# Air Quality and Energy Technical Report
# Honolulu High-Capacity Transit Corridor Project

**August 15, 2008**

Prepared for:
City and County of Honolulu

# Preface

This technical report supports the Draft Environmental Impact Statement (EIS) prepared for the Honolulu High-Capacity Transit Corridor Project. It provides additional detail and information as it relates to:

- Methodology used for the analysis
- Applicable regulations
- Results of the technical analysis
- Proposed mitigation
- Coordination and consultation (as appropriate)
- References
- Model output (as appropriate)
- Other information/data

As described in the Draft EIS, the Locally Preferred Alternative, called the "Full Project," is an approximate 30-mile corridor from Kapolei to the University of Hawaiʻi at Mānoa with a connection to Waikīkī. However, currently available funding sources are not sufficient to fund the Full Project. Therefore, the focus of the Draft EIS is on the "First Project", a fundable approximately 20-mile section between East Kapolei and Ala Moana Center. The First Project is identified as "the Project" for the purpose of the Draft EIS.

This technical report documents the detailed analysis completed for the Full Project, which includes the planned extensions, related transit stations, and construction phasing. The planned extensions and related construction planning have not been fully evaluated in the Draft EIS and are qualitatively discussed in the Cumulative Effects section of the Draft EIS as a foreseeable future project(s). Once funding is identified for these extensions, a full environmental evaluation will be completed in a separate environmental study (or studies), as appropriate.

Figure 1-3 through Figure 1-6 (in Chapter 1, Background) show the proposed Build Alternatives and transit stations, including the areas designated as planned extensions.

# Table of Contents

## List of Tables



## List of Figures

# Acronyms and Abbreviations

| | |
|---|---|
| BTU | British thermal unit |
| CO | carbon monoxide |
| EIS | Environmental Impact Statement |
| EPA | U.S. Environmental Protection Agency |
| ‘Ewa (direction) | toward the west |
| FHWA | Federal Highway Administration |
| FTA | Federal Transit Administration |
| GWH | gigawatt hours |
| H-1 | Interstate Route H-1 (the H-1 Freeway) |
| $H_2S$ | hydrogen sulfide |
| HECO | Hawaiian Electric Company |
| Koko Head (direction) | toward the east |
| kg | kilogram |
| makai (direction) | toward the sea |
| mauka (direction) | toward the mountains |
| MBTU | million British thermal units |
| mph | miles per hour |
| MSAT | Mobile Source Air Toxics |
| MW | megawatts |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act |
| NO | nitric oxide |
| $NO_2$ | nitrogen dioxide |
| $NO_x$ | nitrogen oxides |
| $O_3$ | ozone |
| O‘ahuMPO | O‘ahu Metropolitan Planning Organization |
| ORTP | *O‘ahu Regional Transportation Plan 2030* |

| | |
|---|---|
| Pb | lead |
| $PM_{10}$ | particulate matter smaller than or equal to 10 microns in size |
| $PM_{2.5}$ | particulate matter smaller than or equal to 2.5 microns in size |
| ppm | parts per million |
| RTD | City and County of Honolulu Department of Transportation Services Rapid Transit Division |
| SIP | State Implementation Plan |
| $SO_2$ | sulfur dioxide |
| TPSS | traction power substation |
| UH | University of Hawaiʻi |
| VMT | vehicle miles traveled |
| VOC | volatile organic compounds |
| Waiʻanae (direction) | toward the west (see also ʻEwa) |

# Summary

The City and County of Honolulu Department of Transportation Services Rapid Transit Division, in coordination with the U.S. Department of Transportation Federal Transit Administration, is preparing a Draft Environmental Impact Statement (EIS) to evaluate alternatives that would provide high-capacity transit service on O‘ahu. The Honolulu High-Capacity Transit Corridor Project’s purpose and need focus on meeting the area’s current and future regional transportation needs. The Project is listed in the area’s Transportation Improvement Plan and in the *O‘ahu Regional Transportation Plan 2030* (ORTP) (O‘ahuMPO 2006). The Project study area is the travel corridor between Kapolei and the University of Hawai‘i at Mānoa (UH Mānoa).

## Air Quality

This report evaluates the quantity of air pollutant emissions that would occur with each project alternative. Results are included for both the Full Project condition and the Project, which extends from the vicinity of the planned East Kapolei campus to Ala Moana Center.

Air pollutants that can be traced principally to motor vehicles are relevant in evaluating project impacts. These pollutants include carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides ($NO_x$), particulate matter ($PM_{10}$ and $PM_{2.5}$), and Mobile Source Air Toxics (MSAT). The State of Hawai‘i is designated as an attainment area for CO, ozone ($O_3$), $PM_{10}$ and $PM_{2.5}$, which means that the State is in compliance with National Ambient Air Quality Standards (NAAQS) for those pollutants.

Air quality effects resulting from project construction would be limited to short-term increased fugitive dust and mobile-source emissions during construction. These impacts would be minimized by adherence to all applicable State and Local regulations.

Air quality effects predicted to result from the Project’s operation are based on the anticipated vehicle miles traveled (VMT) and average network speed for each alternative. The Project is predicted to reduce regional pollutant levels by approximately 3.2 to 4.4 percent (varying by alternative) compared to the No Build Alternative (Table S-1). The following two alternatives are predicted to demonstrate the largest reduction in emissions compared to the No Build Alternative: the Airport Alternative, Full Project; and the Airport & Salt Lake Alternative, Full Project. All alternatives are predicted to demonstrate a slight, though not quantifiable, improvement in MSAT levels.

Currently, monitored values of CO in the study area are less than 20 percent of the applicable NAAQS, and regional VMT is predicted to decrease with the Build Alternatives compared to the No Build Alternative. Therefore, no violations of the applicable NAAQS are likely to occur with the Project.

*Table S-1: Summary of Transportation Air Quality Emissions, 2030*

| Alternative | Daily Emissions (kilograms/day) | | | | |
|---|---|---|---|---|---|
| | VOC | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ |
| No Build | 6,854 | 147,464 | 4,842 | 375 | 174 |
| Salt Lake | | | | | |
| Full Project | 6,571 | 142,011 | 4,659 | 360 | 167 |
| First Project | 6,585 | 142,616 | 4,678 | 361 | 168 |
| Airport | | | | | |
| Full Project | 6,554 | 142,056 | 4,659 | 360 | 167 |
| First Project | 6,580 | 142,500 | 4,674 | 361 | 167 |
| Airport & Salt Lake | | | | | |
| Full Project | 6,560 | 142,087 | 4,660 | 360 | 167 |
| First Project | 6,588 | 142,694 | 4,680 | 362 | 168 |

VOC = Volatile organic compounds
CO = Carbon monoxide
$NO_x$ = Nitrogen oxides
$PM_{10}$ = particulate matter smaller than or equal to 10 microns in size
$PM_{2.5}$ = particulate matter smaller than or equal to 2.5 microns in size

# Energy

Energy is consumed during the construction and operation of transportation projects. It is used during construction to manufacture and transport materials and to operate construction machinery. Energy used during project operation includes fuel consumed by vehicles in the project area; electricity used to power transit vehicles; and a negligible amount of energy for signals, lighting, and maintenance.

For all of the Project's Build Alternatives, the total transportation energy demand for transit and highway vehicles would be lower than the No Build Alternative. Energy consumption reductions would range from 2.1 percent for the Airport & Salt Lake Alternative (First Project) to 2.2 to 2.5 percent for the remaining Build Alternatives (Table S-2).

Construction of the Build Alternatives would require between 7,140,000 (Salt Lake Alternative, First Project) and 11,560,000 (Airport & Salt Lake Alternative, Full Project) million British thermal units (MBTUs) of energy.

***Table S-2: Summary of Average Daily Transportation Energy Demand by Alternative, 2030***

| Alternative | Motor Vehicle Energy Consumption (MBTUs)[1] | Guideway Vehicle Energy Consumption (MBTUs)[1] | Total Energy Consumption (MBTUs)[1] | Percent Change from No Build |
|---|---|---|---|---|
| No Build | 94,610 | 0 | 94,610 | N/A |
| Salt Lake | | | | |
| Full Project | 90,812 | 1,714 | 92,526 | -2.2% |
| First Project | 91,082 | 1,163 | 92,245 | -2.5% |
| Airport | | | | |
| Full Project | 90,677 | 1,775 | 92,452 | -2.3% |
| First Project | 91,013 | 1,224 | 92,237 | -2.5% |
| Airport & Salt Lake | | | | |
| Full Project | 90,709 | 1,745 | 92,454 | -2.3% |
| First Project | 91,132 | 1,194 | 92,326 | -2.4% |

[1] MBTUs = million British thermal units

# 1 Background

## 1.1 Introduction

The City and County of Honolulu Department of Transportation Services Rapid Transit Division (RTD), in cooperation with the U.S. Department of Transportation Federal Transit Administration (FTA), is evaluating fixed-guideway alternatives that would provide high-capacity transit service on O‘ahu. The project study area is the travel corridor between Kapolei and the University of Hawai‘i at Mānoa (UH Mānoa) (Figure 1-1). This corridor includes the majority of housing and employment on O‘ahu. The east-west length of the corridor is approximately 23 miles. The north-south width is, at most, 4 miles because the Ko‘olau and Wai‘anae Mountain Ranges bound much of the corridor to the north and the Pacific Ocean to the south.

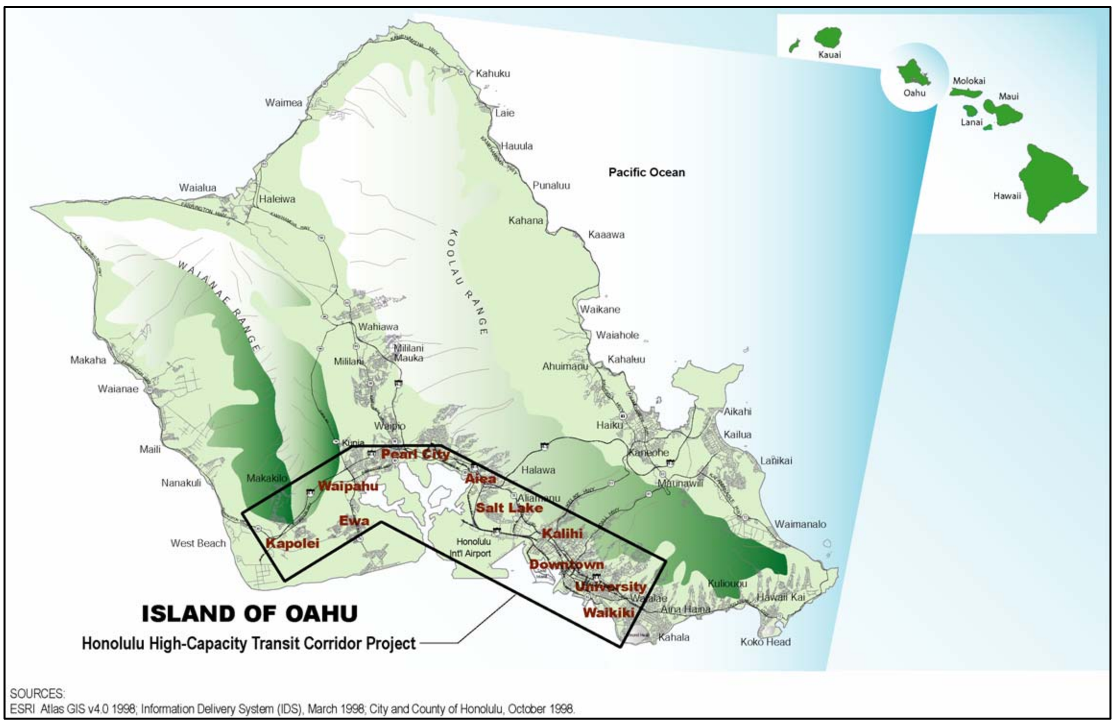


**Figure 1-1: Project Vicinity**

## 1.2 Description of the Study Corridor

The Honolulu High-Capacity Transit Corridor extends from Kapolei in the west (Wai‘anae or ‘Ewa direction) to UH Mānoa in the east (Koko Head direction) and is confined by the Wai‘anae and Ko‘olau Mountain Ranges in the mauka direction (towards the mountains, generally to the north within the study corridor) and the Pacific Ocean in the makai direction (towards the sea, generally to the south within the study corridor). Between Pearl City and ‘Aiea, the corridor’s width is less than 1 mile between Pearl Harbor and the base of the Ko‘olau Mountains (Figure 1-2).

