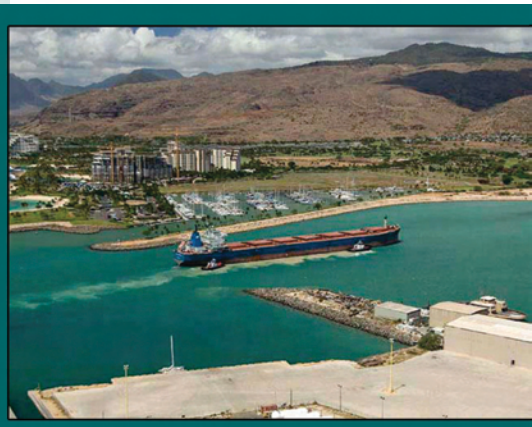
KALAELOA BARBERS POINT HARBOR 2040 MASTER PLAN

KALAELOA, O'AHU, HAWAI'I



June 2015

DEPT. OF TRANSPORTATION
HARBORS DIVISION

KALAELOA BARBERS POINT HARBOR 2040 MASTER PLAN

KALAELOA, O'AHU, HAWAI'I

Harbors Division
79 S. Nimitz Highway
Honolulu, HI 96813

JUNE 2015

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1-1

2.0 INTRODUCTION TO KBPH 2040 MASTER PLAN 2-1
2.1 Overview 2-1
2.2 Purpose 2-1
2.3 Mission, Vision and Strategy 2-2
2.4 Goals 2-3
2.5 Planning Process 2-4
2.6 Literature Review 2-5

3.0 EXISTING FACILITIES AND OPERATIONS 3-1
3.1 Regional and Site Overview 3-1
3.2 Background of Kalaeloa Barbers Point Harbor 3-1
3.3 Ownership, Zoning and Land Use 3-5
3.4 Natural and Man-Made Hazards 3-7
3.5 Physical Facilities 3-15
3.5.1 Harbor Basin 3-15
3.5.2 Piers/Yards 3-15
3.5.3 Facilities 3-26
3.5.4 Coral Stockpiles 3-30
3.6 Infrastructure 3-32
3.6.1 Power and Lighting 3-32
3.6.2 Telecommunications 3-34
3.6.3 Roadways and Traffic 3-34
3.6.4 Fencing and Security 3-35
3.6.5 Potable Water 3-36
3.6.6 Fire Protection Water 3-37
3.6.7 Stormwater 3-37
3.6.8 Wastewater Treatment 3-40
3.6.9 Solid Waste 3-41
3.6.10 Fuel Pipelines 3-41
3.7 Harbor Users and Operations 3-42
3.7.1 Current Tenants 3-43
3.7.2 KBPH Cargo Commodities 3-44
3.7.3 Maritime Service Industries 3-46
3.7.4 Harbor Vessel Types and Berth Utilization 3-46
3.7.5 Harbor Operations 3-49

4.0 FUTURE FACILITY DEMAND ASSESSMENT 4-1
4.1 Overview of Demand Assessment Methodology 4-1
4.2 User Demand Analysis 4-2
4.3 Fuels Market Analysis 4-4
4.4 Berth Utilization Analysis 4-6
4.5 Land Requirement Analysis 4-14

TABLE OF CONTENTS (CONTINUED)

5.0 LAND USE PLAN 5-1
5.1 Land Use Overview 5-1
5.2 Land Use and Alternatives 5-6
5.2.1 Buffer/Open Space 5-6
5.2.2 Circulation 5-7
5.2.3 Harbor Operations 5-7
5.2.4 Multi-Purpose Yard 5-8
5.2.5 Multi-Purpose Piers 5-9
5.2.6 Bulk A 5-10
5.2.7 Cargo Yard 5-11
5.2.8 Cargo Piers 5-12
5.2.9 Maritime Support Services 5-13
5.2.10 Maritime Support Pier 5-14
5.2.11 Bulk B 5-15
5.2.12 Fuel Terminal 5-16
5.2.13 Fuel Piers 5-18

6.0 DEVELOPMENT PLAN 6-1
6.1 Development Plan Overview 6-1
6.1.1 Piers and Cargo Yards 6-3
6.1.2 Maritime Support Services 6-15
6.1.3 Harbor Operations 6-15
6.1.4 Circulation 6-17
6.1.5 Infrastructure 6-20
6.1.6 Navigational Aids and 24-Hour Access 6-29
6.2 Development Constraints 6-37
6.2.1 Land Management 6-37
6.2.2 Height Restriction 6-39
6.2.3 Bulk A (S-A1) and Bulk B (S-B1) Drainage Issues 6-40
6.2.4 Critical Habitat Area 6-41
6.2.5 Culturally Sensitive Area 6-42
6.2.6 Climate Change and Sea Level Rise Effect 6-43
6.3 Maintenance 6-45

7.0 IMPLEMENTATION PLAN 7-1
7.1 Phasing and Cost Estimates of Improvements 7-1
7.2 Permitting and Approvals 7-9
7.3 Economic Benefits 7-10

8.0 REFERENCES 8-1

LIST OF FIGURES

1.1 Kalaeloa Barbers Point Harbor 2040 Master Plan Preferred Alternative 1-3
3.1 KBPH Regional Map 3-2
3.2 Barber's Point Barge Harbor Under Construction.....3-3
3.3 Barbers Point Harbor Design, 1975 3-3
3.4 Land Use Surrounding KBPH 3-6
3.5 Existing Land Use at KBPH.....3-9
3.6 Tsunami and Flood Hazards at KBPH.....3-11
3.7 High Surge Conditions at Pier 1, January 1995 3-12
3.8 Entrance Channel and Markers to KBPH.....3-13
3.9 The Coal Vessel *MV Vogetrader* Aground at the KBPH Channel Entrance 3-14
3.10 Location of Existing Range Lights 3-14
3.11 View of KBPH Range Lights from the Bridge of a Panamax Bulk Carrier.....3-15
3.12 Super Yacht *Silver Lining* in the Phoenician, LLC Loading Slip.....3-16
3.13 KBPH Existing Tenants and Neighboring Landowners.....3-17
3.14 Propane Barge with Tug Assist at Pier 1 3-19
3.15 KBPH Unimproved Pier 2 Area Revetment 3-19
3.16 Pier 3, Marisco Mooring Area 3-20
3.17 Pier 4, Finger Pier 3-20
3.18 Example of a Fuel Hose Connection.....3-22
3.19 The Pier 6 Bulk Unloader Offloads Coal to a Conveyor System.....3-22
3.20 A Vessel Overhang at Pier 7.....3-23
3.21 Sheet Pile Embankment Reinforcement at Piers 7/8, 8/9, and 9 3-24
3.22 Pier 9 with *Lil' Perris* Dry Dock in the Foreground.....3-25
3.23 Unimproved Face of Pier 10 3-25
3.24 KBPH Harbor Office and Carport 3-26
3.25 Personnel Shelter Adjacent to KBPH Harbor Office 3-26
3.26 KBPH Transit Cargo Shed.....3-27
3.27 Marisco Office Building and Warehouse 3-27
3.28 View of the Hawaiian Cement Storage Domes and Truck Loadout Station 3-28
3.29 GLP Asphalt Terminal 3-28
3.30 AES Office at Pier 6-½ 3-29
3.31 Grace Pacific Hot-Mix Asphalt Batch Plant 3-29
3.32 Locations of Coral Stockpiles at KBPH.....3-30
3.33 Coral Stockpile 2 3-31
3.34 Coral Stockpile 3 3-31
3.35 Coral Stockpile 4 3-31
3.36 Coral Stockpile 5 3-31
3.37 Existing Electrical System at KBPH 3-33
3.38 Nighttime Photo of Northern Jetty Inside Harbor Area with Existing Lights 3-33
3.39 Existing Circulation at KBPH 3-34
3.40 Existing Fencing at KBPH 3-36
3.41 Existing Potable Water and Fire Protection at KBPH.....3-37
3.42 Existing Drainage at KBPH 3-38
3.43 Existing Wastewater Treatment Systems at KBPH 3-40
3.44 FY 2012 Cargo Berth Utilization by Cargo Commodity.....3-44

LIST OF FIGURES (CONTINUED)

3.45 Berth Utilization by Vessel Types FY 2012 3-48
4.1 Oil Product Demand in 2030 under the Eight Scenarios (kb/d) 4-5
4.2 Berthing Utilization Rates at KBPH (2012 and 2040) 4-7
4.3 KBPH Commodity Forecast 4-15
5.1 Kalaeloa Barbers Point Harbor 2040 Master Plan Preferred Alternative 5-3
5.2 Temporary Storage and Removal of Dry-Bulk Cargo at KBPH 5-8
5.3 Alternative Considered: Weigh Station Location 5-10
5.4 Alternative Considered: Bulk Focus 5-11
5.5 Alternative Considered: Container/Biofuels Focus 5-12
5.6 Heavy Lift Pad Location Between Piers 5 and 6 5-13
5.7 Alternative Considered: Energy Focus 5-17
6.1 Segmented Partial Piers Layout Plan (Phases I and II) 6-6
6.2 Example of a Fuel Terminal with Aboveground Pipelines 6-6
6.3 New DOT-H Pipeline Easement 6-7
6.4 Pier 7 As-Built Plans 6-8
6.5 Example Pile-Supported T-Pier Layberth 6-9
6.6 Continuous Pile-Supported Pier with Narrow Apron 6-10
6.7 Sheet Pile Bulkhead Concept 6-11
6.8 Example of Floating Dock Concept 6-11
6.9 Mooring Dolphin 6-13
6.10 Example of Possible Berthing Configuration for Pier 10 6-14
6.11 Example of Harbor Office Facilities (Nawiliwili Harbor) 6-16
6.12 Personnel Shelter Locations 6-17
6.13 KBPH Circulation and Parking Plan 6-18
6.14 Example of Medium Speed, In-Motion Axle Weighing System 6-19
6.15 KBPH Power Plan 6-20
6.16 KBPH Fencing and Security Plan 6-22
6.17 KBPH Potable Water Plan 6-23
6.18 KBPH Drainage Plan 6-25
6.19 KBPH Wastewater Plan 6-27
6.20 Recommended Native Plants for Kalaeloa Barbers Point Harbor 6-28
6.21 Proposed Ocean Current Data Buoy Locations 6-31
6.22 Range Viewpoint Using Existing and Repositioned Range Lights 6-32
6.23 Proposed Gated Buoy Locations 6-35
6.24 Linear Ship Position in Channel for Range Viewpoint 6-36
6.25 Ponding in the Bulk B Storage Area, Southwest of Grace Pacific 6-40
6.26 USFWS O'ahu Critical Habitat LDU8, September 18, 2012 – Final Rule 6-41
6.27 Culturally Sensitive Area 6-42
6.28 Expected Sea Level Rise at KBPH and Surrounding Area in 2100 6-44

