Honolulu’s Rail Transit Project

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ABSTRACT: The Honolulu Authority for Rapid Transportation (HART) is building a 20-mile (32 km), 21 station driverless light metro system—the first of its kind in the United States. Permanently-coupled four-car trains will feature wide, open gangways. The design and construction of the elevated system is being integrated into the community through culturally-rich design treatments, extensive historic preservation programs, and sensitive archaeological protection plans. In addition, comprehensive Transit-Oriented Development (TOD) planning is shaping community revitalization along this rail corridor.
1.0 INTRODUCTION

The City and County of Honolulu and the US Federal Transit Administration are building a 20-mile, driverless fixed-guideway rapid transit system in Honolulu, Hawaii. The Honolulu Rail Transit Project includes the construction and initial operation of the rapid transit system between East Kapolei and Ala Moana Center (See Figure 1). The system includes 21 stations, park-and-ride facilities for 4,000 cars, bus transit centers, and two freeway access ramps. The initial project budget was $5.2 billion, although construction costs have increased since the project funding agreement in 2012. About 119,600 riders are forecasted to use the system each day in 2030.

2.0 PROJECT OVERVIEW

2.1 Context and Need

The project is located on the Island of Oahu, which contained about 975,000 residents and 815,000 registered cars in 2010. The island is about 600 square miles (1,500 sq. km or 384,000 acres) in size, but the urbanized area is about 170 square miles within a narrow corridor between the mountains and the ocean. A fleet of 541 public transit buses serves over 100 routes and carries about 215,000 passengers every weekday.

The project was initiated in 2005 to provide high-capacity transit in a highly congested east-west corridor between the second urban center of Kapolei and a key activity center in Honolulu—the University of Hawaii at Mānoa. The corridor includes rapidly developing areas as well as large neighborhoods of limited income and aging populations. The project is intended to provide faster, more reliable transit service than can be achieved with buses in congested traffic.

Figure 1: Project Alignment and Construction Sections
2.2 Project Development

Development of a modern fixed-guideway rapid transit system on Oahu stretches back over 50 years. A planning study in 1967 and subsequent preliminary engineering efforts resulted in the development of the Honolulu Area Rapid Transit Project, which was an 8-mile-long (12.9 km) corridor from the airport to the University of Hawaii and included a 1.7-mile (2.7 km) subway tunnel through Downtown Honolulu. This project, however, was cancelled in 1981 due to changes in the City administration. Subsequently, another 14-mile (22.5 km) project was also stopped in 1992 when a tax funding measure failed to pass the City Council. Planning and construction of a bus rapid transit system along the same corridor was initiated in 1999, and some facilities were completed prior to the initiation of the current project in 2005.

Project officials completed the Alternatives Analysis in 2006, and the Honolulu City Council selected a 20-mile (33.8 km) corridor for implementation. Officials completed the Draft Environmental Impact Statement in November 2008. After the City Council shifted the alignment to include service to the airport and naval base, the issuance of the Final Environmental Impact Statement was delayed until June 2010. The Federal Transit Administration issued a Record of Decision in January 2011, and local project officials held a ceremonial groundbreaking on February 22, 2011.

The first guideway column was erected in June 2012. In August, however, officials stopped construction after the State of Hawaii Supreme Court ruled that archaeological studies had been improperly phased and permits were invalid. In a second, unrelated lawsuit later that year, a Federal Court upheld the project environmental approvals but required additional documentation. The Federal Transit Administration issued a Full-Funding Grant agreement in December 2012, and committed $1.55 billion in Federal funding to assist the City in completing the project, or 30% of the total expected construction costs.

Project archaeological studies were completed in August 2013. Permits were reissued and construction on the first 10-miles (16 km) of guideway and the maintenance facility resumed in September 2013. In order to resolve the Federal lawsuit, project officials also completed a Supplemental Final EIS and Amended Record of Decision. After the last Federal appeals were resolved in February 2014, right-of-way acquisition resumed. In 2015, the Hawaii State Legislature passed the enabling legislation to allow the City to extend the half-percent general excise tax for another five years until 2028, in order to resolve the expected construction funding shortfall.