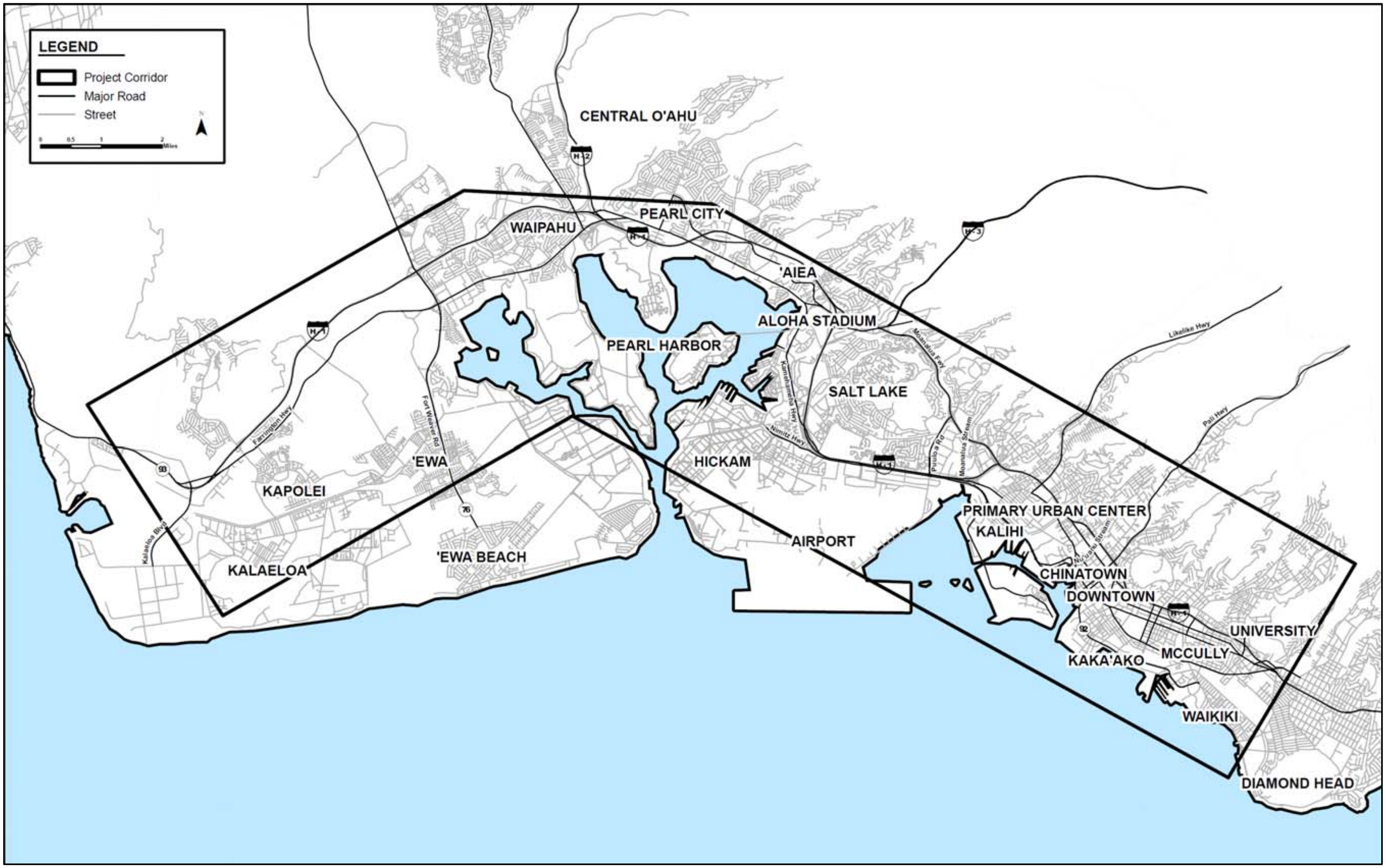


**Figure 1-2: Areas and Districts in the Study Corridor**

## 1.3 Alternatives

Four alternatives are being evaluated in the Environmental Impact Statement (EIS). They were developed through a screening process that considered alternatives identified through previous transit studies, a field review of the study corridor, an analysis of current and projected population and employment data for the corridor, a literature review of technology modes, work completed by the O‘ahu Metropolitan Planning Organization (O‘ahuMPO) for its *O‘ahu Regional Transportation Plan 2030* (ORTP) (O‘ahuMPO 2007), a rigorous Alternatives Analysis process, selection of a Locally Preferred Alternative by the City Council, and public and agency comments received during the separate formal project scoping processes held to satisfy National Environmental Policy Act (NEPA) (USC 1969) requirements and the Hawai‘i EIS Law (Chapter 343) (HRS 2008). The alternatives evaluated are as follows:

1. No Build Alternative
2. Salt Lake Alternative
3. Airport Alternative
4. Airport & Salt Lake Alternative

### *1.3.1 No Build Alternative*

The No Build Alternative includes existing transit and highway facilities and committed transportation projects anticipated to be operational by 2030. Committed transportation projects are those identified in the ORTP, as amended (O‘ahuMPO 2007). Highway elements of the No Build Alternative also are included in the Build Alternatives. The No Build Alternative would include an increase in bus fleet size to accommodate growth, allowing service frequencies to remain the same as today.

### *1.3.2 Build Alternatives*

The fixed guideway alternatives would include the construction and operation of a grade-separated fixed guideway transit system between East Kapolei and Ala Moana Center (Figure 1-3 to Figure 1-6). Planned extensions are anticipated to West Kapolei, UH Mānoa, and Waikīkī. The system evaluated a range of fixed-guideway transit technologies that met performance requirements, which could be either automated or employ drivers. All parts of the system would either be elevated or in exclusive right-of-way.

Steel-wheel-on-steel-rail transit technology has been proposed through a comparative process based on the ability of various transit technologies to cost-effectively meet project requirements. As such, this technology is assumed in this analysis.

The guideway would follow the same alignment for all Build Alternatives through most of the study corridor. The Project would begin by following North-South Road and other future roadways to Farrington Highway. Proposed station locations and other project features in this area are shown in Figure 1-3. The guideway would follow Farrington Highway Koko Head on an elevated structure and continue along Kamehameha Highway to the vicinity of Aloha Stadium (Figure 1-4).

Between Aloha Stadium and Kalihi, the alignment differs for each of the Build Alternatives, as detailed later in this section (Figure 1-5). Koko Head of Middle Street, the guideway would follow Dillingham Boulevard to the vicinity of Kaʻaahi Street and then turn Koko Head to connect to Nimitz Highway in the vicinity of Iwilei Road.

The alignment would follow Nimitz Highway Koko Head to Halekauwila Street, then along Halekauwila Street past Ward Avenue, where it would transition to Queen Street and Kona Street. Property on the mauka side of Waimanu Street would be acquired to allow the alignment to cross over to Kona Street. The guideway would run above Kona Street through Ala Moana Center.

Planned extensions would connect at both ends of the corridor. At the Waiʻanae end of the corridor, the alignment would follow Kapolei Parkway to Wākea Street and then turn makai to Saratoga Avenue. The guideway would continue on future extensions of Saratoga Avenue and North-South Road. At the Koko Head end of the corridor, the alignment would veer mauka from Ala Moana Center to follow Kapiʻolani Boulevard to University Avenue, where it would again turn mauka to follow University Avenue over the H-1 Freeway to a proposed terminal facility in UH Mānoa's Lower Campus. A branch line with a transfer point at Ala Moana Center or the Hawaiʻi Convention Center into Waikīkī would follow Kalākaua Avenue to Kūhiō Avenue to end near Kapahulu Avenue (Figure 1-6).

### *Salt Lake Alternative*

The Salt Lake Alternative would leave Kamehameha Highway immediately ʻEwa of Aloha Stadium, cross the Aloha Stadium parking lot, and continue Koko Head along Salt Lake Boulevard (Figure 1-5). It would follow Pūkōloa Street through Māpunapuna before crossing Moanalua Stream, turning makai, crossing the H-1 Freeway and continuing to the Middle Street Transit Center. Stations would be constructed near Aloha Stadium and Ala Lilikoʻi. The total guideway length for this alternative would be approximately 19 miles and it would include 19 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 28 miles and it would include 31 stations.