LIST OF TABLES

3.1 KBPH Existing IWS Locations and Specifications 3-41
3.2 KBPH Vessel Types 3-47
3.3 Berth Utilization by Vessel Type FY 2012 3-48
4.1 Summary of FY 2012 and Projected Berth Demand 4-9
4.2 Projected Berth Length by Vessel type 4-9
4.3 Vessel Type and Associated Pier Length.....4-11
4.4 KBPH Incremental Additional Monthly Fuel Vessel Calls Forecasted.....4-12
4.5 Forecasted Cargo Yard Area Required by Cargo Type 4-15
4.6 Stakeholder Landside Requirements.....4-16
4.7 Liquid-Bulk Storage Area Demand.....4-16
4.8 Dry-Bulk Terminal Area Demand 4-17
4.9 Dry-Bulk Terminal and Storage Area Demand 4-17
4.10 Summary of 2040 Cargo Land Requirements at KBPH 4-17
4.11 2040 Future Harbor Demand: Land Area.....4-18
5.1 Master Plan Land Use Categories.....5-2
5.2 Master Plan Land Area Demand Analysis Summary 5-6
6.1 Summary of Kalaeloa Barbers Point Harbor Improvements 6-2
6.2 Master Plan Berthing Analysis Demand Summary.....6-3
6.3 Routine Stormwater-Related Maintenance for KBPH.....6-44
7.1 Phasing Table for Priority Projects and Actions 7-3
7.2 Projected Development Costs of DOT-H Projects 7-6

APPENDICES

Appendix A: Stakeholder Meeting Summaries

Appendix B: Fuels Market in Hawai'i: Current Situation and Future Prospects (Facts Global Energy, 2014)

Appendix C: Berthing Occupancy – Berthing Utilization (Amergent Techs, 2013)

Appendix D: Fuel Forecast Report (Amergent Techs, 2014)

Appendix E: Harbor User Questionnaire

Appendix F: Summary of Questionnaire Results

Appendix G: Consideration of Liquefied Hazardous Gas Shipments and Storage at Kalaeloa Barbers Point Harbor (Group 70, 2015)

Appendix H: Rough Order of Magnitude Cost Estimate (Rider, Levitt and Bucknall, 2014)

Appendix I: Pipeline Preliminary Probable Costs (Arcadis, 2014)

Appendix J: Adjusted Fuel Pier Cost Estimates (Group 70, 2014)

ABBREVIATIONS AND ACRONYMS

AST	Above-Ground Storage Tanks
ATB	Articulated Tug Barge
BAU	Business as Usual
BBL	Barrel
BFD	Berth Foot Days
BMP	Best Management Practices
BPH	Barbers Point Harbor
BWS	Board of Water Supply, City and County of Honolulu
CAFE	Corporate Average Fuel Economy
CCTV	Closed Circuit Television
CIP	Capital Improvement Program
DBEDT	Department of Business, Economic Development and Tourism, State of Hawai‘i
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
DOH	Department of Health, State of Hawai‘i
DOT	Department of Transportation, State of Hawai‘i
DOT-H	Department of Transportation, Harbors Division, State of Hawai‘i
DOT-HWY	Department of Transportation, Highways Division
DWT	Dead Weight Ton
EDP	‘Ewa Development Plan
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FGE	Facts Global Energy
FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Greenhouses Gases
HAR	Hawai‘i Administrative Rules
HCEI	Hawai‘i Clean Energy Initiative
HECO	Hawaiian Electric Company

HMA	Hot-Mix Asphalt
HIE	Hawaii Independent Energy
HPD	Honolulu Police Department
HRS	Hawai‘i Revised Statutes
ISO	International Standard Organization
IWS	Individual Wastewater Systems
kb/d	Kilo Barrels Per Day
KBPH	Kalaeloa Barbers Point Harbor
KPL	Kapolei Properties, LLC
kV	Kilovolt
LHG	Liquefied Hazardous Gas
LID	Low Impact Development
LNG	Liquefied Natural Gas
LOA	Length Overall
LOS	Level of Service
LPG	Liquefied Petroleum Gas or Propane
LSFO	Low Sulfur Fuel Oil
MARSEC	Maritime Security
MATS	Mercury and Air Toxics Standard
MLLW	Mean Lower Low Water
MS4	Small Municipal Storm Sewer System
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NGPC	Notice of General Permit Coverage
NOAA	National Oceanic and Atmospheric Association
NPDES	National Pollutant Discharge Elimination System
OR&L	O‘ahu Railway & Land Company
OWTS	Onsite Wastewater Treatment Systems
PENCO	Pacific Environmental Corporation
PIANC	Permanent International Association of Navigation Congress
PIC	Person-in-Charge
PORTS	Physical Oceanographic Real-Time System
RO/RO	Roll-On / Roll-Off

RPS	Renewable Portfolio Standards
SEC	State Energy Corridor
SHPD	State Historic Preservation District
SMA	Special Management Area
SWMP	Stormwater Management Plan
TWIC	Transportation Worker Identification Credential
UKC	Under Keel Clearance
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Services
VTS	Vessel Traffic Service
WIM	Weigh-in-Motion
WQv	Water Quality Volume
WWB	Wastewater Branch
WWTP	Waste Water Treatment Plant

GLOSSARY

Aboard: On or in a vessel. Synonymous with "on board."

Abreast: Side by side; by the side of.

Aground: Touching or fast to the bottom (usually involuntarily).

Alongside: By the side of a ship or pier.

Amidships: In or toward the center of the boat.

Anchor: (noun) Device usually of metal attached to a ship or boat by a cable and cast overboard to hold it in a particular place by means of fluke that digs into the bottom. (verb) To keep hold or be firmly fixed.

Apron: That portion of a wharf or pier between the waterfront edge and the (transit) shed. Strictly speaking, from the view point of construction, that portion of the wharf carried on piles beyond the solid fill.

Barge: A towed or self-propelled flat-bottomed boat, built mainly for river, canal, and coastal transport of heavy goods.

Basin, Turning: An area of water or enlargement of a channel used for the turning around of vessels.

Beam: The greatest width of the boat.

Berth: A location in a port or harbor used specifically for mooring vessels while not at sea.

Berth Foot Day (BFD): Tabulated to determine a vessel's linear berthing used with corresponding mooring allowances and the vessel's port call duration, in relation to the maximum linear berth that is available for the specific berth.

Bitt: A post or pair mounted on the ship's bow, for fastening ropes or cables.

Boat: A fairly indefinite term - A waterborne vehicle smaller than a ship.

Bollard: A substantial vertical pillar to which lines may be made fast.

Booking: The reservation or assignment of space or accommodation aboard a vessel for specific cargo or passengers.

Boom (containment): A temporary floating barrier used to contain an oil spill.

Bow: The forward part of a boat.

Break-bulk cargo: Goods that must be loaded aboard a ship individually, and not in intermodal containers or in bulk, carried by a general cargo ship.

Breakwater: A structure constructed on a coast as part of a coastal defense system or to protect an anchorage from the effects of weather and longshore drift.

Bridge: The location from which a vessel is steered and its speed controlled.

Bulkhead: A vertical partition separating compartments; wall built parallel to the shoreline, usually near or at the high-water mark, to mitigate wave and current erosion of the uplands, and often used as a retaining wall to keep uplands from becoming submerged lands.

Bulk cargo: Cargo stored without benefit of package or container, i.e., shipped loose, as in grains or liquid.

Bulk carrier: A merchant ship specially designed to transport unpackaged bulk cargo in its cargo holds.

Bull rail: A guard, wooden, concrete or metal, placed along the outer edge of a pier wharf to prevent operating equipment from sliding.

Bunker fuel: Fuel oil for a ship.

Bunkering: Replenishment of a ship's fuel.

Buoy: A floating object of defined shape and color, which is anchored at a given position and serves as an aid to navigation.

Call: Planned visit by a ship, especially to load or unload passengers or cargo, to obtain supplies, or to undergo repairs.

Captain of the Port (COP): A United States Coast Guard officer, usually a captain, responsible for enforcement of safety, security, and marine environmental protection regulations in a commercial port.

Cargo ship: Any sort of ship or vessel that carries cargo, goods, and materials from one port to another, including general cargo ships (designed to carry break bulk cargo), bulk carriers, container ships, multipurpose vessels, and tankers. Tankers, however, although technically cargo ships, are routinely thought of as constituting a completely separate category.

Centerline: An imaginary line down the center of a vessel lengthwise. Any structure or anything mounted or carried on a vessel that straddles this line and is equidistant from either side of the vessel is on the centerline.

Channel: The buoyed, dredged and policed fairway through which ships proceed from the sea to their berth.
Class: 1) A group of naval ships of the same or similar design; 2) A standard of construction for merchant vessels, including standards for specific types or specialized capabilities of some types of merchant vessels. A ship meeting the standard is in class, one not meeting them is out of class.

