, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Dumbarton Valve House, detail of a Chapman Valve Manufacturing Company screw top gate valve for submarine pipeline, looking southwest, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Dumbarton Valve House, detail view of Chapman Valve Manufacturing Company screw top gate valve and pipe hold for submarine pipes, looking north, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Dumbarton Valve House, detail view of Chapman Valve Manufacturing Company screw top gate valve and pipe hold for submarine pipes, looking west, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Dumbarton Valve House, environmental view looking northwest from the valve house towards the pilings formerly associated with the SVWC's water system, discarded ball-and-socket submarine pipe above and below the waterline, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

View of Bay Caisson and pipe bridge, looking west, October 2013. Kirk Ranzetta, URS photographer.

View of Bay Caisson and pipe bridge, looking southwest, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

View of Bay Caisson and pipe bridge, looking southwest, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, control room with gate valves, looking west, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, Pelton Water Wheel Company patent plates on gate valve, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, water pressure monitoring panel for submarine pipes and BDPL No. 1 and 2, October 2013. Note the brass embossed nameplate that reads "Pacific Bridge Co 1935". Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, pipe hold beneath control room, October 2013. Note the horizontal gate valve that extends just right of the base of the stairs. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, pipe hold beneath control room, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, detail of piping in pipe hold beneath control room, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Bay Caisson, detail of piping in pipe hold beneath control room, October 2013. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Pipe Bridge with BDPL No. 1 (left) and BDPL No. 2 (right), looking east. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Detail view of pipe flange and wooden cradles of BDPL No. 1, pipe bridge, looking northeast, October 2013. Kirk Ranzetta, URS photographer.

Detail view of pipe bridge gusset plate, looking north, October 2013. Kirk Ranzetta, URS photographer.

Elevation view of pipe bridge, looking north, October 2013. Kirk Ranzetta, URS photographer.

Elevation view of pipe bridge, showing pier and pipe connections, looking north, October 2013.
Kirk Ranzetta, URS photographer.

View of pipe bridge, Bay Caisson, and Dumbarton Valve House, looking east, October 2013. Kirk Ranzetta, URS photographer.

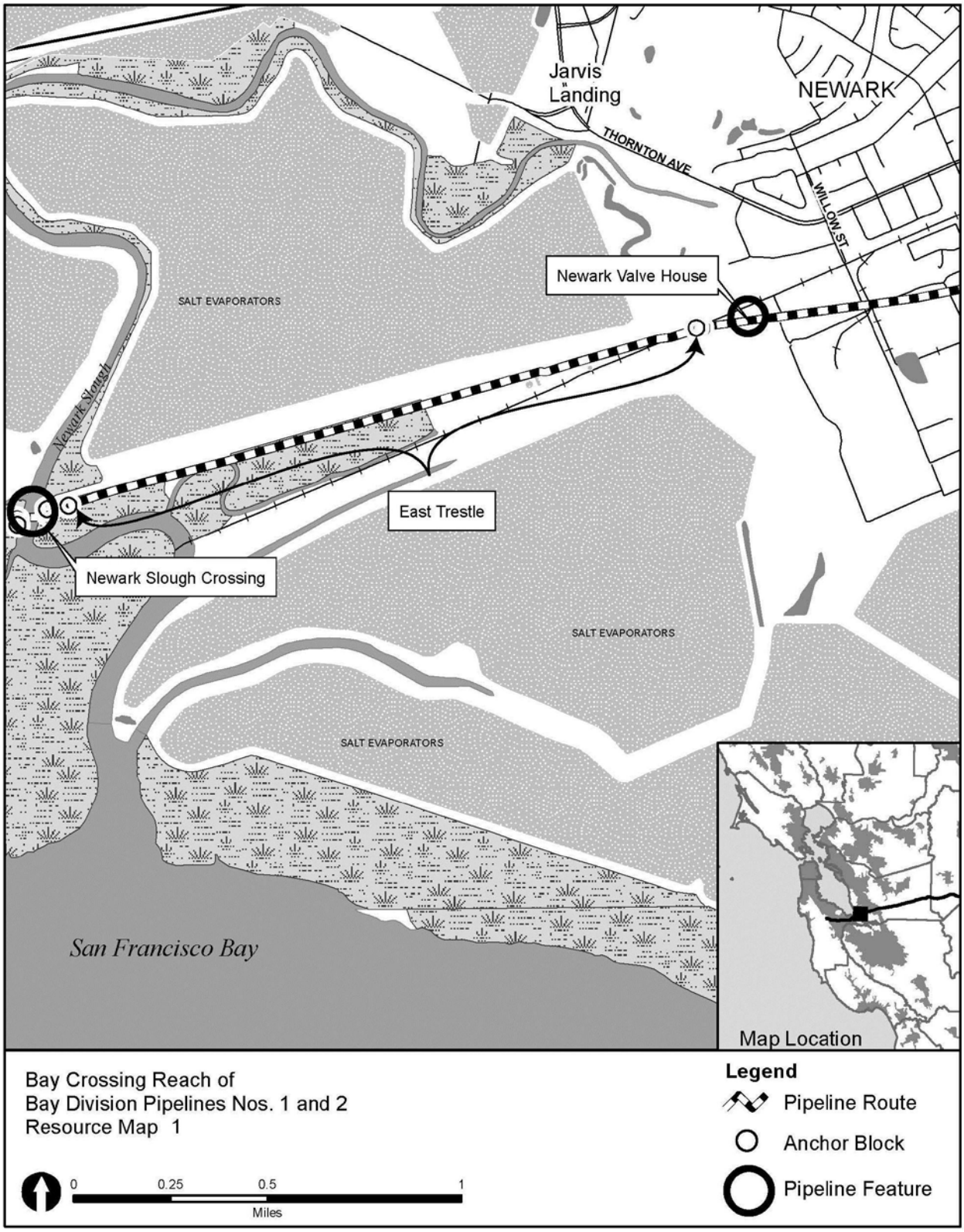
Pipe bridge landing with anchor block in left foreground in addition to the west trestle extending west, October 2013. Ravenswood Valve House is the building near the visual terminus of the pipelines. Robin Scheswohl and Katherine Du Tiel, SFPUC photographers.