As of June 2016, the first 7-miles (11.3 km) of guideway structure have been completed, and another 3-miles (4.8 km) is well underway. The systems contractor has brought the first four-car trainset to the Rail Operations Center, which is also nearing substantial completion. Construction of the initial 9 stations has also begun, and could be opened for service as early as late 2018. The remaining guideway and 11 stations are being procured under two design-build contracts, and are scheduled to be completed in 2022.
2.3 Project Delivery

The project is being undertaken by the City and County of Honolulu in cooperation with the Federal Transit Administration. In July 2011, the City established a semi-autonomous transit agency, the Honolulu Authority for Rapid Transportation (HART), to assume all responsibilities for the design, construction, and operation of the project. About 100 agency staff members at HART are supplemented with additional general engineering consultants.

3.0 SYSTEM OVERVIEW

Although there are over 50 urban light metro systems throughout the world, the Honolulu system will be the first such system in the United States. The system will use a conventional steel-wheel trains operating on steel rails. Traction power will be supplied by a 750-volt DC third rail system. Trains will operate almost entirely on an aerial guideway structure, except for a 0.3-mile section adjacent to the Rail Operations Center. All but one of the 21 stations will be elevated.

3.1 Guideway and Stations

About 80 percent of the alignment is being built above the center or side medians of existing urban roadways in order to minimize right-of-way impacts. The elevated guideway superstructure is being constructed using precast concrete box girder segments supported by columns spaced 120 to 140 feet apart (37-43m). Each segment is about 11 feet long, weighs about 50 tons, and is custom-matched to the previous segment during the off-site casting process. About 5,200 segments are being used on the first 11 miles of guideway. Each guideway span is typically comprised of 11 to 14 segments which are individually placed onto a temporary overhead truss and then post-tensioned using internal cables.

In two locations along the alignment, special long spans of up to 340 feet in length (67-73m) are constructed using a balanced cantilever method. This alternative method involves segments which are formed and cast-in-place, and gradually extended outward.

Guideway support columns are typically 6 to 7 feet (1.8-2.1 m) in diameter. The columns are supported by drilled shaft foundations which are up to 250 feet deep, depending on the geological conditions.

On average, the typical track elevation is about 35 feet (10.6 m) above ground level, although the guideway climbs up to 70 feet (21.3 m) above ground level in order to clear highway ramps and overpasses, in some locations. The guideway is designed with a minimum vertical clearance of 17.5’ minimum clearance (5.3m) above roadways.

The guideway deck for a typical dual-track section is about 30 feet wide (9.1 m), and is supported by a girder that is about 9 feet high (2.7m) and 12 feet wide (3.7 m) (Figure 2). A 3'-9”-wide emergency egress walkway is located between the tracks. The western half of the alignment uses a plinthless direct fixation design to secure
the rails to the guideway deck. In order to achieve the necessary tolerances, the guideway spans and tracks are shimmed into final position prior final setting. The eastern half of the guideway will use a more conventional design with plinths. The segments include a 3’-high (0.9 m) integrated sound barrier and parapet wall that is incorporated into the entire elevated guideway. Due to the urban nature of this system, the integrated sound barrier reduces the environmental impacts associated with train noise.

There will be 21 stations. One station will be at-grade; all others will be elevated. Three stations will have a center platform which is 30 feet (9.1m) wide; all other stations will have dual side platforms which are 12 feet (3.7m) wide. Platforms will be 240 feet long (73.2m) and will be equipped with platform screen gates in order to prevent passengers from falling onto the tracks. In order to meet accessibility standards, each platform will be equipped with at least one elevator to the concourse or ground level; a second elevator can be added in the future as necessary. Other vertical circulation is accomplished via stairs and escalators. Bicycle channels or ramps are also being incorporated along the sides of the stairways in order to facilitate vertical circulation for cyclists.

![Figure 2: Typical elevated dual-track guideway configuration.](image)
3.2 Vehicles and Operation

The train systems are being supplied by Hitachi-Ansaldo Honolulu JV, under a design-build-operate maintain contract. Ansaldo Honolulu JV will also operate and maintain the system for 5 years after full system opening.