Container (types): A single rigid, non-disposable cargo box and as the case may be: ventilated, insulated, reefer (i.e., refrigerated), flat rack, vehicle rack or open top container with / without wheels or bogies attached not less than 20 feet in length, having a closure or permanently-hinged door, that allow ready access to the cargo. All types of containers will have construction, fittings and fastenings able to withstand, without permanent distortion, all the stresses that may be applied in normal service use of continuous transportation.

Containerized cargo: Cargo that can fit physically, conveniently, and economically into a container.

Conveyor: A transfer of handling mechanism that affords continuous movement through application of power or by gravity.

Course: The direction in which a boat is steered.

Crane: A machine for hoisting weights or cargo moving them vertically / horizontally for limited distances and lowering them to new locations.

Cruise ship: A passenger ship used for pleasure voyages, where the voyage itself and the ship's amenities are part of the experience, as well as the different destinations along the way. Transportation is not the prime purpose, as cruise ships operate mostly on routes that return passengers to their originating port. A cruise ship contrasts with a passenger liner, which is a passenger ship that provides a scheduled service between published ports primarily as a mode of transportation. Large, prestigious passenger ships used for either purpose sometimes are called ocean liners.

Current: The horizontal movement of water; tidal or non-tidal movement of lake or ocean water.

Cutter: In the 20th and 21st centuries, a small- or medium-sized vessel whose occupants exercise official authority, such as harbor pilots' cutters, United States Coast Guard Cutters, and UK Border Agency cutters.

Dead Weight Ton (DWT): a measure of how much weight a ship is carrying or can safely carry; it does not include the weight of the ship.

Deck: The working surface of a pier or wharf or a loading surface on board a ship.

Delivery: Transfer of care and custody of containers (full or empty) and / or cargo from carrier to shipper / consignee and / or their legal representative.

Demurrage: Penalty charged shippers or receivers of freight, usually at a stated sum per day for detention beyond the free time provided for loading or unloading.

Discharge: To remove or unload cargo from a vessel.

Dock: A fixed structure attached to shore to which a vessel is secured when in port, generally synonymous with *pier* and *wharf*, except that *pier* tends to refer to structures used for tying up commercial ships and to structures extending from shore for use in fishing, while *dock* refers more generally to facilities used for tying up ships or boats, including recreational crafts.

Dock, dry: A narrow basin or vessel used for the construction, maintenance, and repair of ships, boats, and other watercraft that can be flooded to allow a load to be floated in, then drained to allow that load to come to rest on a dry platform.

Dolphin: An isolated cluster of piles used as a support of mooring devices or marker lights.

Draft: The depth of a vessel below the waterline, measured to the lowest point of the hull, the bottom of the propeller, or other reference point.

Dray: To convey goods by a dray (any vehicle typically without sides used to haul goods, especially one used to carry heavy loads).

Dredge: To excavate material from the bottom of a body of water.

Dredge spoils: Byproduct of dredging process; the residual accumulated silt that must be disposed of.

Dry-bulk: A category of cargo stowed in large, unpackaged amounts, consisting of grain, cotton, coal, etc.

Ebb: A receding current.

Fender: A cushion, placed between boats, or between a boat and a pier, to prevent damage.

Flat rack (flat container): Containers of various lengths designed for carrier of general cargo (see container types), other than for liquid cargo.

Flood: An incoming current.

Freeboard: The minimum vertical distance from the surface of the water to the upper edge of the side of a boat or ship.

Gangway: The opening by which a ship is boarded.

Gear: A general term for ropes, blocks, tackle and other equipment.

Harbor: An area of water affording a natural or artificial haven for ships.

Hatch, fuel: An opening in a pier to a fuel pipeline fitted with a watertight cover.

Hopper: A temporary container for bulk material shaped like a funnel, but with four flat tapering sides arranged like an inverted truncated pyramid, with the large end up and generally open and the small end down and generally closed by a gate or valve.

Hull: The frame or body of a ship or boat.

Inshore: Near (especially in sight of) or toward the shore.

ISO-container: ISO or intermodal containers are used for the intermodal transport of freight. They are manufactured according to specifications from the International Organization for Standardization (ISO) and are suitable for multiple transportation methods such as truck, rail, or ship.

Jetty: An engineering structure at the mouth of a river or harbor or elsewhere to control the water flow and currents, to maintain depth of channel, to protect harbor or beach.

Keel: The chief structural member of a boat or ship that extends longitudinally along the center of its bottom and that often projects from the bottom; the centerline of a boat running fore and aft; the backbone of a vessel.

Layberth: A berth used for idle vessels where no loading or unloading takes place.

Linear length: Measurement of length in one dimension (a line).

Length Overall (LOA): The maximum length of a vessel's hull measured parallel to the waterline, usually measured on the hull alone, and including overhanging ends that extend beyond the main bow and main stern perpendicular members. For sailing vessels, this may exclude the bowsprit and other fittings added to the hull, but sometimes bowsprits are included.

Lightering: A process in which a barge or smaller vessel transfers cargo between ship and shore.

Liner: Any cargo or passenger ship running scheduled service along a specific route with published ports of call, excluding ferries and other vessels engaged in short-sea trading.

Liquid-Bulk: Liquid cargo that is transported or stored unpackaged in large volumes.

Makai: Hawaiian term for “towards the ocean.”

Maritime: Of or related to the sea, i.e., maritime-dependent use is a use that is dependent on the sea.

Mauka: Hawaiian term for "towards the mountains."

Mean Lower Low Water: The average height of the lowest tide recorded at a tide station each day during the recording period.

Mole: A massive structure, usually of stone or concrete, used as a pier, a breakwater, or a causeway between places separated by water.

Moor: 1) To attach a boat to a mooring buoy or post; 2) To dock a ship; 3) To secure a vessel with a cable or anchor.

Mooring: A place at which or an object to which a craft can be moored, or made fast.

Mothership: A vessel which serves smaller vessels.

Nautical mile: One minute of arc of latitude; approximately 6076 feet - about 1/8 longer than the statute mile of 5280 feet.

Navigation: The art and science of conducting a boat safely from one point to another.

Neo-bulk: Cargo or commodities that move in large unitized loads such as newsprint, lumber, steel, construction components, etc.

Offshore: At some distance from the shore; located in the sea away from the coast.

Pier: A dock for loading or unloading ships or vessels.

Pile: Long slender column usually of timber, steel, or reinforced concrete driven into the ground to carry a vertical load.

Piling: Support, protection for wharves, piers, etc.; constructed of piles (see Pile).

Pilot: 1) Navigator; 2) A specially knowledgeable person qualified to navigate a vessel through difficult waters, e.g. harbor pilot etc.

Pontoon: A flat-bottomed vessel used as a float moored alongside a jetty or a ship to facilitate boarding.

Port: The left side of a boat looking forward; a harbor.

Quarter: To align a vessel along the line of the keel (the central structural basis of the hull) and the beam (the width of the vessel at its widest point).

Radar: Acronym for RAdio Detection And Ranging. An electronic system designed to transmit radio signals and receive reflected images of those signals from a "target" in order to determine the bearing and distance to the "target".

Range lights: Two lights associated to form a range (a line formed by the extension of a line connecting two charted points) which often, but not necessarily, indicates the channel centerline. The front range light is the lower of the two, and nearer to the mariner using the range. The rear light is higher and further from the mariner.

Rigging: The system of masts and lines on ships and other sailing vessels.

Roll-On / Roll-Off (RO/RO): Cargo which is rolled or driven on and off the ships, as opposed to lift on / lift off (LO/LO) or bulk loading methods.

Ship: A larger vessel usually thought of as being used for ocean travel.

Shipyard: A facility where ships or boats are built and repaired.

Skiff: A small boat, traditionally a coastal or river craft, for leisure or fishing, with a single person or small crew. Sailing skiffs have developed into high performance competitive classes.

Slip: Water-based parking spot for a boat, typically enclosed on three sides.

Starboard: The right side of a boat when looking forward.

Stern: The rear end of a ship / boat.

Surge: A sudden swelling, rolling or sweeping forward like that of a wave or series of waves.

Tanker (*also tank ship or tankship):* A ship designed to transport liquids in bulk.

Terminal: A berthside area where cargo is loaded to and discharged from vessels.

Tide: The periodic rising and falling of the surface of the ocean and of water bodies.

Ton: A unit of measure, may be short ton (St) (2,000 pounds), long ton (Lt) (2,240 pounds); metric ton (Met.ton) (2,204.6 pounds); measurement ton (Mt) (40 cubic feet of space); revenue ton (Rt) (any combination above, as manifested or producing the greatest revenue).

Towing: The operation of drawing a vessel forward by means of long lines.

Transit shed: Wharf structure for the short-time storage of merchandise in transit.

Tug boat: A boat that maneuvers other vessels by pushing or towing them. Tugs are powerful for their size and strongly built, and some are ocean-going.

Vessel: Any craft designed for transportation on water, such as a ship or boat.

Voyage: A long journey by ship.

Waterway: A navigable body of water.

Wharf: A structure on the shore of a harbor or on the bank of a river or canal where ships may dock to load and unload cargo or passengers.

GROUP 70
INTERNATIONAL

Architecture • Planning & Environmental Services • Interior Design • Civil Engineering
925 Bethel Street, 5th Floor, Honolulu, HI 96813 (808) 523-5866

1.0
Executive Summary

1.0 EXECUTIVE SUMMARY

The Hawai'i Department of Transportation, Harbors Division (DOT-H) master plans are long-range strategic guides that provide guidance on comprehensive long-range strategies and land use concepts for the orderly development, efficient utilization and sufficient capability of the State's commercial harbors. The *Kalaeloa Barbers Point Harbor* (KBPH) *2040 Master Plan* (*2040 Master Plan*) defines DOT-H's vision for KBPH over the next 25 years, balancing user needs by prioritizing harbor land uses and improvements that are necessary to serve forecasted demand.