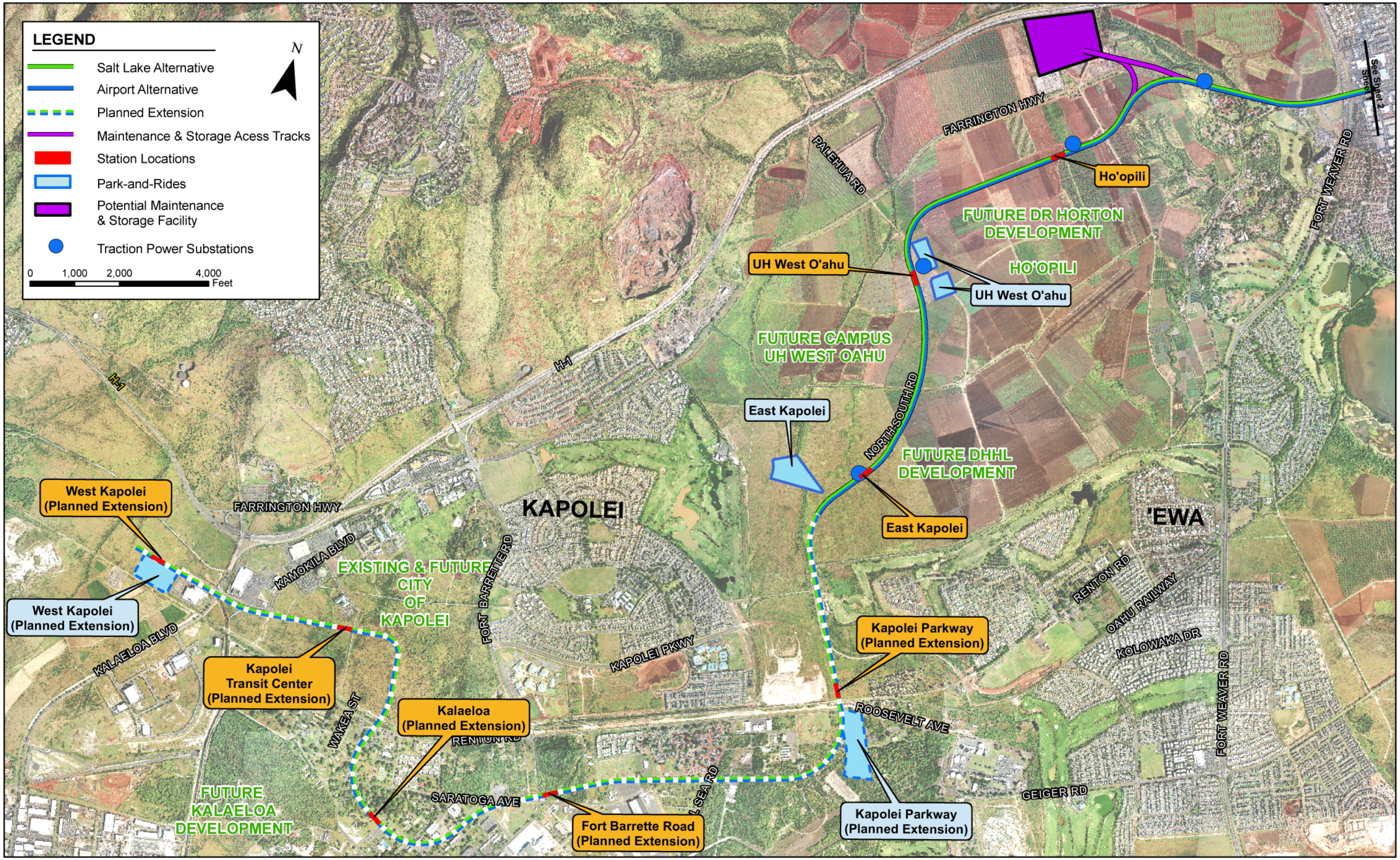


**Figure 1-3: Fixed Guideway Transit Alternative Features (Kapolei to Fort Weaver Road)**

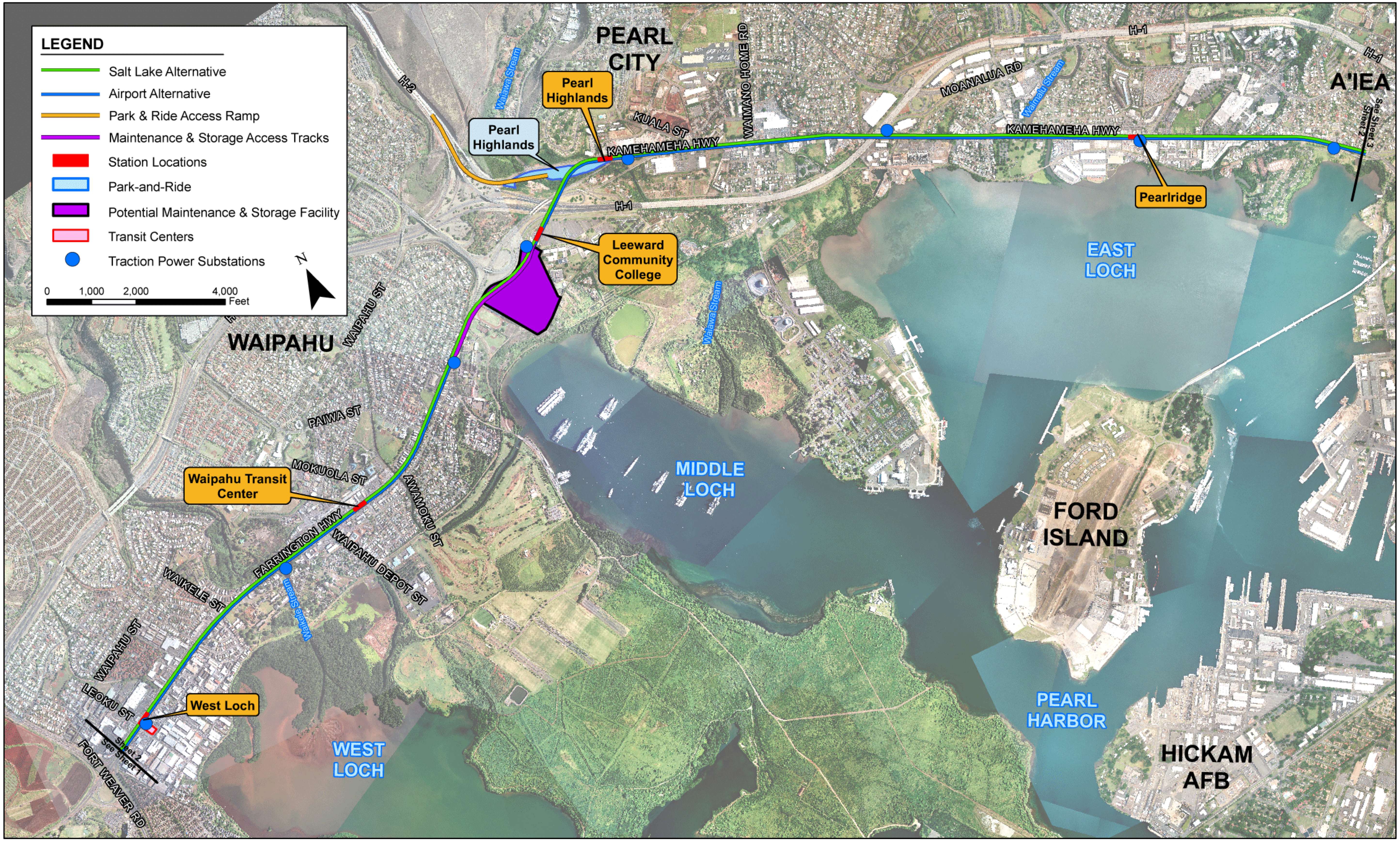


Figure 1-4: Fixed Guideway Transit Alternative Features (Fort Weaver Road to Aloha Stadium)

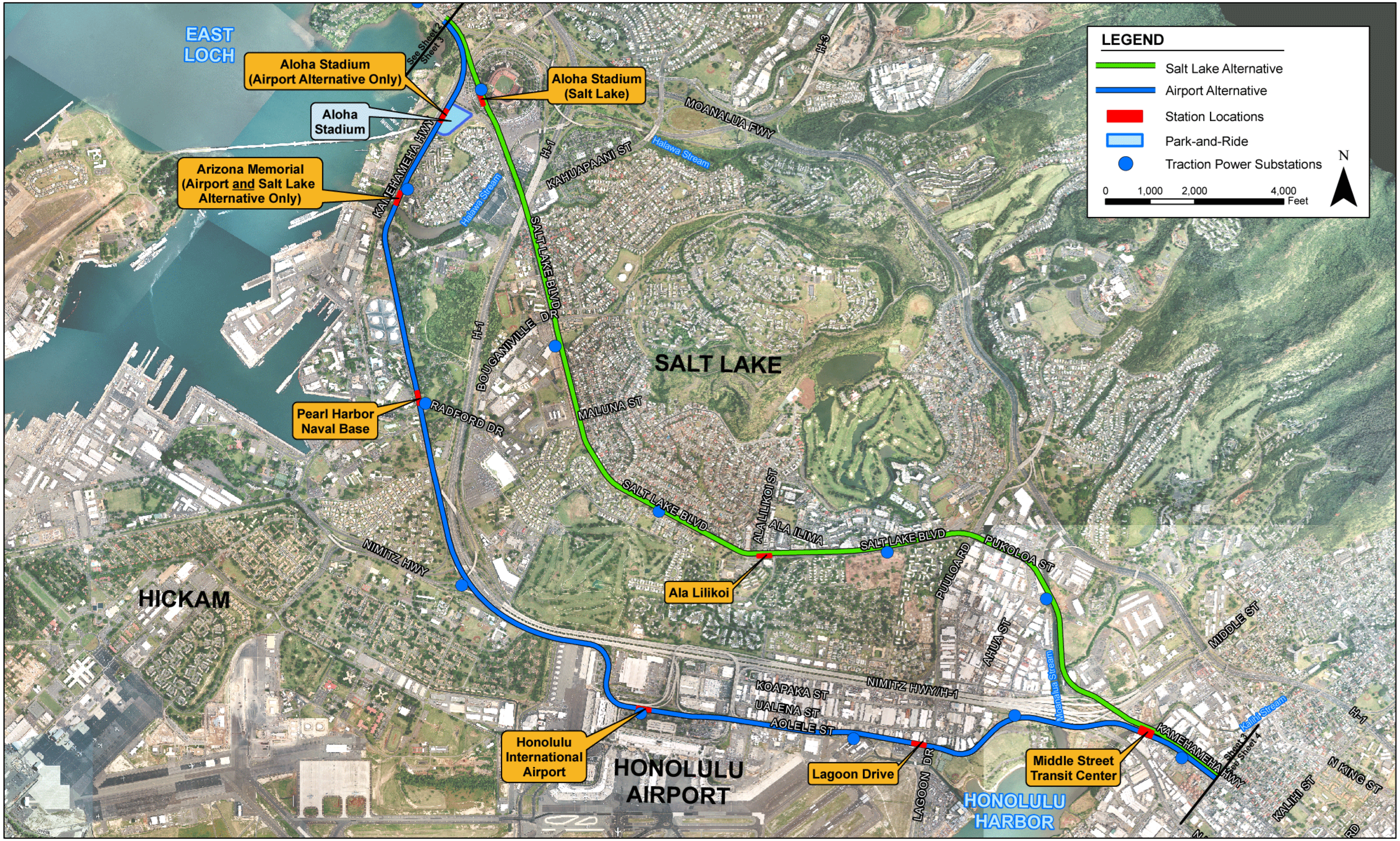


Figure 1-5: Fixed Guideway Transit Alternative Features (Aloha Stadium to Kalihi)