Each train car is about 64-feet in length (19.5m), and the cars are permanently coupled into four-car trainsets. There are three plug-type doors on the side of each vehicle, and will provide a 55 inch-wide clearance when fully open (1.4m). Each four-car trainset will have 188 seats, and will have a total capacity of 600-800 people (Figure 3). The permanently-coupled trains will have open gangways, allowing free access throughout the 256-foot-long train (78m). Each trainset will also be equipped with 4 bicycle hooks and 2 overhead surfboard racks. There are also 16 areas with fold-down seats, allowing extra space for standees, wheelchair securement, and luggage storage (Figure 4).

Ansaldo is supplying a total of twenty trainsets. A maximum of 17 trainsets are expected to be used in peak operation. Average operating speed, including station stops, is 30 miles per hour. It will take about 45 minutes to travel along the entire length of the corridor. Initial operating headways will be about 5.6 minutes during peak periods, and 11 minutes off-peak. The vehicles will be controlled from a central Rail Operations Center (ROC) at a 43-acre site near the middle of the line. The ROC features a fully automatic central yard control system.
3.3 System Integration

Project officials are coordinating with various local, state, and federal agencies to ensure an integrated, multimodal transportation system. The rail system will be integrated with the bus network, and a new electronic fare payment system is under development. The existing bus system, which currently carries about 215,000 people per day, are planned to be restructured to feed into the rail stations. The rail system is expected to have about 119,600 daily boardings in 2030. Approximately 60% of all rail passengers are expected to connect from a bus. Another 30% will
walk or bike to the rail station. About 8% of rail passengers would use a park-and-ride lot, and another 5% would be dropped off at the station.

This system access pattern, however, differs greatly by station location and neighborhood typology. At suburban stations, for example, about 60% of the passengers are expected to arrive at the station by bus or auto. At urban neighborhood stations, however, about 60-80% of the passengers will arrive by walking or biking. The typical urban station will handle about 2,000 to 4,000 rail passenger boardings per day, while the typical suburban station will handle about 5,000 to 7,000 rail boardings each day. Major transfer intermodal stations will handle about 7,000 to 10,000 passenger boardings per day.

4.0 CULTURAL AND COMMUNITY INTEGRATION

Project officials are integrating the design and construction of the rail system into the community by protecting and documenting historic properties along the alignment, incorporating context-sensitive design, and adopting culturally-respectful construction programs.

4.1 Design Features

Project architects are using a design language pattern which utilizes cultural references to guide the design of the stations and other project features. The language pattern describes themes and indigenous Hawaiian practices that embody the island’s rich cultural heritage. Inspirations and reference examples include visual connections to the mountains and oceans, textures and colors that reflect traditional landscapes, and stories which celebrate modern lifestyles.

For community planning and design purposes, the 21 stations were initially divided into six development groups, each encompassing 3-4 stations. Community outreach for each station development group typically entailed a series of three public meetings in which project architects: (1) received initial community input, (2) presented designs that incorporated this input, and (3) presented final refined designs. Station designs were scaled back in 2012, in order to implement a smaller, more efficient modular typology that minimized building size and right-of-way takings. For most stations, project architects have incorporated a tensile fabric roof structure that is intended to invoke images of Polynesian sailing canoes.

Column Treatments. Local artists have also designed aesthetic column form-liners with icons that illustrate legends and cultural histories appropriate to each station (Figure 5). Community members at early station design workshops in 2009 and 2010 suggested using molded concrete as well as “murals along the highway to display scenes from the past, present, and future” and “reflect the area history.” To implement these concepts, project designers developed context-sensitive aesthetic treatments for the guideway columns under each station and potentially in other areas. Customized reveal pattern motifs are designed for each station, and incorporated into formliners at reveal depths of up to 1.5 inches from the surface of the column.
Each panel design is approximately 9 feet high and 18 to 21 feet wide, depending on the column diameter. The panels are organized around three thematic categories used by traditional Native Hawaiians for organizing knowledge: (1) Papahulilani (the spiritual heavens); (2) Papahānaumoku (cycle of life and death); and (3) Papahulihonua (natural earth and ocean). Each panel design is customized to convey the mo’olelo (stories) of each place, its people, and their culture and traditions, such as sugar industry immigrants, nearby natural features, or even modern activities.