Background

KBPH is one of two commercial harbors on O'ahu. First established in 1990, KBPH has become the second busiest port in the state. KBPH is capable of handling dry-bulk (i.e., coal, cement, sand, scrap metal and aggregates) and liquid-bulk (i.e., petroleum products, ethanol and asphalt) cargos, and also provides space for ship maintenance and repair services. In recent years, KBPH berths have become increasingly congested, causing berthing conflicts between dry- and liquid-bulk shipments. Projections to the year 2040 show demand for dry- and liquid-bulk cargos increasing at KBPH, driving the need for expansion of harbor facilities.

Collaborative Planning Process

To address future growth issues, the *2040 Master Plan* was developed by a collaborative process with input from stakeholders, including harbor users, potential tenants, government agencies, adjacent land owners, and the public. Previous plans for KBPH and the surrounding area provided background and context for the current planning effort. Verification and reconnaissance included site visits, workshops, questionnaires and individual interviews with stakeholders. The process also included engagement of the community and elected officials in public informational meetings. Stakeholder requests were analyzed to identify potential opportunities and constraints for the *2040 Master Plan* alternatives.

Future Scenarios

Hawai'i dry- and liquid-bulk markets were analyzed and forecasted for various scenarios to determine the probable future demand of imports, transshipments and exports. Technical studies conducted for the *2040 Master Plan* include: (1) user demand analysis, (2) fuels market analysis, (3) berthing utilization analysis, and (4) land requirements analysis. Findings from these studies allowed the project team to quantify demand for berthing and storage space at KBPH, and translate them into improvements and spatial requirements. This information guided the formation of the *2040 Master Plan* alternatives.

User Demand Analysis
To understand the current and foreseeable future users of KBPH, extensive outreach was conducted with stakeholders and agencies via a website, questionnaires, emails, telephone calls, small group meetings, planning workshops, and public meetings. An internal user matrix was created to capture the existing and potential harbor users and their functional needs at KBPH. Information from cases where users expressed greater likelihood of planned operations occurring at KBPH was used to enhance the forecasted demand analyses (below). The user matrix allowed for a refinement of the demand analysis, which was tested in separate scenarios and master plan alternatives.

Fuels Market Analysis
Liquid-bulk fuel imports to Hawai'i are expected to *diminish* due to local conservation and renewable energy measures. National measures such as the Corporate Average Fuel Economy (CAFE) mileage standards (which require automobile manufacturers to increase average fuel efficiencies) will also lower liquid-bulk fuel demand. Crude oil imports that provide the feedstock to manufacture low sulfur fuel oil (LSFO) for utility power generation will also be reduced. The required phase out of LSFO by Hawaiian Electric Company (HECO) is mandated by the Hawai'i Clean Energy Initiative (HCEI) and United States (US) Environmental Protection Agency (EPA) Clean Air Act regulations, including Mercury and Air Toxics Standard (MATS) and National Ambient Air Quality Standards (NAAQS).

However, due to world energy markets and the local refinery business structure, Hawai'i's oil refineries may end local production of refined products if their economics cannot be justified. In this scenario, imported shipments of *refined* petroleum products (e.g., jet fuel, diesel and gasoline) to Hawai'i is expected to *grow* dramatically. Therefore, although the future demand for liquid-bulk petroleum products in Hawai'i is forecasted to decline by 2030, waterborne movements of imported liquid-bulk refined petroleum products are projected to *increase*, potentially increasing the number of ships calling at KBPH.

Berthing Analysis
Historic berthing utilization data was analyzed to evaluate vessel movement within the harbor and served as a guide to estimate future berthing needs due to projected increases in dry- and liquid-bulk shipments. Under current conditions, four of the six piers experience periodic conflicts. With forecasted cargo increases, regular berthing conflicts are anticipated by 2040. To accommodate this future activity, pier length requirements were determined for each berth type (i.e., dry-bulk, neo-bulk, container, liquid-bulk, layberth, and maritime support services). The berthing analysis served as a key analytical tool to yield pier requirements for master planning.

Land Requirements Analysis
Determination of land area requirements to support dry- and liquid-bulk operations in 2040 was derived using three separate planning methods. First, detailed cargo commodity throughput data was collected from DOT-H records and projected into the future using computed trend lines. The amount of land currently associated with these cargo types was extrapolated to 2040 using the percentage increase of dry- and liquid-bulk from the commodity forecast. The second method used to determine land area requirements relied on input from current and potential users collected via questionnaires and in meetings.

Projected user demand was recorded in a matrix which summarized requirements by land use type. The third method used industry-standard planning guidelines based on commodity type and throughput projections.

Land Use Plan

Alternative scenarios for the *2040 Master Plan* were considered to address future needs and user functions. Waterfront industrial land use categories within KBPH were assigned risk-based performance criteria, and grouped according to similar disposition for fire, explosion and other environmental risks. A risk-based approach to land use planning provides flexibility, rationality, transparency and accountability, as well as accommodates market principles and environmental protection. The *2040 Master Plan* guides DOT-H and tenants toward lease areas consistent with risk group class. With input from harbor stakeholders, the application of risk criteria resulted in three alternative concepts, with emphasis toward: (1) Dry-bulk cargo, (2) Energy, and (3) Containers/biofuels. The preferred land use plan was selected based on the satisfaction of evaluation criteria including: balancing competing needs; maximizing capacity, capability, efficiency and operational performance; and using best planning doctrines and principles. The plan makes the most efficient use of berthing space and back-up land, creates efficient relationships among the terminals, provides convenient connections between the terminals and adjacent land uses, and accommodates future expansion.

Figure 1.1 – Kalaeloa Barbers Point Harbor 2040 Master Plan Preferred Alternative

Development Plan

The *2040 Master Plan* preferred alternative recommends a program of improvements that will optimize harbor operational efficiencies and benefit Hawai'i's bulk cargo industry. KBPH will be prepared to accommodate future demand for the next 25 years with the addition of new piers that separate conflicting operations. The new piers will serve both active unloading and layberth vessel activities, and provide modern support facilities.

Dedicated Fuel Pier and Terminal

The cornerstone project of the *2040 Master Plan* is the construction of a dedicated Fuel Pier at the Piers 3 and 4 area. Development of a Fuel Pier has been a priority consistently identified in KBPH master planning efforts dating back to 1977. The Fuel Pier will add 1,325 linear feet of berth space, which will meet future berthing demands. Cargo handling efficiencies will be optimized by separating liquid-bulk operations from Piers 5 and 6. The development of the Fuel Pier will displace an existing maritime support services tenant currently located at the Pier 3 area, and will require the demolition of a Finger Pier at full build out under Phase II. The Finger Pier is currently used as a layberth for harbor support vessels. The displaced tenant can be relocated to the Pier 9 area. A 410-foot long layberth will be constructed at the Pier 8 area to replace the Finger Pier, if or when Phase II of the Fuel Pier is executed.

Product quality assurance and security-related facilities will be located at the Fuel Terminal on approximately eight acres. Recommended components include a new fuel control and administration building with a second-story observation deck, maintenance building, Person-in-Charge (PIC) tankerman shelters, security guard shack and parking area for up to 30 personnel. Above-ground pipelines will convey fuels between the Fuel Pier and off-site storage, either connecting with existing lines near Pier 5 or through new lines within a designated easement along Malakole Street.

Main Cargo Pier Expansion

Pier 7 will be extended approximately 200 feet to accommodate the simultaneous berthing of an interisland barge with two large ships at both Piers 6 and 7. The Pier 7 Cargo Yard will also be expanded by approximately 13 acres. This will accommodate additional cargo operations at KBPH. The installation of a double-bitt mooring bollard at Pier 6 is recommended to secure vessels in periods of strong harbor surge.

Miscellaneous Improvements

The Pier 9 area improvements will facilitate berthing for maritime support services, including a tenant floating dry dock. Construction of a vessel layberth at the Pier 10 area will provide additional large vessel berthing capacity of approximately 750 linear feet. Layberth at both the Piers 8 and 10 area combined will provide an additional 1,160 linear feet of berth capacity.

Harbor Office and Support Facilities

There are several support facility improvements essential to the modernization of KBPH. A new Kalaeloa Harbor Access Road will be constructed landside of Piers 6 and 7 to provide a new entrance from Kalaeloa Boulevard to the harbor. A new DOT-H Harbor Office building, maintenance facility and parking will be constructed adjacent to the new entrance. Perimeter Road will be relocated further northeast and northwest to provide for a larger contiguous area at the Multi-Purpose Yard and a larger area for Maritime Support Services. Utilities such as electrical power, communication systems, potable water and fire hydrants will be extended to the northern harbor area to support harbor users. Electrical power and potable water will also be provided at key sites along the piers. Increased safety and efficiency will be made with improvements to navigation aids and inner harbor basin perimeter lighting, allowing for larger vessels to access KBPH 24 hours per day. Flaring of the channel entrance and dredging by the US Army Corps of Engineers to deepen the harbor entrance and basin will allow fully loaded ships to access the harbor, resulting in more efficient ship calls and less port congestion.

Implementation Plan

Implementation of the *2040 Master Plan* is expected to be completed in phases based upon funding availability and priorities set within the DOT-H system-wide Capital Improvement Program (CIP). It will be critically important not to disrupt cargo operations during improvements, as such prudent and careful planning will be paramount to ensure workarounds are in place to mitigate any cargo throughput disruption. The appropriate parties (i.e., DOT-H, other agencies and tenants) will be responsible for implementing their respective projects. The rough order-of-magnitude cost for all proposed DOT-H *2040 Master Plan* improvements is estimated at $256.8 million (in 2014 Dollars).

2.0
Introduction to KBPH 2040 Master Plan

2.0 INTRODUCTION TO KBPH 2040 MASTER PLAN

2.1 Overview

The Hawai'i Department of Transportation (DOT) was established in 1959 to provide efficient transportation facilities and systems that support the state's commerce and economy. It is comprised of three modal divisions: Airports, Harbors and Highways.