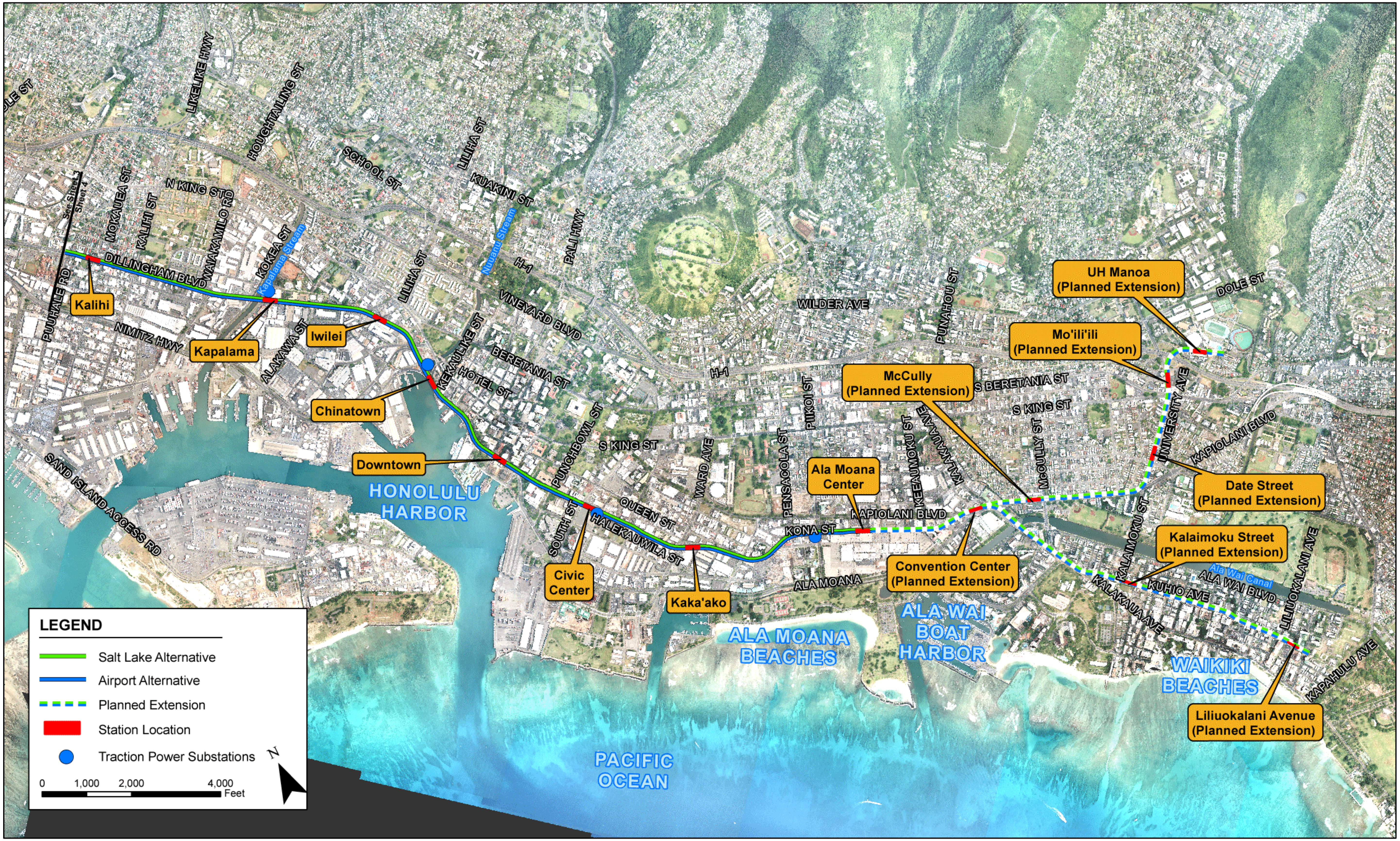


**Figure 1-6: Fixed Guideway Transit Alternative Features (Kalihi to UH Mānoa)**

### *Airport Alternative*

The Airport Alternative would continue along Kamehameha Highway makai past Aloha Stadium to Nimitz Highway and turn makai onto Aolele Street and then follow Aolele Street Koko Head to reconnect to Nimitz Highway near Moanalua Stream and continuing to the Middle Street Transit Center (Figure 1-5). Stations would be constructed at Aloha Stadium, Pearl Harbor Naval Base, Honolulu International Airport, and Lagoon Drive. The total guideway length for this alternative would be approximately 20 miles and it would include 21 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 29 miles and it would include 33 stations.

### *Airport & Salt Lake Alternative*

The Airport & Salt Lake Alternative is identical to the Salt Lake Alternative, with the exception of also including a future fork in the alignment following Kamehameha Highway and Aolele Street at Aloha Stadium that rejoins at Middle Street. The station locations discussed for the Salt Lake Alternative would all be provided as part of this alternative. Similarly, all the stations discussed for the Airport Alternative also would be constructed at a later phase of the project; however, the Aloha Stadium Station would be relocated makai to provide an Arizona Memorial Station instead of a second Aloha Stadium Station. At the Middle Street Transit Center Station, each line would have a separate platform with a mezzanine providing a pedestrian connection between them to allow passengers to transfer. The total guideway length for this alternative would be approximately 24 miles and it would include 23 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 34 miles and it would include 35 stations.

## *1.3.3 Features Common to All Build Alternatives*

In addition to the guideway, the project will require the construction of stations and supporting facilities. Supporting facilities include a maintenance and storage facility, transit centers, park-and-ride lots, and traction power substations (TPSS). The maintenance and storage facility would either be located between North-South Road and Fort Weaver Road or near Leeward Community College (Figure 1-3 and Figure 1-4). Some bus service would be reconfigured to transport riders on local buses to nearby fixed guideway transit stations. To support this system, the bus fleet would be expanded.

# 2 Studies and Coordination

*Air pollution* is a general term that refers to one or more chemical substances that degrade the quality of the atmosphere. *Air quality* describes the amount of pollution in the air. Individual air pollutants degrade the atmosphere by reducing visibility, damaging property, reducing the productivity or vigor of crops or natural vegetation, or reducing human or animal health. This report evaluates the quantity of air pollutant emissions that would occur with each of the project alternatives.

Energy is consumed both directly and indirectly during the construction and operation of transportation projects. The energy consumption required to complete a project is proportional to the project's size and the nature of the work involved. Direct energy consumption includes the energy used to operate construction machinery, provide construction lighting, and produce and transport materials such as asphalt. Indirect energy consumption includes activities such as manufacturing and maintaining construction equipment and the energy consumed by workers commuting to the project site.

Energy used during project operation includes fuel consumed by vehicles in the project area, electricity used to power transit vehicles, and a negligible amount of energy for signals, lighting, and maintenance. Energy consumption depends on the number of vehicle miles traveled (VMT) and travel conditions, such as the vehicle type, speed of travel, roadway grade, and pavement type.

The transportation sector is very energy-dependent on petroleum. In 2006, transportation within the United States consumed approximately 28.4 quadrillion BTUs of energy per year, which is approximately 28.5 percent of the total U.S energy consumption. Transportation energy consumption increased by an annual average of 1.5 percent from 1996 to 2006 (USDOE 2007).

## 2.1 Clean Air Act Amendments of 1990

The Clean Air Act Amendments of 1990 and the Final Transportation Conformity Rule (CFR 2005a and CFR 2005b) direct the U.S. Environmental Protection Agency (EPA) to implement environmental policies and regulations that will ensure acceptable air quality levels. The Clean Air Act and the Final Transportation Conformity Rule affect proposed transportation projects. According to Title I, Section 176 (c) 2:

> "No federal agency may approve, accept or fund any transportation plan, program or project unless such plan, program, or project has been found to conform to any applicable State Implementation Plan (SIP) in effect under this act."

The Final Conformity Rule defines *conformity* as follows:

> "Conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards; and
>
> That such activities will not:
>
> - Cause or contribute to any new violation of any NAAQS in any area,
> - Increase the frequency or severity of any existing violation of any NAAQS in any area, or
> - Delay timely attainment of any NAAQS or any required interim emission reductions or other milestones in any area."

## 2.2 National and State Ambient Air Quality Standards

As required by the Clean Air Act, NAAQS have been established for six major air pollutants. Known as *criteria pollutants*, these are carbon monoxide (CO), nitrogen dioxide ($NO_2$), ozone ($O_3$), particulate matter ($PM_{10}$ and $PM_{2.5}$), sulfur dioxide ($SO_2$) and lead (Pb). The State of Hawai'i has also established ambient air quality standards that are either the same or more stringent than the corresponding Federal standards.

State and Federal standards are summarized in Table 2-1. "Primary" standards have been established to protect public health. "Secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the general welfare.

## 2.3 Criteria Pollutants and Their Effects

Pollutants that have established national standards are referred to as *criteria pollutants*. The sources of these pollutants, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. This section briefly describes each pollutant.

### *2.3.1 Carbon Monoxide*

CO, a colorless gas that interferes with the transfer of oxygen to the brain, is emitted almost exclusively from the incomplete combustion of fossil fuels. Prolonged exposure to high CO levels can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban "street canyon" conditions. Consequently, CO concentrations must be predicted on a localized (or micro-scale) basis.

*Table 2-1: National and State Ambient Air Quality Standards*

| Pollutant | Standards | | |
|---|---|---|---|
| | Hawai'i State Standard | Federal Primary Standard[a] (Health) | Federal Secondary Standard[b] (Welfare) |
| Carbon Monoxide (CO) | | | |
| 1 Hour[1] | 10 µg/m³ (9 ppm) | 40 µg/m³ (35 ppm) | 40 µg/m³ (35 ppm) |
| 8 Hour[1] | 5 µg/m³ (4.5 ppm) | 10 µg/m³ (9 ppm) | 10 µg/m³ (9 ppm) |
| Nitrogen Dioxide ($NO_2$) | | | |
| 1 Hour | ---- | ---- | ---- |
| 24 Hour | ---- | ---- | ---- |
| Annual (Arithmetic) | 70 µg/m³ (0.04 ppm) | 100 µg/m³ (0.05 ppm) | 100 µg/m³ (0.05 ppm) |
| $PM_{10}$[c] | | | |
| 24 Hour[3] | 150 µg/m³ | 150 µg/m³ | 150 µg/m³ |
| Annual (Arithmetic)[2] | 50 µg/m³ | Revoked | Revoked |
| $PM_{2.5}$[d] | | | |
| 24 Hour[5] | ---- | 35 µg/m³ | 35 µg/m³ |
| Annual (Arithmetic)[4] | ---- | 15 µg/m³ | 15 µg/m³ |
| Ozone ($O_3$) | | | |
| 8 Hour[6] | 157 µg/m³ (0.08 ppm) | 157 µg/m³ (0.08 ppm) | 157 µg/m³ (0.08 ppm) |
| Sulfur Dioxide ($SO_2$) | | | |
| 3 Hour[1] | 1,300 µg/m³ (0.5 ppm) | ---- | 1,300 µg/m³ (0.5 ppm) |
| 24 Hour[1] | 365 µg/m³ (0.14 ppm) | 365 µg/m³ (0.14 ppm) | ---- |
| Annual (Arithmetic) | 80 µg/m³ (0.03 ppm) | 80 µg/m³ (0.03 ppm) | ---- |
| Lead (Pb) | | | |
| 3 Months (Arithmetic) | 1.5 µg/m³ | 1.5 µg/m³ | 1.5 µg/m³ |
| Hydrogen Sulfide ($H_2S$) | | | |
| 1 Hour | 35 µg/m³ | ---- | ---- |

µg/m3 = micrograms per cubic meter

ppm = parts per million

[a] Designated to prevent against adverse effects on public health

[b] Designated to prevent against adverse effects on public welfare, including effects on comfort, visibility, vegetation, animals, aesthetic values, and soiling and deterioration of materials.

[c] Particulate matter 10 microns or less in diameter

[d] Particulate matter 2.5 microns or less in diameter

[1] Not to be exceeded more than once per year

[2] Due to lack of evidence linking health problems to long-term exposure to coarse particle pollution, the EPA revoked the annual $PM_{10}$ standard in 2006 (effective December 17, 2006).

[3] Not to be exceeded more than once per year on average over three years.

[4] To attain this standard, the three-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m³.

[5] To attain this standard, the three-year average of the 98th-percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³ (effective December 17, 2006).

[6] To attain this standard, the three-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

*Sources: State of Hawai'i, Department of Health, Clean Air Branch—Hawai'i Administrative Rules, Chapter 59.*
*CFR Title 40, Part 50, http://www.Hawai'i.gov/health/environmental/air/chart.pdf, accessed December 10, 2007.*
*EPA, National Ambient Air Quality Standards; http://www.epa.gov/air/criteria.html, accessed December 10, 2007.*

### 2.3.2 Nitrogen Dioxide

$NO_2$ is a brownish gas that irritates the lungs. $NO_2$ can cause breathing difficulties at high concentrations. Like $O_3$, $NO_2$ is not directly emitted but formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and $NO_2$ are collectively referred to as *nitrogen oxides* ($NO_x$) and are major contributors to ozone formation. $NO_2$ also contributes to the formation of $PM_{10}$, small liquid and solid particles that are less than 10 microns in diameter (see the following discussion of $PM_{10}$). At atmospheric concentration, $NO_2$ is only potentially irritating. In high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between $NO_2$ and chronic pulmonary fibrosis. Some increase in bronchitis in children (two to three years old) has also been observed at concentrations below 0.3 parts per million (ppm).

### 2.3.3 Particulate Matter

Particulate matter pollution is composed of solid particles or liquid droplets small enough to remain suspended in the air. This can include dust, soot, smoke, salts, acids, and metals and can be irritating but is usually not poisonous. Particulate matter pollution can also form when industry and gases emitted from motor vehicles and industry undergo chemical reactions in the atmosphere. The main health effect of airborne particulate matter is on the respiratory system.

Particulate matter pollution can also include bits of solid or liquid substances that can be highly toxic. Of particular concern are particles smaller than or equal to 10 microns ($PM_{10}$) and 2.5 microns ($PM_{2.5}$) in diameter.

$PM_{10}$ refers to particulate matter less than 10 microns in diameter, or about $1/7^{th}$ the thickness of a human hair (Figure 2-1). Major sources of $PM_{10}$ include motor vehicles; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. These suspended particulates produce haze and reduce visibility.