A single panel design is created for each neighborhood and installed at up to 6 columns in sequence under each station. At each consecutive column, the design is rotated by 90 degrees in order to allow viewers traveling along roadway to see the different parts of the design and further enhancing a sense of movement. An anti-graffiti coating is also applied to each column design.

Figure 5: Column treatment at the West Loch Station.

Other Station Treatments. Hawaii’s rich cultural heritage and historical themes are also embodied in other station design elements such as artwork, windscreens, tiles, paving, and landscaping. The project includes a $5 million dollar art-in-transit program. A committee selected 25 artists (out of over 400) to develop customized architectural elements such as platform glass windscreens, art glass windows, wall murals, and artistic grille work. These features are typically made out of durable materials which are impervious to environmental conditions, such as metal, glass, mosaic tile, and concrete.

In addition, each of the 21 stations is designated with a unique selection of flower lei (garlands) and plants that are featured on station platform windscreens. Interpretive
displays and text will highlight the cultural significance or traditions associated with the plant selection. Station plazas and flooring materials are also designed to reflect cultural themes, such as seasonal elements, stars, or times of day. Landscaping designs feature native plants which appropriate to each ahupua’a (traditional Native Hawaiian land divisions).

4.2 Archaeological, Cultural, and Historic Resources

Archaeological, cultural, and historic resources are protected by the Federal government under Section 106 of the National Historic Preservation Act and Chapter 6E of the Hawaii Revised Statues. The Section 106 process includes the identification, assessment, and resolution of adverse effects to districts, sites, buildings, structures or objects that are eligible for listing on the National Register of Historic Places (NRHP). In order to mitigate the adverse effects to 33 historic resources along the project corridor, HART and its agency partners entered into a Programmatic Agreement (PA) that outlines specific mitigation measures that are being undertaken during construction. These mitigation measures include consultation and treatment of Hawaiian burials under HRS Chapter 6E, design standards and reviews, interpretive programs, Traditional Cultural Property and historic context studies, and others.

- **Documentation of Historic Properties.** Project staff are preparing documentation for the Historic American Building Survey, Historic American Engineering Record, and Historic American Landscape Survey (HABS/HAER/HALS) records for 33 architectural and engineering resources that have been determined to be NRHP-eligible. Staff are also preparing NRHP nominations for 31 properties that will remain in place after the project is complete.

- **Historic Lava Rock Curbs.** Many of the streets that require reconstruction and are adjacent to the Guideway or near stations have lava rock curbs that are between 80-100 years of age. The curbs are recorded in place, numbered, removed for storage, and then reinstalled as part of street reconstruction.

- **Historical Preservation Fund.** HART established a Historic Preservation Committee to oversee the expenditure of $2.0 million on brick-and-mortar historic preservation projects adjacent to the route. These include façade improvements as well as graffiti removal for individual NRHP-listed properties and contributing properties in NRHP-listed districts. The first round of awards that were submitted competitively by property owners produced $0.77 in HP projects in 2014.

- **Educational Programs.** In addition to interpretive signage located at all stations and the decorative column designs, HART is also producing educational and interpretative programs, materials, and signage. These include a Humanities program and other educational materials. A station naming committee has also been assembled to appropriately assign culturally appropriate monikers to individual stations based upon Hawaiian toponomy.
• **Park Improvements.** There are three historic municipal parks along the project corridor that were built in the early twentieth century. Project staff are developing plans to protect and enhance these parks, and $0.75 million is budgeted to construct these improvements.

### 4.4 Archaeological Protection

The project environmental mitigation program includes measures to identify and protect archaeological sites and the proper treatment of Na Iwi Kūpuna, or Hawaiian burials of human skeletal remains. These procedures include Archaeological Inventory Surveys (AIS) prior to construction, consultations with lineal descendants and the Island Burial Councils, and data recovery.