DOT, Harbors Division (DOT-H) is responsible for administering the commercial harbors system used by the cargo, passenger, and fishing industries. Hawai'i Revised Statutes Chapter 266 delineates this responsibility as the control, management, use and regulation of commercial harbors, and their improvements. DOT-H manages 10 commercial harbors located within the state.

Kalaeloa Barbers Point Harbor (KBPH) is one of two commercial harbors on O'ahu and the second busiest port in the state. KBPH is capable of handling liquid-bulk (i.e., petroleum products, ethanol and asphalt) and dry-bulk (i.e., coal, cement, sand, aggregates, and including neo-bulk such as scrap metal) cargos and provides space for ship maintenance and repair activities. It surpasses Honolulu Harbor in liquid-bulk cargo volume and offers a number of specialized cargo handling facilities not found in Honolulu Harbor (i.e., a coal bulk unloader system and a pneumatic cement pump system). Due to its close proximity to the island's two refineries, KBPH serves as the hub for Hawai'i's fuel supply system as well as for the interisland distribution of finished petroleum and non-petroleum products.

2.2 Purpose

In recent years, KBPH berths have become increasingly congested, causing berthing conflicts between dry- and liquid-bulk shipments. The purpose of the *Kalaeloa Barbers Point Harbor 2040 Master Plan* (*2040 Master Plan*) is to provide guidance on comprehensive long-range strategies and land use concepts for the orderly development, efficient utilization and sufficient capability of KBPH for the next 25 years. Through collaboration of facility users, government agencies, adjacent property owners and the public, needs were identified. Alternatives were developed and evaluated, and a preferred alternative selected.

The preferred alternative will help identify and prioritize feasible long-range improvements for the DOT-H system-wide Capital Improvement Program (CIP) and effectuate orderly programming of respective biennial CIP budgets through the State's Legislature. Furthermore, the need for supplemental financing through bond markets can be identified and bond sales can be scheduled accordingly.

2.3 Mission, Vision and Strategy

The mission of DOT-H is: *To effectively manage and operate a statewide commercial harbors system that facilitates the efficient movement of people and goods to, from and between the Hawaiian Islands.* The vision for KBPH is of a highly functioning, efficient harbor with the capacity to accommodate future needs and support the operations of all harbor users.

With a wide variety of competing interests for the future of KBPH, the *2040 Master Plan* follows a comprehensive approach to identify and evaluate alternative development options. This strategy is outlined as follows:

1. Balance Competing Needs
2. Maximize Capacity, Capability, Efficiency and Operational Performance
3. Use Best Planning Doctrines and Principles

A brief discussion of each strategy and its application in the planning process is presented below.

Balance Competing Needs
The planning process balances interests and accommodates the needs of all user groups in order to improve KBPH and Honolulu Harbor as a system. The planning process also remains responsive to environmental, fiscal, and other directives. The *2040 Master Plan* covers a 25-year time frame; therefore, the recommended alternatives must be functional throughout various stages of the plan, and have the flexibility to meet unforeseen future conditions.

Maximize Capacity, Capability, Efficiency and Operational Performance
KBPH's operational performance must be evaluated from several perspectives, including capacity, capability, and efficiency. Various harbor capacity evaluations were conducted for vessel berthing, cargo activities, and harbor access elements. Consistent application of these techniques allowed a comparison of each alternative's capability to accommodate future demands. The *2040 Master Plan* identifies and reviews the capability of KBPH to meet specific functional objectives, such as accommodation of various vessel configurations, provision of adequate number and size of vessel berths, and sufficient land areas for cargo handling and storage requirements. The efficiency of the harbor as a system is examined for each of the alternative scenarios.

Use Best Planning Doctrines and Principles
The following best planning doctrines were applied when determining the effectiveness of the KBPH alternatives:

1. Allows the highest and best use of land
2. Provides safety, accessibility, and security
3. Allows for growth and flexibility
4. Conforms to regulatory standards
5. Ensures technical, economic, social, and political feasibility

2.4 Goals

Early in the planning process, representatives from DOT-H and KBPH maritime users participated in several individual and group meetings. From those meetings, seven major themes emerged which formed the goals for the *2040 Master Plan*. They are as follows:

1. Be Realistic and Achievable
2. Be Flexible to Meet Future Needs
3. Be Compatible with Surrounding Uses
4. Consider Environmental Concerns
5. Consider Navigational Concerns
6. Provide Safety and Security
7. Outline a Phased Sequence of Improvements

Each goal contributes to meeting the demands of the harbor and is consistent with the DOT-H mission statement. The key elements of these goals are discussed below.

Be Realistic and Achievable
The *2040 Master Plan* should address current and future needs with solutions that have a realistic opportunity for funding and implementation.

Be Flexible to Meet Future Needs
The *2040 Master Plan* should be flexible and provide alternatives to meet a range of future harbor user requirements, State funding limitations, and changes in regulatory compliance requirements. The *2040 Master Plan* should consider new facilities that can accommodate a variety of uses, as well as future changes in ship technology; vessel and pier designs; and cargo handling technology and processes. The *2040 Master Plan* should also place minimal restrictions on land uses.

Be Compatible with Surrounding Uses
The *2040 Master Plan* should present uses and activities that are compatible with the I-3 (Waterfront Industrial) county zoning and neighboring land uses. Neighboring landowners and users should be consulted early in the process to provide a venue where concerns over the proposed uses could be expressed. These consultations will help shape the compatibility of uses, operations and land use designations at the harbor.

Consider Environmental Concerns
The *2040 Master Plan* should be environmentally responsible in addition to being economically and operationally feasible. Best management practices should be implemented to avoid or minimize potential impacts on the environment (including corals and seabirds) during construction activities and long-term operations.

Consider Navigational Concerns
Navigational concerns should be addressed regarding the entrance channel, harbor basin depth, and harbor surge control. KBPH should provide lighting for 24-hour transit operations, which will increase berthing efficiency. Improvements to navigational aids and the installation of real-time current information in partnership with the United States Coast Guard (USCG) and the National Oceanic and Atmospheric Association (NOAA) should be installed to increase navigational safety.

Provide Safety and Security
The *2040 Master Plan* should be compliant with standards and best practices to create a safe environment for harbor users. Reference standards include:

1. International Maritime Organization (IMO)
2. International Safety Management code (ISM)
3. International Standard Organization (ISO)
4. International Safety Guide for Oil Tankers and Terminals (ISGOTT)

Safety zones should be included within the *2040 Master Plan* to protect harbor users and neighbors. The Plan should require users to have safety and evacuation plans, emergency notification, and spill response plans. Spill response should have water access and facilities to enable rapid responses to emergencies.

Outline a Phased Sequence of Improvements
The *2040 Master Plan* should provide a sequence of phasing for facility development and support infrastructure to the year 2040. Improvements, land leases and integration should be phased beginning with the most immediate needs and then logically sequenced into the future. Phasing should allow the State to be flexible in serving the future growth of markets within normal capital budget constraints.

2.5 Planning Process

The planning process for the *2040 Master Plan* included five planning stages, as outlined below:

1. ***Research and Data Collection***
   The first phase of planning identified the potential opportunities and constraints for *2040 Master Plan* alternatives. Reconnaissance included site visits, workshops and interviews with harbor users and stakeholders, and engagement of the community through public information meetings. These actions helped to identify needs and concerns regarding the project plan and scope. Technical studies, forecasts, and analyses were used to further inform and define the future needs. A summary of meeting dates, locations, attendance, and topics is contained in *Appendix A.*

2. ***Demand Assessment***
   Hawai'i dry- and liquid-bulk markets were analyzed and various future scenarios were forecasted in order to estimate demand, imports, transshipments and exports. These quantities projected demand for berthing and storage space needed at KBPH.

3. ***Alternatives Formulation and Analysis***
   A range of alternatives were developed and considered for the *2040 Master Plan* to address and balance the anticipated future needs and functions of the users. Generalized *2040 Master Plan* scenarios with differing emphasis were formulated to consider the wide range of operational requirements for waterfront facilities, storage areas, structures and utilities. Input from stakeholders and analysis of risk helped guide the formation of three primary alternative concepts, with emphasis toward (1) Dry-bulk cargo, (2) Energy and (3) Containers/biofuels. A preferred alternative was then established using the following criteria: balancing competing needs; maximizing capacity, capability, efficiency and operational performance; and using best planning doctrines and principles. The plan makes the most efficient use of berthing space and back-up land, creates efficient relationships among the terminals, provides convenient connections between the terminals and adjacent land uses, and accommodates future expansion.

4. ***Cost Projections***
   The *2040 Master Plan* recommends phasing improvements incrementally over 25 years. Rough order-of-magnitude costs for each development project were prepared to guide Capital Improvement Planning.

5. ***Plan Preparation***
   The *2040 Master Plan* documents the studies and process that guided the recommendation of a preferred alternative. The *2040 Master Plan* will help to establish new guidelines for the leasing of State lands and guide State appropriations to implement recommended improvements.

2.6 Literature Review

Planning for KBPH has been an ongoing effort for the past 40 years. The *2040 Master Plan* has the benefit of these earlier studies and reports which were reviewed as part of the current planning effort. Brief summaries of the prior studies and related regional development plans are provided below.

- ***Plan for Barbers Point Harbor Facilities and Expansion of James Campbell Industrial Park* (1977) -** This plan estimated the types and volumes of commodities expected to be handled at the proposed Barbers Point Harbor, reviewed and commented on alternative harbor configurations prepared by the Unites States Army Corps of Engineers (USACE), and presented a series of plans that illustrate the phased development of four types of marine terminals through the year 2030: container; interisland; bulk- and break-bulk cargo; and petroleum. The initial port development was estimated to require 246 acres of land and expected to be operational in the early 1980s. Dredging of the harbor was estimated to produce approximately 12.8 million cubic yards of coral that would be stockpiled, requiring about 250 acres of land for a 30- to 35-foot high pile. Actual dredging produced approximately 3 million cubic yards of coral on 100 acres. The report included plans for vehicular circulation, land use, site subdivision, grading, utilities and staging of industrial development. Finally, a schedule was included that related the various phases of development activities at both the port and neighboring industrial park.