Embossed name plate that reads "UNION MACHINE CO 1924 SAN FRANCISCO CAL", looking east, October 2013. Kirk Ranzetta, URS photographer.

Detail of interior outhouse, Ravenswood Valve House, looking east, October 2013. Kirk Ranzetta, URS photographer.

Appendix D

Bay Crossing Reach Location Maps


Jarvis Landing
NEWARK
THORNTON AVE
WILLOW ST
Newark Valve House
SALT EVAPORATORS
Newark Slough
East Trestle
Newark Slough Crossing
SALT EVAPORATORS
SALT EVAPORATORS
San Francisco Bay
Map Location
Bay Crossing Reach of
Bay Division Pipelines Nos. 1 and 2
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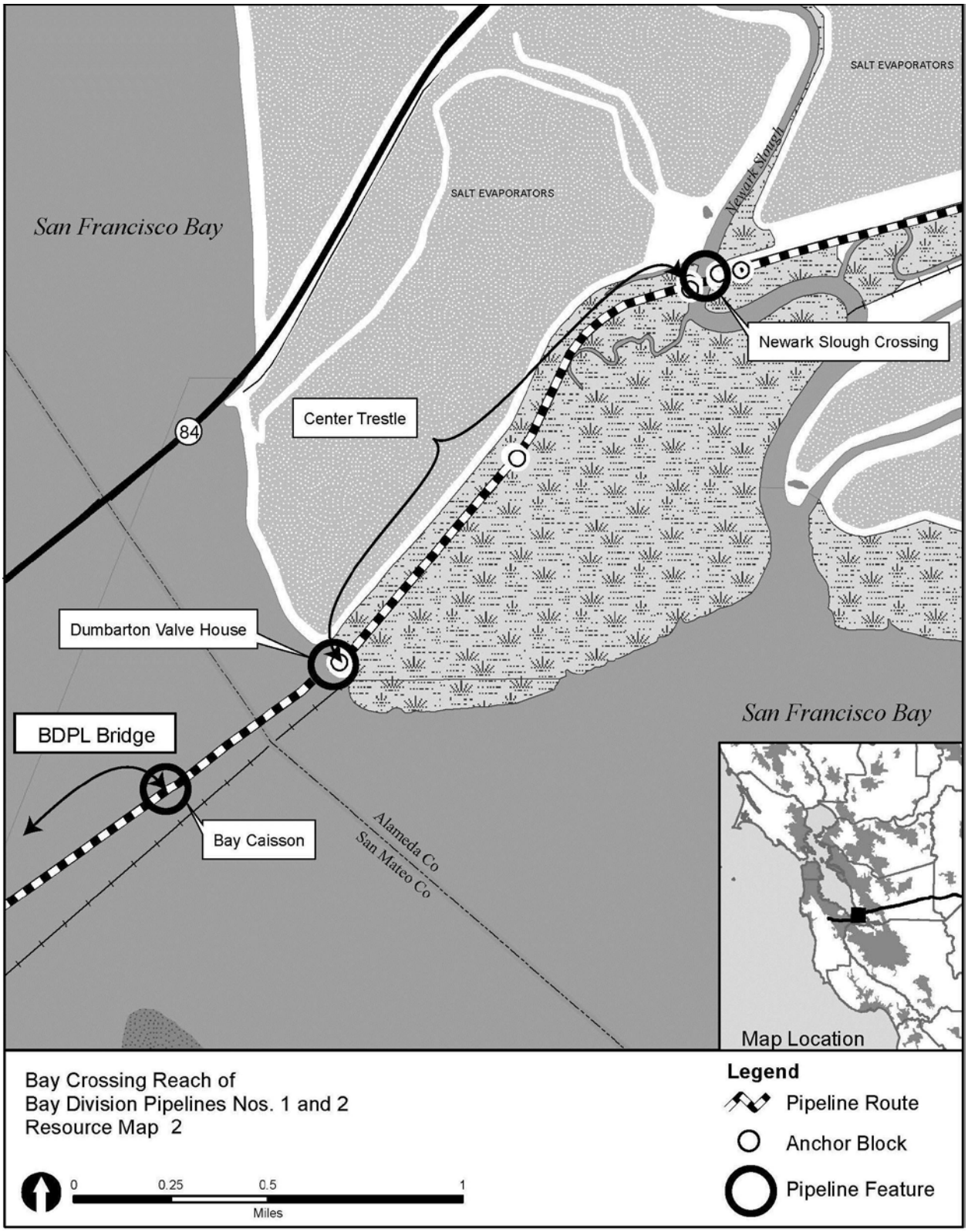
Legend
Pipeline Route
Anchor Block
Pipeline Feature