Data collected through numerous nationwide studies indicates that most $PM_{10}$ comes from fugitive dust, wind erosion, and agricultural and forestry sources.

$PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly $1/28^{th}$ the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. $PM_{2.5}$ can also be formed in the atmosphere from gases such as $SO_2$, $NO_x$, and VOC. Like $PM_{10}$, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, but particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.

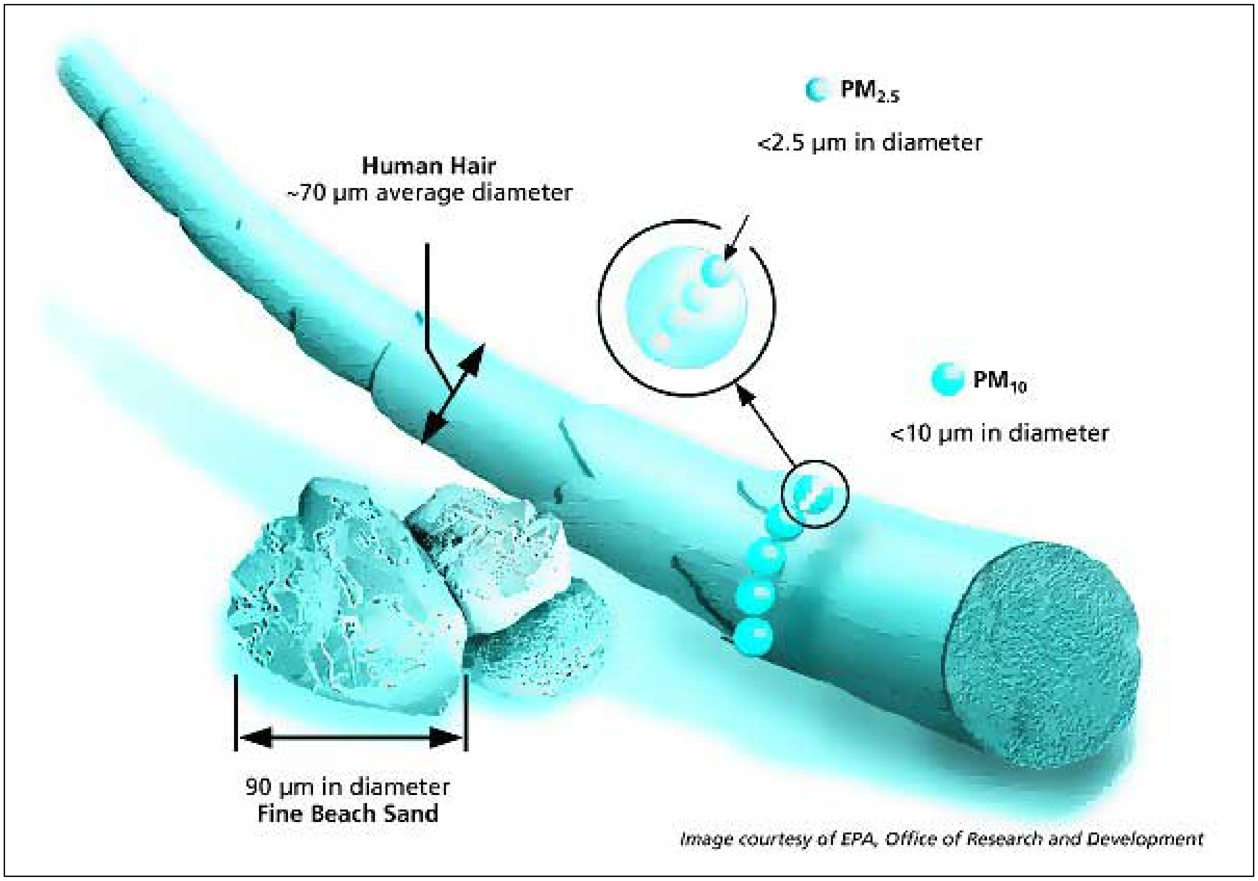


**Figure 2-1: Relative Particulate Matter Size**

### 2.3.4 Ozone

$O_3$ is a colorless toxic gas that enters the blood stream and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. $O_3$ also damages vegetation by inhibiting its growth. Although $O_3$ is not directly emitted, it forms in the atmosphere through a chemical reaction between VOC and $NO_x$, which are emitted from industrial sources and automobiles. Substantial $O_3$ formations generally require a stable atmosphere with strong sunlight.

### 2.3.5 Sulfur Dioxide

$SO_2$ is a product of high-sulfur fuel combustion. The main sources of $SO_2$ are coal and oil used in power stations, industry, and domestic heating. Industrial chemical manufacturing is another source. $SO_2$ is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator (pulmonary) function in children. $SO_2$ can also yellow plant leaves and erode iron and steel.

### 2.3.6 Lead

Pb is a stable element that persists and accumulates in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline.

### *2.3.7 Hydrogen Sulfide*

Hawai‘i has developed a standard for hydrogen sulfide ($H_2S$). $H_2S$ is a colorless, toxic, flammable gas that causes the foul odor of rotten eggs. It often results when bacteria breaks down organic matter in the absence of oxygen. It also occurs in volcanic gases. $H_2S$ is considered a broad-spectrum poison, meaning that it can poison several different systems in the body, although the nervous system is most affected.

## 2.4 Mobile Source Air Toxics

In addition to the criteria pollutants addressed in the NAAQS, the EPA regulates air toxics. Toxic air pollutants are those known or suspected to cause cancer or other serious health effects. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners) and stationary sources (e.g., factories or refineries).

The Clean Air Act identified 188 air toxics. In 2001, the EPA identified 21 MSATs and highlighted six as priority MSATs. Since 2001, the EPA has conducted an extensive review of the literature and produced a list of the compounds identified in exhaust or evaporative emissions from on-road and non-road sources and from alternative fuels. This list currently includes approximately 1,000 compounds, many emitted in trace amounts.

In February 2007, the EPA finalized the *Control of Hazardous Air Pollutants from Mobile Sources* rule to reduce hazardous air pollutants from mobile sources (EPA 2007). This rule limits the benzene content of gasoline and reduces toxic emissions from passenger vehicles and gas cans. The EPA estimates that in 2030 this rule will reduce total emissions of MSATs by 330,000 tons and VOC emissions (precursors to ozone and $PM_{2.5}$) by over 1 million tons.

By 2010, the EPA’s existing programs will reduce MSAT emissions by over one million tons nationwide from 1999 levels. In addition to controlling pollutants such as hydrocarbons, particulate matter, and nitrogen oxides, recent EPA regulations that control emissions from highway vehicles and non-road equipment will also result in large air toxic reductions. The EPA is also developing programs that would provide additional benefits from further controls on small non-road gasoline engines and diesel locomotive and marine engines. The EPA has also developed a variety of programs to reduce risk in communities, such as Clean School Bus USA, the Voluntary Diesel Retrofit Program, Best Workplaces for Commuters, and National Clean Diesel Campaign.

## 2.5 Air Quality Levels and Compliance

Section 107 of the 1977 Clean Air Act Amendments requires the EPA to publish a list of all geographic areas that are in compliance with the NAAQS and areas that do not attain the NAAQS. Areas not in compliance are called *nonattainment areas*. Areas for which insufficient data is available to make a determination are *unclassified*, and treated as being in compliance (*attainment areas*) until proven otherwise. Designation of an area is made on a pollutant-by-pollutant basis. The entire State of Hawai‘i is designated as an attainment area for CO, $O_3$, $PM_{10}$, and $PM_{2.5}$.

Transportation projects are analyzed as part of a regional transportation network developed by a County or State. The Hawai‘i Statewide Transportation Plan goals are to:

- Achieve an integrated multimodal transportation system that provides mobility and accessibility for people and goods;
- Ensure the safety and security of the air, land, and water transportation systems;
- Protect and enhance Hawai‘i’s unique environment and improve the quality of life;
- Support Hawai‘i’s economic vitality; and
- Implement a statewide planning process that is comprehensive, cooperative, and continuing.

Projects included in Hawai‘i’s regional transportation network are found in the Transportation Improvement Plan. The Honolulu High-Capacity Transit Corridor Project is listed in the area’s Transportation Improvement Plan and complies with the goals set forth in the Statewide Transportation Plan.

## 2.6 Energy

### *2.6.1 Energy Units*

Energy is commonly measured in British Thermal Units (BTUs). Because these are relatively small units, energy is often reported in million BTUs (MBTUs). Even larger amounts of energy are reported in Terra BTUs (million MBTUs). One gallon of gasoline contains approximately 0.125 MBTUs. One gallon of diesel fuel contains approximately 0.139 MBTUs.

### *2.6.2 Energy Consumed by Transit Operations*

Fixed-guideway high-capacity transit systems consume energy directly for propulsion. They also consume energy indirectly, through energy lost during transmission from the energy generation site to the transit vehicles.

Transit energy consumption depends on numerous variables. Some of these include: vehicle size, type, weight, and efficiency; passenger-related load factors; system grade; spacing of stations; operational issues such as acceleration, deceleration, and top and average speeds; throttle positions; horsepower-to-weight ratio; and deadheading requirements. These variables result in a wide range of operational energy requirements.

Previous studies have documented energy consumption of between 50,000 and 100,000 BTUs per transit vehicle mile of service (Caltrans 1983). The average energy consumption for a rail transit vehicle in the United States is 62,720 BTUs per vehicle mile of travel (USDOE 2007).

### *2.6.3 Energy Consumed by Roadway Vehicles*

Vehicle fuel consumption is the primary component of operating costs paid by individual users of transportation facilities. Road geometry, surface conditions, and traffic flows substantially affect the operating efficiency of vehicles, and consequently affect total energy consumption.

For the various project alternatives, fuel consumption rates can be differentiated by comparing changes in traffic operations, as measured by VMT and changes in traffic speed. Fuel consumption is proportional to distance traveled, and decreases as speed increases up to about 30 miles per hour (mph). Fuel economy is fairly flat between about 30 mph and 60 mph and decreases as speed increases above that point (USDOE 2007) (Figure 2-2).

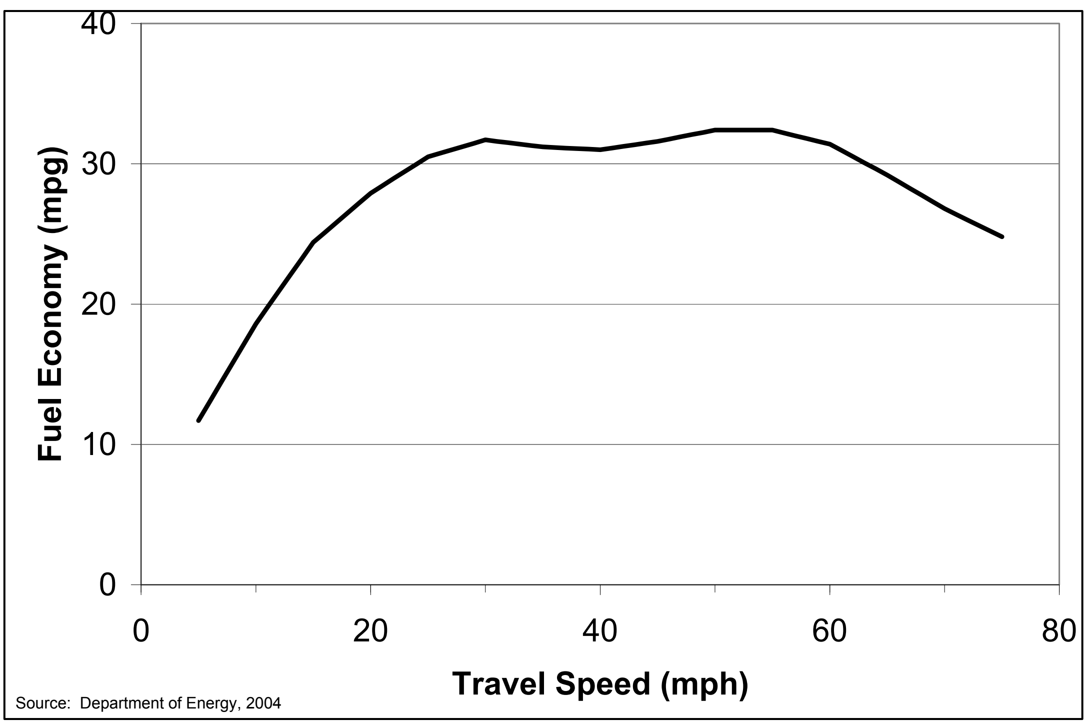


**Figure 2-2: Average Automobile Fuel Economy in Relation to Speed**

# 3 Methodology

The Project would affect travel patterns within the study area, so pollutants that can be traced principally to motor vehicles are relevant in evaluating project impacts. These pollutants include CO, VOC, $NO_x$, $PM_{10}$, $PM_{2.5}$ and MSAT, which are discussed in previous sections. The regional impacts of these pollutants were evaluated for the Project (see Chapter 5, Consequences). Transportation sources only account for a small percentage of regional $SO_2$ and Pb emissions, so a detailed analysis of these pollutants was not required.