- ***Development Plan for Barbers Point Harbor* (1983) -** In anticipation of O'ahu's increase in ocean shipping to the year 2030, a Barbers Point Harbor Task Force was convened to guide the development of the harbor. This development plan recommended the following improvements/uses for each pier: Pier 1 - an off-loading pier for commercial Class A high explosives; Pier 2 - a small petroleum pier for loading interisland barges; Pier 3 - the main petroleum pier for loading petroleum products from nearby refineries as well as general cargo unloading as needed; Pier 4 - the designated dry-bulk cargo pier, and Piers 5 through 9 – capable of handling general cargo and roll-on/roll-off (RO/RO) shipments. Additional construction included a control tower/pilot house, two personnel shelters on the pier areas, a new Harbor Office Building, and a prefabricated open cargo shed for general cargo storage to the rear of Piers 5 and 6.

- ***Honolulu Waterfront Master Plan* (1989) -** This plan represented a comprehensive, long range (2020) vision for the Honolulu waterfront. The waterfront considered Ala Moana Beach Park by the Ala Wai Yacht Harbor to Ke'ehi Lagoon Park near the Honolulu International Airport, and also included Barbers Point Harbor. Barbers Point Harbor was included because of its important functional relationship with the commercial maritime operations of Honolulu Harbor. Short-term plans for Barbers Point included the provision of facilities to handle a combination of neo-bulk, dry-bulk and liquid-bulk cargo. Long-term plans included the relocation of grain and flour manufacturing activities at Honolulu Harbor to Barbers Point Harbor, and possible construction of a new slip with two or four 800-foot cargo berths mauka of the existing basin along with up to 120 acres of backland. Constraints that existed then and persist today include: a) The alignment and size of the harbor entrance channel and the maximum basin depth of minus 38 feet limiting the size of vessels that can operate efficiently and safely in the harbor and b) major expansion and development of surrounding lands requires the removal of dredged materials. Beyond 2020, the investigation developed several long-term options which should be considered by policy makers such as: reducing transshipment of interisland freight (encouraging more direct Neighbor Island shipments), and long-term mixed use of Pearl Harbor.

- ***2010 Master Plan for Barbers Point Harbor* (1991) -** This report provided a long-range development planning guide for the improvement of Barbers Point Harbor due to increased economic growth and expansion related to the harbor and surrounding area. Recommendations from the plan included: deepening the harbor and channel to accept more fully laden Panamax vessels; dredging a 90-degree angle at Piers 4 and 5; providing a dedicated Fuel Pier at Piers 3 and 4; construction of a control tower at the end of Pier 3 for local traffic control; provision of facilities to accommodate smaller support vessels, even if temporary; construction of transit sheds; comfort stations at Piers 6 and 9; immediate depletion of stockpiles No. 2 and 3; relocation of the access road; provision of perimeter lighting to allow for vessel movement after dark; provisions for measuring real-time current conditions for pilot use; and purchase of additional lands.

- ***O'ahu Commercial Harbors 2020 Master Plan* (1997) -** This plan served as a planning guide for the O'ahu commercial port and harbor facilities of Honolulu, Kewalo Basin, and Barbers Point Deep Draft harbors. At Barbers Point it recommended a new access road, dredging additional berths, deepening the basin to accommodate future demand for cargo, dredging and flaring of the harbor's entrance channel, and construction of a jetty to attenuate cross-currents. Development of a dedicated Fuel Pier and control tower with perimeter lighting was recommended to accommodate liquid-bulk carriers and future bunkering operations at Pier 4. This was in addition to the private pipelines at Piers 5 and 6. This plan recommended moving the dry dock operation at Pier 4 to the northwest area of Barbers Point.

- ***Hawai'i Harbor Users Group Report on Port Facilities and Development Priorities* (2005) -** This report described Hawai'i commercial harbors deficiencies due to limitations on the availability of berth and terminal resources. The shortage of port facilities on many Neighbor Islands was brought about by the continued growth in intra and interstate cargo, the cruise ship industry, and interisland ferry. The report also listed development priorities for KBPH. These included improving channel width/depth and breakwater arrangement (as noted in previous plans), and expanding berth capacity to accommodate increasing demand. The report also recommended extending the pipeline system at KBPH to create more locations, and possibly a dedicated location, where fuel barges can load to increase flexibility and capacity. This action would have freed up the main KBPH berths (i.e., Piers 5A, 5 and 6) to serve increasing general cargo operations.

- ***Hawai'i 2050 Sustainability Task Force* (2008) -** The 2050 Sustainability Task Force was created by the Hawai'i State Legislature to review the Hawai'i State Plan and the State's comprehensive planning system, and to create the *Hawai'i 2050 Sustainability Plan*, known as *Hawai'i 2050*. The Task Force was placed under the Office of the Auditor, and was comprised of a mix of public and private sector representatives. The first statewide planning initiative in more than 30 years, Hawai'i 2050 created a long-term action agenda to achieve sustainability for the state, and consolidated into one document key goals and initiatives from a variety of long-term strategic efforts. These key goals relate to: A Way of Life, The Economy, Environment and Natural Resources, Community and Social Well-Being, and Kanaka Maoli Culture and Island Values. An objective of the Economy goal was to plan ahead for the financing of infrastructure (including harbors) so that transportation and other vital economic systems are prepared to manage and accommodate planned growth. An objective of the Environment and Natural Resources goal was to aggressively address the impacts of global warming and rising sea levels on harbors and waterfront properties. This plan does not replace the *Hawai'i State Plan* or take precedence over other governmental plans. Each county had representatives participate on the Task Force, and Hawai'i 2050 was a guide for each county to further their sustainability efforts.

- ***Statewide Fuel Facilities Development Plan* (2009) -** This development plan focused on needed facility improvements in Hawai'i's commercial harbors to allow for a continued safe and secure fuel supply chain. The development plan presented the design approach for fuel piers and components of fuel facilities. It also explored fuel facility alternatives in the existing commercial harbors. The development plan recommended that flexibility in design and construction are a key consideration for future fuel facilities in the commercial harbors to accommodate Hawai'i's changing fuel and energy needs. For KBPH, the development plan provided recommendations for facility improvements to Piers 3 and 4, with the anticipation that KBPH will become the hub for Hawai'i's fuel system. Both fuel berths were planned as protruding pier structures, composed of fuel transfer platforms and breasting dolphins. Main pier components of the two fuel berths included fixed fire-fighting systems and a vapor control system. Three options for ancillary facilities are also proposed, which would provide support functions to the two new fuel berths.

- ***'Ewa Development Plan* (2013) -** The 'Ewa region has been identified as one of two main regions on O'ahu which has expected population growth and development activity over the next 25 years. The *'Ewa Development Plan* (EDP) was prepared in accordance with Charter-prescribed requirements and utilized a community-based planning approach led by the City and County of Honolulu's Department of Planning and Permitting. The EDP summarized a vision for the region, and listed the land use and infrastructure policies of the plan and the means of implementation. Elements of the vision included:

    - Protect Agricultural Land and Open Space
    - Develop the Secondary Urban Center
    - Build Master Planned Residential Communities
    - Protect Natural, Historic, and Cultural Resources
    - Provide Adequate Infrastructure

  KBPH plays a role in the development of a secondary urban center on O'ahu by supporting the region's commercial and industrial centers. General policies in the EDP addressed resort development to the north and industrial park development to the south of KBPH.

- ***Hawai'i Statewide Transportation Plan* (2013) -** The seventh edition of the *Hawai'i Statewide Transportation Plan* was released in 2013. A policy document, its chief focus was development of an updated set of goals and objectives that can guide system-level plans and master plans for air, water and land modes of transportation. Research and review of important issues facing the transportation system led revisions in goals and objectives to reflect:

    - Emphasis on security requirements as separate from safety needs
    - Adaptation of the transportation system to the effects of climate change and sea level rise
    - Inclusion of a goal for clean energy, less dependence on imported oil, more use of renewable sources, and greater energy efficiency

- ***Hawai'i Refinery Task Force Final Report* (2014) -** This was the third and final report of the Hawai'i Refinery Task Force. It built on the findings contained within the first two volumes and provided recommendations for specific transitional measures needed through 2020. In the event of both refineries closing, the refineries should be modified to manage most product imports through the single point moorings. KBPH imports would be primarily for specific products such as naphtha, propane, and asphalt, and on occasion gasoline or diesel. Ethanol movements were not expected to change if the refineries close. Instead, ethanol movements will be dictated by future gasoline consumption, which was expected to decline steadily over the coming decade. Lastly, asphalt imports would shift exclusively to KBPH, though asphalt has been largely sourced through KBPH imports even during current refinery operations.

These plans and studies have helped guide the evolution of harbor development and support facilities at KBPH. For example, the original barge harbor was expanded with the excavation of the main basin completed in 1985, with coral stockpiles stored on site *(Plan for Barbers Point Harbor Facilities and Expansion of James Campbell Industrial Park,* 1977). In 1988, Piers 5 and 6 were constructed with fuel pipelines and an adjacent cargo yard, and a cargo shed added in 1996 *(Development Plan for Barbers Point Harbor,* 1983). Extension of the harbor in the northeast corner began in 1997 *(Honolulu Waterfront Master Plan,* 1989). Additional realized improvements such as the Finger Pier, dredging of a 90-degree angle at Piers 4 and 5, extension of Pier 5, installation of perimeter lighting, and purchase of additional lands were presented in the *2010 Master Plan for Barbers Point Harbor,* 1991. At the suggestion of the *O'ahu Commercial Harbors 2020 Master Plan* (1997), Pier 7 was extended in 2001. Although not all of the improvements suggested from these plans were implemented, the *2040 Master Plan* integrates the relevant objectives from over 40 years of planning for KBPH.