SALT EVAPORATORS
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San Francisco Bay
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Center Trestle
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Dumbarton Valve House
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Alameda Co
San Mateo Co
San Francisco Bay
Map Location
Bay Crossing Reach of
Bay Division Pipelines Nos. 1 and 2
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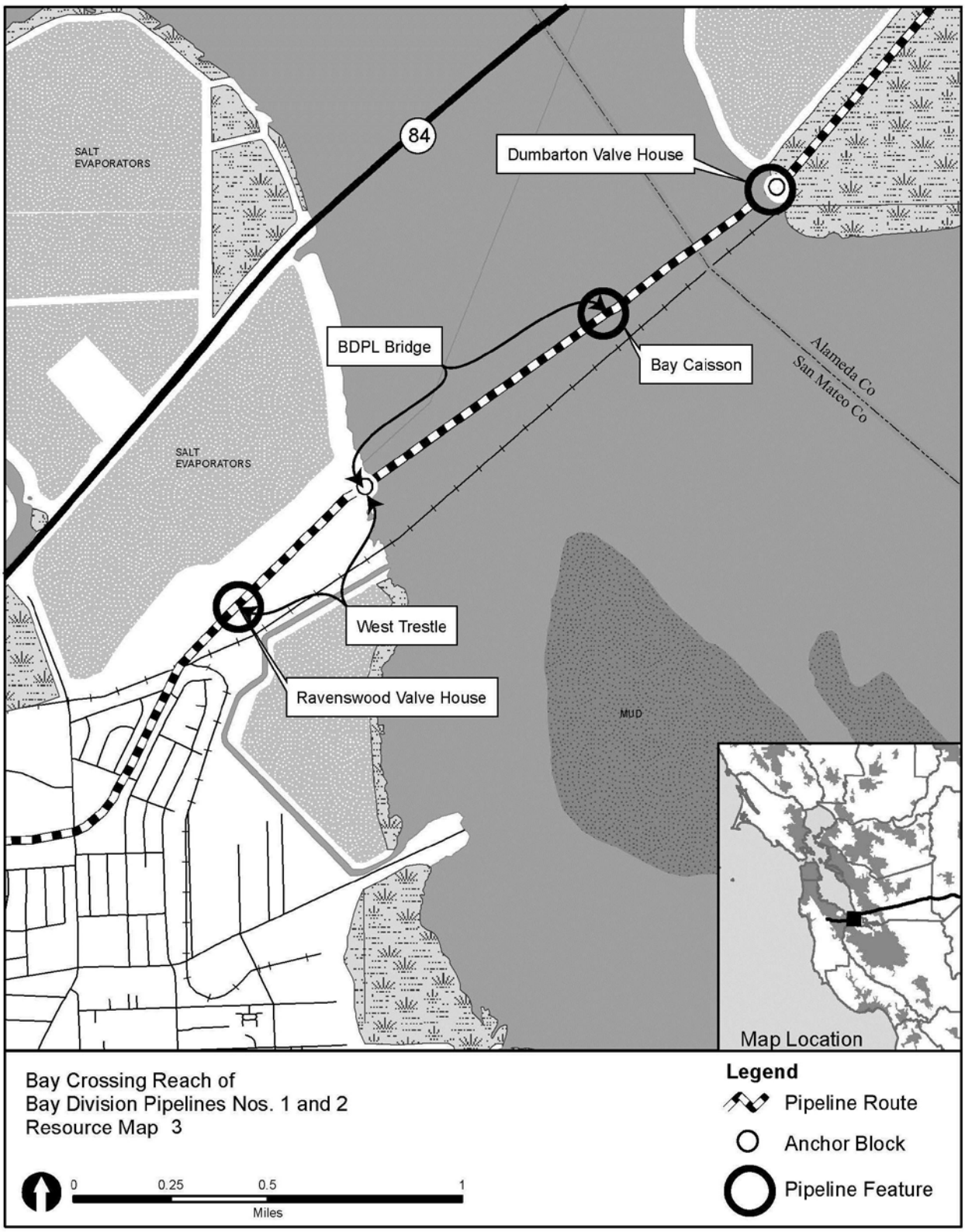
Pipeline Route
Anchor Block
Pipeline Feature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SALT EVAPORATORS
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BDPL Bridge
Bay Caisson
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Bay Crossing Reach of
Bay Division Pipelines Nos. 1 and 2
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Pipeline Route
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