## 3.1 Regional Air Quality Analysis

A regional mobile source pollutant burdens analysis, based on link-by-link VMT and speed was conducted for each of the Build Alternatives compared to the No Build Alternative. Pollutants analyzed included VOC, $NO_x$, $PM_{10}$, $PM_{2.5}$ and CO. VMT and the associated traffic simulation network speeds were used. Emissions factors were obtained through the EPA's mobile source emission model, MOBILE6.2, in accordance with the Hawai'i Department of Health Clean Air Branch's recommendation. This analysis compares regional pollutant burdens (the total quantity of each pollutant released in the region) for each alternative. Changes in regional emission levels were estimated to describe the potential effect that the alternatives may have on regional air quality.

## 3.2 Mobile Source Air Toxics

MSAT impacts are both regional and local. EPA's Final Rule regarding emission control of Hazardous Air Pollutants from Mobile Sources (66FR17229) determined that many existing and newly promulgated mobile source emission control programs would result in a reduction of MSATs. The Federal Highway Administration (FHWA) projects that even if an area experienced a 64-percent increase in VMT, these programs will reduce on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 57 to 65 percent, and will reduce on-highway diesel PM emissions by 87 percent within the area (FHWA 2006). As a result, the EPA concluded that no further motor vehicle emission standards or fuel standards are necessary to further control MSATs.

On February 3, 2006, the FHWA issued Interim Guidance regarding MSAT analysis in NEPA documentation. Given the emerging state of the science and of project-level analysis techniques regarding MSAT, no established criteria exist for determining when MSAT emissions should be considered a significant issue. FHWA has suggested the following three-tiered approach to determining potential project-induced MSAT impacts:

- Tier 1—No analysis for projects that have no potential for meaningful MSAT effects
- Tier 2—Qualitative analysis for projects with a low potential for MSAT effects
- Tier 3—Quantitative analysis to differentiate alternatives for projects with a higher potential for MSAT effects

FHWA has developed this approach because the technical tools currently available are not able to predict the project-specific health impacts of emission changes associated with project alternatives. Based on this recommended tiering approach, the Project falls within the Tier 2 approach.

## 3.3 Microscale CO Analysis

Currently, local traffic impacts have not been calculated for the Project, so CO screening based on intersection level-of-service and delay cannot be conducted.

The study area is currently in attainment for CO and monitored values of CO are less than 20 percent of the applicable NAAQS. Therefore, no violations of the applicable NAAQS are likely to occur with the Project.

## 3.4 Energy Analysis

### *3.4.1 Project Operation*

Analysis of operational energy consumption within the project study area was based on the transportation analyses prepared for the Project and proposed transit operations. Net changes in overall transportation energy use in the study area were assessed using daily VMT and speed calculated from the transportation demand forecasting model for the study area. Energy consumed by electrically powered transit operations for the Build Alternatives was also calculated. The indirect energy required to transport fuel and materials to Hawai‘i has been omitted, because this would tend to comprise the same proportion of energy consumption for each alternative.

The alternatives were compared based on daily differences in fuel consumed by traveling automotive vehicles (USDOT 1980). This value is approximate for each alternative and does not include several factors, such as energy consumption for facility maintenance and signal operation. However, this value provides an appropriate basis for comparing the alternatives.

Estimates of operational energy requirements for the fixed guideway system are based on calculations of direct propulsion energy and indirect energy needs, such as energy lost during transmission from the energy generation site to the transit system vehicles. Propulsion energy consumption for a rail transit, high-capacity transit system typically ranges from 50,000 to 100,000 BTUs per vehicle mile (Caltrans 1983). The Department of Energy estimates a typical rail transit vehicle’s energy consumption to be 62,720 BTUs per vehicle mile of travel (USDOE 2007).

### 3.4.2 Project Construction

Direct one-time energy consumption for roadway projects is much greater than indirect energy consumption, and indirect energy consumption is difficult to define. Because of these factors, only direct energy consumption was considered in this evaluation. (See Chapter 2 for an explanation of direct and indirect energy consumption.)

Construction energy consumption was estimated for each alternative, by estimating the energy consumed based on the construction of major project elements. An approximate construction energy consumption factor for roadway elements on a structure ranges from 220,000 to 275,000 MBTUs per mile of structure, depending on its width. Placement of the roadway surface increases the energy required by an additional 3,000 to 4,000 MBTUs per mile of roadway.

For the at-grade portions of the high-capacity transit system, a construction energy estimate of 20,000 MBTUs per track mile constructed was used (Caltrans 1983). This figure includes installing the system's track and power systems. A construction energy estimate of 150,000 MBTUs per track mile constructed was added for elevated portions of the alignment. This accounts for the energy required to construct the elevated support structure.

# 4 Affected Environment

## 4.1 Local Meteorology

O‘ahu, the island on which Honolulu is located, is the third-largest of the Hawaiian Islands. The Ko‘olau Range, at an average elevation of 2,000 feet, parallels the northeastern coast. The Wai‘anae Mountains, somewhat higher in elevation, parallel the west coast. Honolulu International Airport, the business and Waikīkī districts, and a number of Honolulu’s residential areas lie along the southern coastal plain.

Hawai‘i’s climate is unusually pleasant for the tropics. Its outstanding features are the persistence of the trade winds, the remarkable variability in rainfall over short distances, the sunniness of the leeward lowlands in contrast to the persistent cloudiness over nearby mountain crests, the equable temperature, and the general infrequency of severe storms. The prevailing wind throughout the year is the northeasterly trade wind, although its average frequency varies from over 90 percent during the summer to only 50 percent in January.

Heavy mountain rainfall sustains extensive irrigation of cane fields and Honolulu’s water supply. O‘ahu is driest along the coast west of the Waianae Mountains, where rainfall drops to about 20 inches a year. Daytime showers, usually light, often occur while the sun continues to shine—a phenomenon referred to locally as “liquid sunshine.”

The moderate temperature range is associated with the small seasonal variation in energy received from the sun and the tempering effect of the surrounding ocean. Honolulu International Airport has recorded temperatures as high as the lower 90s and as low as the lower 50s.

Because of the trade winds, even the warmest months are usually comfortable. However, when the trade winds diminish or give way to southerly winds—a situation known locally as “kona weather” or “kona storms” when stormy—the humidity may become oppressively high.

Intense rains in the October to April winter season sometimes cause serious flash flooding. Thunderstorms are infrequent and usually mild, and hail seldom occurs. Infrequently, a small tornado or waterspout may cause some damage. Only a few tropical cyclones have struck Hawai‘i, although others have come near enough for their outlying winds, waves, clouds, and rain to affect the Islands.

Hawai‘i experiences very good air quality as a result of the prevailing strong trade winds and very low background concentrations of air pollutants.

## 4.2 Monitored Air Quality

Air pollutant levels in Hawai‘i are monitored by a network of sampling stations operated under the supervision of the Hawai‘i Department of Health at various locations around O‘ahu. The monitoring locations used for this study are listed in Table 4-1, which summarizes the pollutants monitored at each station.

*Table 4-1: Ambient Air Quality Monitoring Data 2004-2006*

| Air Pollutant | Standards and Exceedances | Sand Island University of Hawai'i Anuenue Fisheries | | | Honolulu Department of Health 1250 Punchbowl Street | | | Pearl City Leeward Medical Center 860 4th Street | | | Kapolei 2052 Lauwiliwili Street Kapolei Business Park | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2004 | 2005 | 2006 | 2004 | 2005 | 2006 | 2004 | 2005 | 2006 | 2004 | 2005 | 2006 |
| Carbon Monoxide (CO) | Max. 1-hr Concentration (µg/m$^3$) | NM | NM | NM | 2736 | 3876 | 2850 | NM | NM | NM | 2394 | 1710 | 1596 |
| | Max. 8-hr Concentration (µg/m$^3$) | NM | NM | NM | 1496 | 1610 | 1226 | NM | NM | NM | 983 | 1055 | 1183 |
| | # Days>Federal 1-hr Std. of >40,000 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| | # Days>State 1-hr Std. of >10,000 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| | # Days>Federal 8-hr Std. of >10,000 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| | # Days>State 8-hr Std. of >5,000 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| Ozone ($O_3$) | Max. 8-hr Concentration (µg/m$^3$) | 110 | 92 | 83 | NM | NM | NM | NM | NM | NM | NM | NM | NM |
| | # Days>Federal & State 8-hr Std. >157µg/m$^3$ | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| Nitrogen Dioxide ($NO_2$) | Annual Arithmetic Mean (µg/m$^3$) | NM | NM | NM | NM | NM | NM | NM | NM | NM | 9 | 9 | 9 |
| | #>Federal Annual Mean Std. of >100 µg/m$^3$ | - | - | - | - | - | - | - | - | - | 0 | 0 | 0 |
| Sulfur Dioxide ($SO_2$) | 3-hr Concentration (µg/m$^3$) | NM | NM | NM | 56 | 75 | 43 | NM | NM | NM | 17 | 64 | 12 |
| | 24-hr Concentration (µg/m$^3$) | NM | NM | NM | 25 | 23 | 13 | NM | NM | NM | 7 | 21 | 8 |
| | Annual Mean Concentration (µg/m$^3$) | NM | NM | NM | 1 | 1 | 1 | NM | NM | NM | 1 | 2 | 5 |
| | # >Fed. & State 3-hr Std. of 1300 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| | # Days>Fed. & State 24-hr Std. 365 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| | # >Federal & State Annual Std. of 80 µg/m$^3$ | - | - | - | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 |
| Suspended Particulates ($PM_{2.5}$) | Max. 24-hr Concentration (µg/m$^3$) | 10 | 13 | 10 | 20*/10 | 45* | 10 | 103*/10 | 88 | 51* | 20*/7 | 55* | 34* |
| | Annual Mean Concentration (µg/m$^3$) | 5 | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| | # Days>Fed. 24-hr Std. of >65 µg/m$^3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | #>Federal Annual Mean Std. of 15 µg/m$^3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lead (Pb) | Max. Quarterly Avg. Concentration (µg/m$^3$) | NM | NM | NM | NM | NM | NM | NM | NM | NM | NM | NM | NM |
| | # Months Exceeding Federal Std. of 1.5 µg/m$^3$ | - | - | - | - | - | - | - | - | - | - | - | - |
| | # Months Exceeding State Std. of 1.5 µg/m$^3$ | - | - | - | - | - | - | - | - | - | - | - | - |

*Flagged value due to fireworks; the highest non-flagged value recorded in the year is given next to the flagged value
NM = Not Measured
*Source: State of Hawai'i—Department of Health, Clean Air Branch, 2004, 2005, 2006 Annual Summaries*

## 4.3 Existing Energy Consumption

Total energy consumption in the State of Hawai‘i was 325 Terra BTUs in 2004 (DBEDT 2006). Approximately 90 percent of the energy consumed in Hawai‘i is derived from petroleum. Transportation accounts for approximately 34 percent of all energy consumption in Hawai‘i (DBEDT 2006). In 2004, 292 million gallons of gasoline (38 Terra BTUs) were consumed by motor vehicles on the Island of O‘ahu (Figure 4-1). Gasoline consumption increased approximately 1.5 percent annually on O‘ahu between 1990 and 2004. Gasoline represents the largest segment of transportation energy consumption, closely followed by aviation fuel, then by diesel.