3.0
Existing Facilities and Operations

3.0 EXISTING FACILITIES AND OPERATIONS

3.1 Regional and Site Overview

O'ahu is served by two commercial harbors: Honolulu Harbor and Kalaeloa Barbers Point Harbor (KBPH). These harbors work as an integrated system to receive 98 percent (Lee and Olive, 1994) of all consumable goods and materials brought to Hawai'i. Over the decades, use of KBPH has grown to become the State's second busiest harbor and serves as the primary 'bulk' harbor for dry-bulk (i.e., coal, cement, sand and aggregates) and liquid-bulk (i.e., petroleum products, ethanol and asphalt) cargo.

KBPH is located at the southwestern tip of O'ahu (*Figure 3.1*). It is adjacent to the island's major industrial center at James Campbell Industrial Park. The area includes two oil refineries, a gas production plant, and several large fuel storage tank facilities. KBPH and fuel storage terminals connect to a regional fuel pipeline between Barbers Point and Honolulu. The harbor is bounded to the north by Ko 'Olina Resort and its private marina and golf course, and to the northeast by the O'ahu Railway & Land Company (OR&L) right of way. To the east lies the future Kapolei Harborside development; to the south, Kenai Industrial Park; and to the west, the Pacific Ocean. Residential areas nearest KBPH include the subdivisions of The Fairways at Ko 'Olina, Ko 'Olina Hillside Villas, and Honokai Hale.

3.2 Background of Kalaeloa Barbers Point Harbor

The literal meaning of Kalaeloa is 'the long point'. The Kalaeloa region is known for fishing and shoreline collecting. Following European contact, the area became known as Barber's Point after the British brig *Arthur* ran aground on a coral reef in high surf conditions in 1796. Commanded by unscrupulous and tyrannical Captain Henry Barber, the crew fought desperately to keep the vessel afloat, but sank by the breakwaters at Kalaeloa. Tragically, six crewmembers drowned, but Captain Barber and the rest of his crew made it to the shore. In 1968, the United States (US) Board of Geographic Names dropped the apostrophe, changing the name from Barber's Point to Barbers Point.

During the 1950s, James Campbell Industrial Park became a major center of industrial activity and an important contributor to Hawai'i's economy. It was particularly suited for all types of industrial operations because of its vast expanse of inexpensive lands. Heavy industries, however, frequently require proximity to a harbor for their efficient operation. Two sites were considered for development: the area near Barbers Point Lighthouse, and an area north of the Lighthouse known as Camp Malakole. Construction of a small L-shaped barge harbor began at the latter site to enable industries to ship products directly to the Neighbor Islands, thus reducing trucking costs and transshipment to and from Honolulu Harbor *(Figure 3.2).*

Figure 3.1 – KBPH Regional Map

Figure 3.2 – Barber's Point Barge Harbor Under Construction
(Source: Harland, Bartholomew & Associates, 1958)

The US Army Corps of Engineers (USACE) initiated planning for a second commercial harbor (in addition to Honolulu Harbor) on O'ahu as early as 1958. In 1961, the Estate of James Campbell constructed Barber's Point Barge Harbor on private lands, which was a nine-acre facility. It was located 19 nautical miles from Honolulu and enabled industry in the 'Ewa area to ship products by barge to the Neighbor Islands. However, the harbor's use was limited by surge and seasonal ocean swells. The late-US Senator Daniel K. Inouye explored establishment of an expanded harbor with the Campbell Estate in the early 1960s, with a goal of expanding commerce outside of Honolulu Harbor to serve a growing O'ahu.

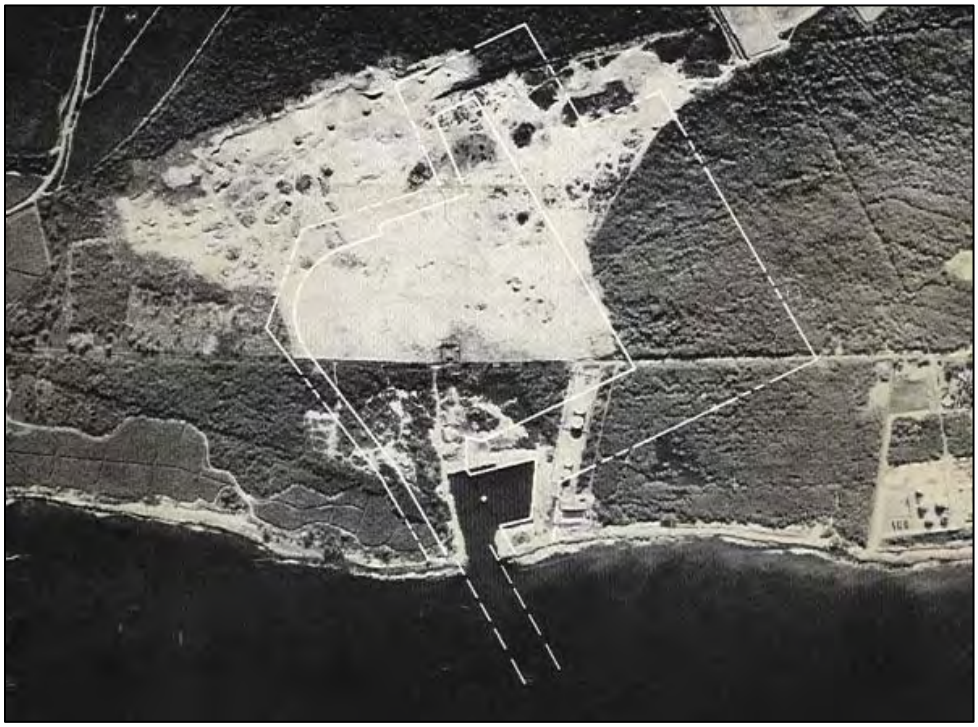


Figure 3.3 – Barbers Point Harbor Design, 1975
(Source: Development Plan for Barbers Point Harbor, 1983)

In 1979, the US Congress appropriated funds to expand Barbers Point Barge Harbor. Construction of the deep-draft harbor was initiated in 1982, as a joint project of the USACE and the Hawai'i Department of Transportation, Harbors Division (DOT-H). Completed in 1985, the harbor basin was expanded to 114 acres with a depth of minus 38 feet. The entrance channel is comprised of an offshore portion 3,300 feet long by 450 feet wide and 42 feet deep; inshore of the land the channel remains 450 feet wide and for 980 feet is reduced to 38 feet deep. A 4,700-foot wave energy absorbing revetment system was built along the north and west periphery of the main basin. With a name change to Barbers Point Harbor (BPH), it became a reliever harbor for Honolulu Harbor, and accelerated the growth of the industrial base centered at the James Campbell Industrial Park.

In 1986, USACE transferred control of BPH to DOT-H. Marisco, Ltd. (Marisco), a maritime services provider, was the first user to move in when they moored a 516-foot long dry dock in the harbor. It was first located in the northeast corner but later moved adjacent to the southwestern edge of the main basin, north of the barge harbor, to allow the construction of Piers 5 and 6.

The legislature appropriated $12 million in 1984 and another $17 million in 1988 to construct a 1,600-foot long pier at Piers 5 and 6 and an adjacent 30-acre paved concrete transfer yard. In conjunction with the construction of the new pier, a total of 16 fuel transmission pipelines were installed. Pacific Resources, Inc. installed a total of 11 pipelines serving Pier 5, nine of which also serve Pier 6. These pipelines were designed to handle a variety of petroleum products ranging from black oil to liquefied petroleum gas (LPG, or propane). Chevron and Texaco installed another three pipelines and Hawaiian Electric Company installed two more as contingency, which were never placed into service. These pipelines provide transfer of petroleum products between vessels at berth and landside storage facilities.

With completion of the improvements in May 1990, BPH officially opened. By 1991, a bulk offloading system to transfer coal from vessels to a coal generation plant in neighboring James Campbell Industrial Park was installed at Piers 5 and 6 by Briggs Pacific Industries, Inc., and later assumed by AES Hawai'i, Inc. (AES). In 1993, the Finger Pier and parking area for ferry and service vessels were constructed at Pier 4. In 1996, the harbor received a four-acre expansion of the cargo handling yard, a new 45,000 square foot Pier 5 Shed and concrete pavement around it. In 1997, DOT-H started a project that enlarged the harbor basin along the northeast margin with a rectangular extension measuring 600 feet wide by 1,100 feet long and 38 feet deep. This project was completed two years later at a cost of $13.9 million.

The *O'ahu Commercial Harbors 2020 Master Plan* (1997) continued to recognize the increasing use and importance of BPH as a supplement to Honolulu Harbor, and also due to continued growth in 'Ewa and Central O'ahu. By 1999, nearby Barbers Point Naval Air Station had been transferred to the State and renamed Kalaeloa, the region's traditional name. In recognition of the native place name, DOT-H renamed BPH to Kalaeloa Barbers Point Harbor (KBPH).

In 2001, the 300-foot long Pier 5 extension project was completed at a cost of $5 million, and the Pier 7 extension project was also constructed at a cost of $17 million. A specialized cargo handling system for cement was installed by Hawaiian Cement, comprised of a mobile rail-mounted pneumatic ship unloader, storage domes, and pneumatic pipelines to move material between components. In 2008, an Asphalt Terminal was constructed near Pier 7 by GLP Asphalt, LLC (GLP Asphalt). The asphalt cement is imported to KBPH and transferred via a heated cargo line to a heated, above-ground storage tank to maintain product viscosity. The heated liquid asphalt is then loaded to specialized asphalt trailers for delivery and use on O'ahu, and loaded into containers certified by the International Standards Organization (ISO) called ISO-containers which are drayed to Honolulu Harbor for transfer by barge to Neighbor Islands.