**Archaeology.** During the planning phase of the project, an extensive archaeological survey was conducted. Archaeological consultants dug over 400 trenches in order to sample areas which ground disturbance was likely to occur, such as at column locations and utility relocations. About two-thirds of these trenches were conducted in the last 4 miles of the alignment through the city center. About a dozen human skeletal remains were discovered, and HART staff worked with lineal descendants to identify appropriate treatment. Where possible, the project is keeping burials remain in place and redesigning project elements to avoid these areas.

**Cultural monitoring.** Project officials have also developed cultural sensitivity training and cultural monitoring programs. Construction crews undergo regular cultural sensitivity training on Hawaiian settlement history, cultural traditions, and practices to create a respectful and culturally-sensitive workplace. The project also hires Native Hawaiian cultural practitioners and community representatives to observe construction teams and ensure the respectful treatment of historic and culturally significant Native Hawaiian resources, artifacts, and na iwi kūpuna which may be uncovered during construction. Cultural monitors lead construction crews in demonstrations of reverence via oli (chants) or pule (prayers) and serve as a liaison with recognized lineal descendants and the broader Native Hawaiian community. In addition, cultural monitors can provide independent interpretations of cultural resources encountered during construction as well as assessing the cultural sensitivity of construction crews and engineers.

### 5.0 TRANSIT ORIENTED DEVELOPMENT

The City and County of Honolulu has been working with citizens, businesses, landowners, and other community stakeholders since 2007 to develop visions and implementation plans for areas around the rail stations that will integrate transportation planning and land use. The Hawaii Community Development Authority is also preparing its own TOD plan for the two stations in Kakaako which are under its jurisdiction.

**TOD Plans.** The City Department of Planning and Permitting (DPP) is preparing a set of eight neighborhood TOD plans which covers a 2,000-foot radius around each of three station areas. The plans generally include allowances for
mixed-use developments, density and building height limits, reduced parking requirements, and other design controls. These plans are developed through a series of public meetings and stakeholder interviews. Potential land use and urban design schemes are narrowed down, reviewed by the community, and then a preferred scheme is identified and incorporated into a design plan. Once a Neighborhood TOD Plan is adopted by City Council, DPP prepares implementing ordinances and special district overlay zoning regulations.

**TOD Zoning.** In order to implement the TOD plans, the City is creating mixed-use zoning for the blocks immediately around the rail station and also creating an overlay special district to facilitate design flexibility and enhanced infrastructure. Height limits generally remain unchanged, except for some taller areas immediately adjacent to the stations. In Waipahu, the City converted 282 acres around two rail stations from residential, business, and industrial zoning into mixed-use zoning.

In addition, the City is creating a new TOD special district which encompasses the station areas around all of the rail stations. The development standards in the TOD special district are designed to encourage compact development that increases transit ridership, reduces automobile dependence, and increases design flexibility. This process enables developer to propose taller building heights than would be normally allowed under existing zoning rules, for example, in exchange for commensurate community benefits such as streetscape improvements, new parks, or affordable housing. The standards are also intended to improve the pedestrian experience around the rail stations, particularly along designated “key streets”. Reduced or eliminated parking regulations are also established in these areas.

**Other Projects.** The City is also leveraging TOD opportunities to address urban development, housing, and other major issues. The Island of Oahu, for example, has a latent demand of 24,000 housing units. Within the next 25-30 years, the City estimates that 55,000 dwelling units could be constructed in TOD areas, helping to meet the shortfall. The City is also focusing capital improvement projects in TOD areas in order to promote strategic development. Current catalytic projects include a new pedestrian mall, a new bus transit center and senior housing facility, stream bank restoration and a promenade. These projects will further leverage the considerable investment in transportation infrastructure which the rail project is bringing into each community.

6.0 **CONCLUSION**

The City and County of Honolulu is uniquely reflecting its host communities in both the design and construction of the first light metro system in the United States. This project is also being strategically coordinated with community redevelopment efforts. The overall project will dramatically transform the island, improving mobility, access to employment opportunities, and enhancing quality of life for residents and visitors alike.

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