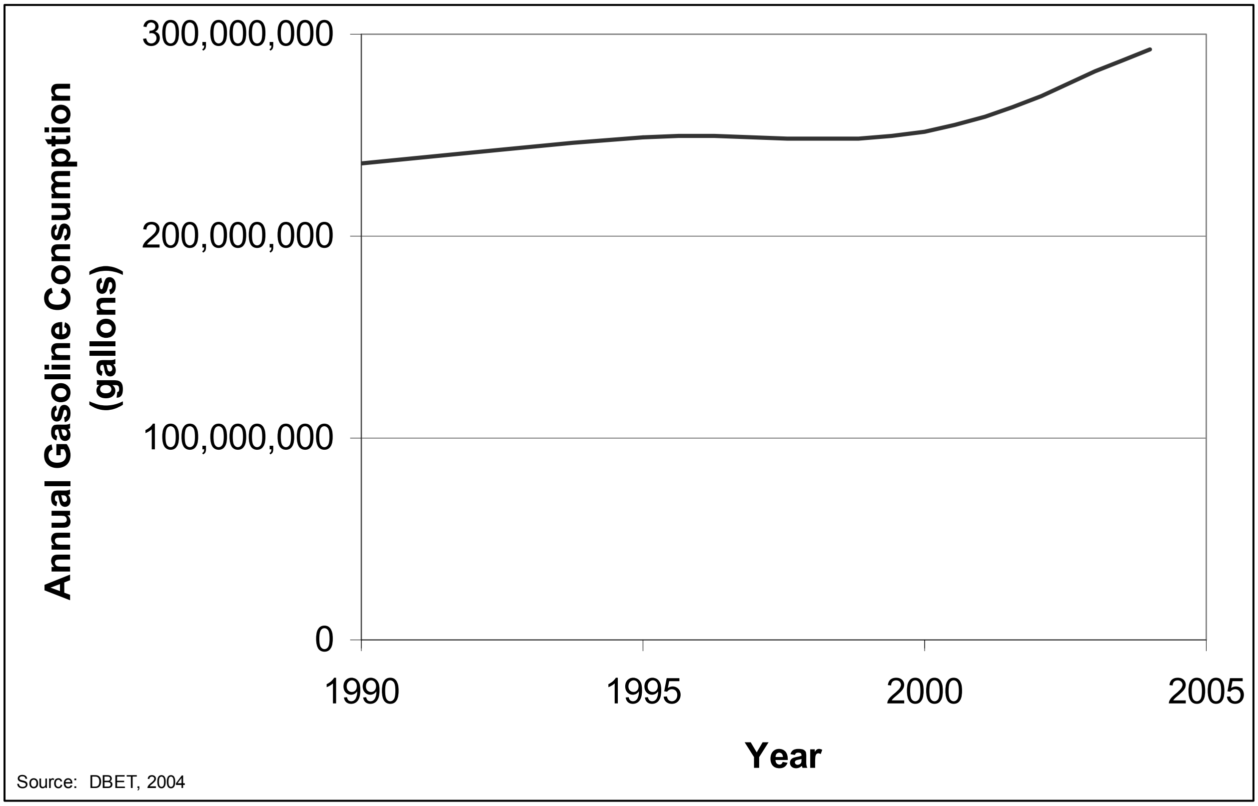


**Figure 4-1: Island of O‘ahu Gasoline Consumption Trend**

*Source: DBEDT 2006*

Transportation modeling results for 2007 show that approximately 11.6 million vehicle miles are traveled daily in the study corridor. This results in a daily consumption of approximately 666,000 gallons of fuel with an energy content of 85,600 MBTUs. In 2007, the peak electrical load on O‘ahu was 1,261 megawatts (MW) (HECO 2008).

## 5.1 Regional Effects on Criteria Pollutant Emissions

Table 5-1 shows the results of the analysis of VOC, CO, $NO_x$, $PM_{10}$ and $PM_{2.5}$ for each of the Build Alternatives compared to the No Build Alternative. If the electricity used to operate the Build Alternatives is generated by combustion, this may produce additional emissions. However, these emissions would be offset in whole or part by the reductions generated by reduced VMT. Furthermore, power plant emissions may be much more easily controlled than emissions from individual automobiles.

### 5.1.1 No Build Alternative

The No Build Alternative provides a baseline to which other alternatives may be compared. With this alternative, 6,854 kilograms (kg) of VOC, 147,464 kg of CO, 4,482 kg of $NO_x$, 375 kg of $PM_{10}$, and 174 kg of $PM_{2.5}$ are predicted to be generated daily by transportation sources within the study corridor in 2030 (Table 5-1).

### 5.1.2 Salt Lake Alternative

With the Salt Lake Alternative, the Full Project is predicted to demonstrate a 3.9-percent reduction in VMT compared to the No Build Alternative. This would result in predicted pollution reductions ranging from 3.7 to 4.1 percent, compared to the No Build Alternative.

With this alternative, the First Project is predicted to demonstrate a 3.6-percent reduction in VMT compared to the No Build Alternative. This would result in predicted pollution reductions ranging from 3.3 to 3.9 percent, compared to the No Build Alternative.

### 5.1.3 Airport Alternative

With the Airport Alternative, the Full Project is predicted to demonstrate a 4.0-percent reduction in VMT. This would result in predicted pollution reductions ranging from 3.7 to 4.4 percent, compared to the No Build Alternative.

With this alternative, the First Project is predicted to demonstrate a 3.7-percent reduction in VMT compared to the No Build Alternative. This would result in predicted pollution reductions ranging from 3.4 to 4.0 percent, compared to the No Build Alternative.

***Table 5-1: 2030 Regional Pollutant Burdens (kg/day)***

| | VMT (miles/day) | Percent Change from No Build | Emission Burden (kg/day) | | | | | Percent Change from No Build | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VOC | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOC | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ |
| No Build Alternative | | | | | | | | | | | | |
| | 13,583,000 | NA | 6,854 | 147,464 | 4,842 | 375 | 174 | NA | NA | NA | NA | NA |
| Salt Lake Alternative | | | | | | | | | | | | |
| Full Project | 13,048,000 | -3.9% | 6,571 | 142,011 | 4,659 | 360 | 167 | -4.1% | -3.7% | -3.8% | -4.0% | -4.0% |
| First Project | 13,097,000 | -3.6% | 6,585 | 142,616 | 4,678 | 361 | 168 | -3.9% | -3.3% | -3.4% | -3.7% | -3.4% |
| Airport Alternative | | | | | | | | | | | | |
| Full Project | 13,038,000 | -4.0% | 6,554 | 142,056 | 4,659 | 360 | 167 | -4.4% | -3.7% | -3.8% | -4.0% | -4.0% |
| First Project | 13,086,000 | -3.7% | 6,580 | 142,500 | 4,674 | 361 | 167 | -4.0% | -3.4% | -3.5% | -3.7% | -4.0% |
| Airport & Salt Lake Alternative | | | | | | | | | | | | |
| Full Project | 13,044,000 | -4.0% | 6,560 | 142,087 | 4,660 | 360 | 167 | -4.3% | -3.6% | -3.8% | -4.0% | -4.0% |
| First Project | 13,104,000 | -3.5% | 6,588 | 142,694 | 4,680 | 362 | 168 | -3.9% | -3.2% | -3.3% | -3.5% | -3.4% |

NA = Not Applicable

### 5.1.4 Airport & Salt Lake Alternative

With the Airport & Salt Lake Alternative, the Full Project is predicted to demonstrate a 4.0-percent reduction in VMT compared to the No Build Alternative. This would result in predicted pollution reductions ranging from 3.6 to 4.3 percent, compared to the No Build Alternative.

The First Project is predicted to demonstrate a 3.5-percent reduction in VMT compared to the No Build Alternative. This would result in predicted pollution reductions ranging from 3.2 to 3.9 percent, compared to the No Build Alternative.

## 5.2 Mobile Source Air Toxics

Based on the recommended three-tiered approach discussed in Chapter 3, the Project falls within the Tier 2 approach. The amount of MSATs emitted would be proportional to the VMT, assuming the vehicle mix does not change. As shown in Table 5-1, all the Build Alternatives are predicted to decrease overall VMT. This reduction ranges from 3.5 to 4.0 percent. Considering these slight reductions in overall VMT levels, the Project may produce some small, though not quantifiable, beneficial effects on regional MSAT levels.

Because of the Project's fixed guideway aspect, VMT may increase in localized areas (e.g., station locations) and decrease in other areas. Therefore, it is possible that localized increases and decreases in MSAT emissions may occur. However, even if these increases do occur, they too will be substantially reduced due to implementation of EPA's vehicle and fuel regulations.

In summary, the Build Alternatives are expected to have a small positive effect on MSAT emissions in the project study area, compared to the No Build Alternative. Because only small changes (between 3.5 and 4.0 percent) in VMT are expected with the Build Alternatives, these benefits would likely be immeasurable. In comparing various project alternatives, MSAT levels could be higher in some locations than others, but current tools and science are not adequate to quantify these levels. However for all alternatives, EPA's vehicle and fuel regulations coupled with fleet turnover will over time result in substantial reductions that are expected to lower region-wide MSAT levels from current levels.

# 5.3 Energy

## 5.3.1 No Build Alternative

Although the No Build Alternative assumes completion of projects included in the 2030 ORTP, no construction would be undertaken as part of the Honolulu High-Capacity Transit Corridor Project. The impacts associated with developing the individual projects listed in this plan are not detailed in this evaluation, because these projects will undergo planning and environmental review as part of their individual development processes.

Transportation energy consumption for the No Build Alternative would include motor vehicle fuel consumption islandwide (Table 5-2). Energy would be consumed during construction of elements of the No Build Alternative, but this energy would also be consumed for all of the Build Alternatives and will be considered in the environmental analysis of the individual projects.

Peak electrical load on O‘ahu is projected to be approximately 1,700 MW and total electricity consumption around 10,000 gigawatt hours (GWH) in 2030 according to Hawaiian Electric Company (HECO) projections (HECO 2008).

***Table 5-2: Average Daily Motor Vehicle Energy Consumption***

| Alternative | Vehicle Miles Traveled | Fuel Consumption (gallons) | Energy Consumption (MBTUs)[1] |
|---|---|---|---|
| 2007 Existing Energy Consumption | | | |
| 2007 Existing Conditions | 11,581,000 | 666,015 | 85,551 |
| 2030 Energy Consumption | | | |
| No Build | 13,583,000 | 736,950 | 94,610 |
| Salt Lake | | | |
| Full Project | 13,048,000 | 707,371 | 90,812 |
| First Project | 13,097,000 | 709,474 | 91,082 |
| Airport | | | |
| Full Project | 13,038,000 | 706,319 | 90,677 |
| First Project | 13,086,000 | 708,936 | 91,013 |
| Airport & Salt Lake | | | |
| Full Project | 13,044,000 | 706,567 | 90,709 |
| First Project | 13,104,000 | 709,863 | 91,132 |

[1]MBTUs = million BTUs

### 5.3.2 Salt Lake Alternative

Motor vehicle energy consumption for this alternative is shown in Table 5-2. With completion of the Full Project, motor vehicles would consume 90,812 MBTUs of energy per day. With the First Project, they would consume 91,082 MBTUs of energy per day.

In addition to motor vehicle energy consumption, electricity would be consumed to power the fixed guideway transit system. The amount of electricity required would depend on the length of the alignment and the number of daily transit-vehicle trips. Based on the assumptions presented in Table 5-3, the Salt Lake Alternative would require 1,714 MBTUs and 1,163 MBTUs daily for the Full and First Projects, respectively (Table 5-3). Using an annualization factor of 308, this corresponds to an annual electricity demand of 143 GWH for the Full Project and 105 GWH for the First Project. These values represent 1 to 2 percent of the total projected electricity demand on O‘ahu for 2030.

***Table 5-3: 2030 Average Daily Energy Consumption of Fixed Guideway Transit System***

| Alternative | Approximate Length (miles) | Daily Vehicle Trips[1] | Energy Consumption (MBTUs)[2] |
|---|---|---|---|
| Salt Lake | | | |
| Full Project[3] | 28 | 976 | 1,714 |
| First Project | 19 | 976 | 1,163 |
| Airport | | | |
| Full Project[3] | 29 | 976 | 1,775 |
| First Project | 20 | 976 | 1,224 |
| Airport & Salt Lake | | | |
| Full Project[3,4] | 34 | 976 | 1,745 |
| First Project[4] | 25 | 976 | 1,194 |

[1]Daily vehicle trips calculated as per vehicle, for two-vehicle consists operating in both directions between 4 a.m. and 12 a.m.
[2]MBTUs = million BTUs
[3]Trips serving UH Mānoa and Waikīkī would include half of the total trips each
[4]Trips to Salt Lake and the Airport would also be half for the Airport & Salt Lake Alternative
Note: Average energy consumption calculated at 62,720 BTU per rail-vehicle mile (*Transportation Energy Data Book 26*)

Planned electricity generation capacity on O‘ahu would be sufficient to support the transit system. However, the electricity distribution system would require various upgrades to provide the electricity to the system (HECO 2008).

Combining the roadway and transit energy consumptions, energy consumption for the Full Project would be 92,526 MBTUs and for the First Project it would be 92,245 MBTUs (Table 5-4). This represents a 2.2-percent reduction in energy consumption for the Full Project and a 2.5-percent reduction for the First Project, compared to the No Build Alternative.

***Table 5-4: 2030 Total Average Daily Islandwide Transportation Energy Consumption (Motor Vehicle and Fixed Guideway)***

| Alternative | Motor Vehicle Energy Consumption (MBTUs)[1] | Fixed Guideway Vehicle Energy Consumption (MBTUs) | Total Energy Consumption (MBTUs) | Change from No Build |
|---|---|---|---|---|
| 2007 Existing Energy Consumption | | | | |
| 2007 Existing Conditions | 85,551 | 0 | 85,551 | N/A |
| No Build Alternative | 94,610 | 0 | 94,610 | N/A |
| Salt Lake | | | | |
| Full Project | 90,812 | 1,714 | 92,526 | -2.2% |
| First Project | 91,082 | 1,163 | 92,245 | -2.5% |
| Airport | | | | |
| Full Project | 90,677 | 1,775 | 92,452 | -2.3% |
| First Project | 91,013 | 1,224 | 92,237 | -2.5% |
| Airport & Salt Lake | | | | |
| Full Project | 90,709 | 1,745 | 92,454 | -2.3% |
| First Project | 91,132 | 1,194 | 92,326 | -2.4% |

[1]MBTUs = million BTUs

### *5.3.3 Airport Alternative*

Motor vehicle energy consumption for this alternative is shown in Table 5-2. With completion of the Full Project, motor vehicles would consume 90,677 MBTUs of energy per day. With the First Project, they would consume 91,013 MBTUs of energy per day.

In addition to motor vehicle energy consumption, electricity would be consumed to power the fixed guideway transit system. The amount of electricity required would depend on the length of the alignment and the number of daily transit-vehicle trips. The Airport Alternative would require 1,775 MBTUs and 1,224 MBTUs for the Full and First Projects, respectively (Table 5-3). Using an annualization factor of 308, this corresponds to an annual electricity demand of 148 GWH for the Full Project and 110 GWH for the First Project. These values represent 1 to 2 percent of the total projected electricity demand on O‘ahu for 2030.

Combining the roadway and transit energy consumptions, energy consumption for the Full Project would be 92,452 MBTUs and for the First Project it would be 92,237 MBTUs (Table 5-4). This represents a 2.3-percent reduction in energy consumption for the Full Project and a 2.5-percent reduction for the First Project, compared to the No Build Alternative.

### 5.3.4 Airport & Salt Lake Alternative

Motor vehicle energy consumption for this alternative is shown in Table 5-2. With completion of the Full Project, motor vehicles would consume 90,709 MBTUs of energy per day. With the First Project, they would consume 91,132 MBTUs of energy per day.

In addition to motor vehicle energy consumption, electricity would be consumed to power the fixed guideway transit system. The amount of electricity required would depend on the length of the alignment and the number of daily transit-vehicle trips. Using typical energy consumption values for steel-wheel-on-steel-rail systems, this alternative would require 1,745 MBTUs and 1,194 MBTUS for the Full and First Projects, respectively (Table 5-3). Using an annualization factor of 308, this corresponds to an annual electricity demand of 157 GWH for the Full Project and 108 GWH for the First Project. These values represent 1 to 2 percent of the total projected electricity demand on Oʻahu for 2030.

Combining the roadway and transit energy consumptions, energy consumption for the Full Project would be 92,454 MBTUs. Energy consumption for the First Project would be 92,326 MBTUs (Table 5-4). This represents a 2.3-percent reduction in energy consumption for the Full Project and a 2.1-percent reduction for the First Project, compared to the No Build Alternative.

## 5.4 Construction Effects

### 5.4.1 Air Quality

The Project's construction-related effects on air quality would be limited to short-term increased fugitive dust and mobile-source emissions. State and Local regulations on dust control and other air quality emission reduction controls would be followed.

Fugitive dust is airborne particulate matter, generally of a relatively large particulate size. Haul trucks, concrete trucks, delivery trucks, and earth-moving vehicles operating around the construction sites would generate fugitive dust during construction. This dust would primarily result from particulate matter resuspended ("kicked up") by vehicle movement over paved and unpaved roads, dirt tracked onto paved surfaces from unpaved areas at access points, and material blown from uncovered haul trucks.

The distance that particles drift from their source generally depends on their size, the emission height, and wind speed. Small particles (in the 30 to 100-micron range) can travel several hundred feet before settling to the ground, but most fugitive dust is comprised of relatively large particles (over 100 microns in diameter). These particles are responsible for the reduced visibility often associated with this type of construction. Given their relatively large size, these particles tend to settle within 20 to 30 feet of their source.

### 5.4.2 Energy

#### *Salt Lake Alternative*

Energy would be consumed during construction of this alternative. It is estimated that the Full Project would require approximately 8,840,000 MBTUs and the First Project would require approximately 7,140,000 MBTUs.

#### *Airport Alternative*

Energy would be consumed during construction of this alternative. It is estimated that the Full Project would require approximately 9,180,000 MBTUs and the First Project would require approximately 7,480,000 MBTUs.

#### *Airport & Salt Lake Alternative*

Energy would be consumed during construction of this alternative. It is estimated that the Full Project would require approximately 11,560,000 MBTUs and the First Project would require approximately 9,020,000 MBTUs.

## 5.5 Indirect and Cumulative Effects

The President's Council on Environmental Quality regulations implementing the National Environmental Policy Act of 1969 defines indirect effects as those:

> "which are caused by the proposed action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts may include growth inducing effects and other effects related to the induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems."

Cumulative effects are those effects:

> "which result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions" (CFR 1978)

The indirect and cumulative effects analysis considers the full range of consequences of actions related to project activities. NEPA, the Council on Environmental Quality regulations, and Hawai'i's Environmental Impact Statement law (HRS 2008) require analysis of cumulative issues within the context of the action, its alternatives, and its effects.

### 5.5.1 Air Quality

This air quality analysis considers changes in travel patterns as a result of the Project. Therefore, the indirect and cumulative effects of the Project are already included in the analysis. Depending on the technology used to generate electricity to power the system, air pollution could be generated during electricity generation. Because pollution control equipment is more efficient for stationary than mobile sources, the total air pollution released would be less with the Build Alternatives than with the No Build Alternative, even if electricity is generated at an oil-fired power plant.

### *5.5.2 Energy*

HECO has stated that there is sufficient capacity to power the transit system and that the energy demand of the transit system alone would not lead HECO to build another power plant (HECO 2008). In addition to planned generation capacity upgrades, HECO would require new or upgraded electricity distribution systems, including transformers, power substations, and power lines that would service both the transit system and other electricity customers on O‘ahu. The system improvements would provide systemwide benefits to electrical utility customers. These system upgrades would be addressed in independent environmental reviews, as required by Hawai‘i State law.

# 6 Mitigation

## 6.1 Operation

Because no substantial air quality impacts are anticipated to result from operation of any of the project alternatives, mitigation would not be required. Any measures to reduce automobile travel would reduce air pollutant emissions. Technologies for electricity generation that do not include combustion could further reduce air pollutant emissions for the Build Alternatives.

All of the Build Alternatives are predicted to consume less total energy than the No Build Alternative, so no mitigation would be required. Any transportation control measures to reduce traffic volumes and congestion would also decrease energy consumption. Incorporation of solar panels into stations or other project features could reduce the Project's electricity demand.

## 6.2 Construction

To minimize the amount of construction dust generated, the following measures could be taken to minimize particulate pollution:

### *6.2.1 Site Preparation*

- Minimize land disturbance.
- Use watering trucks to minimize dust.
- Cover trucks when hauling dirt.
- Stabilize the surface of dirt piles if they are not removed immediately.
- Use windbreaks to prevent accidental dust pollution.
- Limit vehicular paths and stabilize these temporary roads.
- Pave all unpaved construction roads and parking areas to road grade for a length of no less than 50 feet from points where they exit the construction site. This will help prevent dirt from washing onto paved roadways.

### *6.2.2 Construction*

- Cover trucks when transferring materials.
- Use dust suppressants on unpaved traveled paths.
- Minimize unnecessary vehicular and machinery activities.
- Minimize dirt track-out by washing or cleaning trucks before leaving the construction site. An alternative would be to pave no less than 50 feet of exit roads just before they enter public roads.

### 6.2.3 Post-Construction

- Revegetate any disturbed land not used.
- Remove unused material.
- Remove dirt piles.
- Revegetate all vehicular paths created during construction, to avoid future off-road vehicular activities.

### 6.2.4 Mobile Source Emissions

Because CO emissions from motor vehicles are inversely proportional to vehicle speed, traffic disruption during construction (e.g., the temporary reduction of roadway capacity and increased queue lengths) could result in short-term elevated concentrations of CO. To minimize CO emissions, efforts should be made during the construction phase to limit disruption to traffic, especially during peak travel hours.

### 6.2.5 Energy

Measures to maintain roadway speeds and construction practices that reduce energy consumption could reduce energy demand during construction. The integration of solar panels into stations and other project features could reduce the system’s total electricity demand.

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