In 2013, DOT-H acquired approximately 54 additional acres adjacent to the harbor's southeast boundary for future expansion. DOT-H assumed the existing lease for Grace Pacific LLC within this acquired acreage. Grace Pacific operates a hot-mix asphalt manufacturing facility and an aggregate storage/terminal facility at this location.

3.3 Ownership, Zoning and Land Use

KBPH lies in the 'Ewa District in the traditional ahupua'a of Honouliuli. The State of Hawai'i Department of Land and Natural Resources (DLNR) owns the land under KBPH, while DOT-H owns the harbor facilities. DOT-H is given control and management of the land via Governor's Executive Orders 3383 and 3644. The State land use designation for KBPH and its waters is Urban. The City and County of Honolulu zoning for the waters is P-2, General Preservation zoning. County zoning for the KBPH land area is zoned I-3, Waterfront Industrial *(Figure 3.4).* Allowable activities in the I-3 zone include accessory offices and retail; base yards; biofuel processing facilities; maritime-related vocational training, sales, construction, maintenance and repairing; repair establishments; salvage, scrap and junk storage and processing; storage yards; warehousing; and wholesale/retail establishments dealing primarily in bulk materials delivered by or to ship, or by ship and truck in combination.

Adjacent land use north of KBPH is zoned B-2 (Community Business), A-2 (Medium Density Apartment), Resort, and P-2 (Preservation) with plans for a neighborhood park, cultural preserve, and golf course. The remaining land surrounding KBPH includes A-1 (Low-Density Apartment), F-1 (Military and Federal Preservation), I-2 (Intensive Industrial) and I-3 (Waterfront Industrial).

The Special Management Area (SMA), a county overlay zone, includes most of the harbor and adjacent coastline *(Figure 3.4).* This boundary does not include the harbor expansion area and was never adjusted when this area was dredged. Construction by a tenant within the SMA requires a permit to assure that developments are designed and carried out in compliance with the Hawai'i Coastal Zone Management Program objectives, policies, and SMA guidelines. DOT-H is exempt from this permit as described in Hawai'i Revised Statutes (HRS) Chapter 266-2(b).

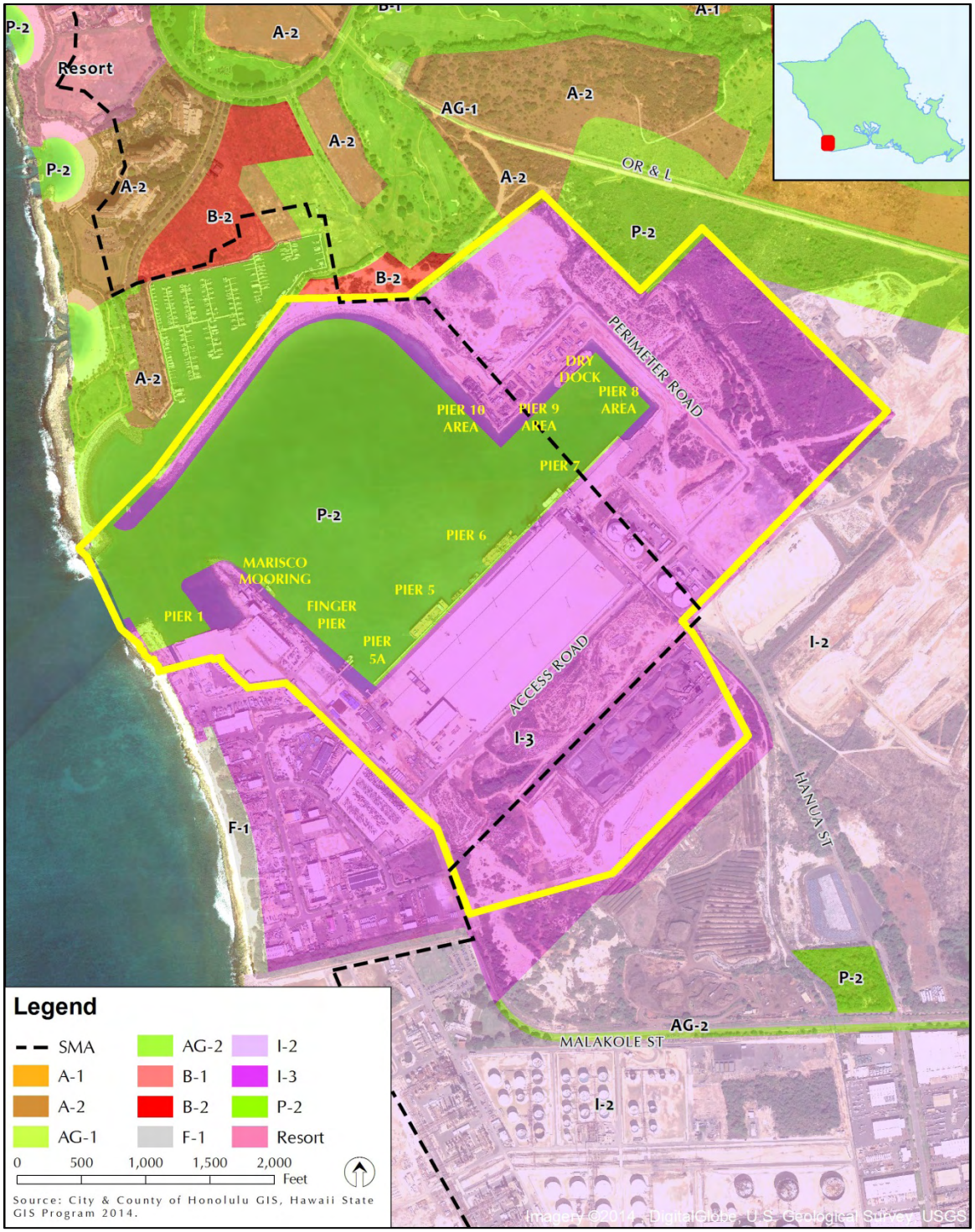


Figure 3.4 – Land Use Surrounding KBPH

Bulk commodities, such as aggregate for concrete and asphalt, are offloaded and processed at adjacent industrial lands or leased parcels at KBPH. Finished fuel products are used on O'ahu or shipped by barge to the Neighbor Islands. Specialized equipment to offload dry- and liquid-bulk products allows efficient movement of commodities between vessels and nearby industrial facilities. Other land uses and activities at KBPH *(Figure 3.5)* include a multi-purpose cargo handling yard and temporary warehouse storage facility; storage yards and facilities for aggregate, asphalt and cement; and maritime support services for construction, maintenance and repairing of marine vessels and equipment. Much of the property surrounding the harbor is currently used for storage of the dredged material obtained from construction of the basin.

3.4 Natural and Man-Made Hazards

Tsunami, Hurricane, Flooding and Earthquakes

The tsunami evacuation zone *(Figure 3.6)* for KBPH includes the seaward side of the harbor (i.e., Piers 1 to 4), and west of the Malakole Street segment that parallels the shore. In addition, the northern breakwater dividing KBPH from the Ko 'Olina Marina is in the evacuation zone. According to the *Atlas of Natural Hazards in the Hawaiian Coastal Zone* (USGS, 2002), the overall hazard assessment for the Barbers Point coast is rated 4 (moderate), on a scale of 1 (low) to 7 (high), primarily due to high storm and tsunami hazards. Stream flooding is ranked moderately low to low as it is an arid region and far removed from the drainages of the Ko'olau and Wai'anae mountain ranges. KBPH is located in Zone 'D', an area of possible but undetermined flood hazard, as noted on the federal Flood Insurance Rate Map. The harbor basin is located in Zone 'VE', an area with a one percent annual chance of flooding with additional coastal hazards.

The Hawaiian Islands are seasonally affected by Pacific hurricanes during the late summer to early winter months. O'ahu's 'Ewa Coastal Plain is infrequently hit by severe storm events. The primary impacts of hurricanes on KBPH are expected to include possible inundation from storm surge and high waves. Hurricane strength winds occasionally reach the Hawaiian Islands, though sea surface temperatures are typically not warm enough to sustain hurricane formation and growth. Predicted winds for such events are between 75 and 115 miles per hour (mph).

Earthquakes in Hawai'i are related to volcanic activity; eruptions and magma movement within presently active volcanoes (Kīlauea and Mauna Loa on Hawai'i Island, and the offshore Lo'ihi) are usually accompanied by numerous small earthquakes. Earthquakes referred to as 'tectonic earthquakes' occur in areas of structural weakness deep within the Earth's crust. Although difficult to predict, an earthquake of sufficient magnitude causing structural or other property damage may occur in the future.

Harbor Currents and Surge Water Movement

KBPH is directly exposed to west, southwest, and northwest swells, and Kona storm wind waves. A combination of wave conditions may occur at the same time. Tropical storms and hurricanes also generate waves that can approach the Hawaiian Islands from virtually any direction. KBPH is sheltered from the direct approach of trade wind waves by the landmass of O'ahu, but it does receive a portion of the wave energy through diffraction. Prevailing currents are east to west around KBPH and winds can become strong very quickly.

Research to establish the predictability of water movement within the harbor has provided no clear answers, possibly because of eddies flowing through. In general, reversing tidal currents dominate the nearshore coastal waters with the primary direction of flow parallel to the shore. Flood tide currents flow predominantly to the southeast and ebb tide currents typically flow to the northwest. However, this is not always the case, and switches in the ebb and flood tide current directions occur relatively often and unpredictably. The direction of the current at the mouth of the harbor entrance can be altogether different than the direction out farther in the ocean. On approach to the harbor basin, it is not uncommon for the current to reverse direction 180 degrees more than once.

Figure 3.5 – Existing Land Use at KBPH

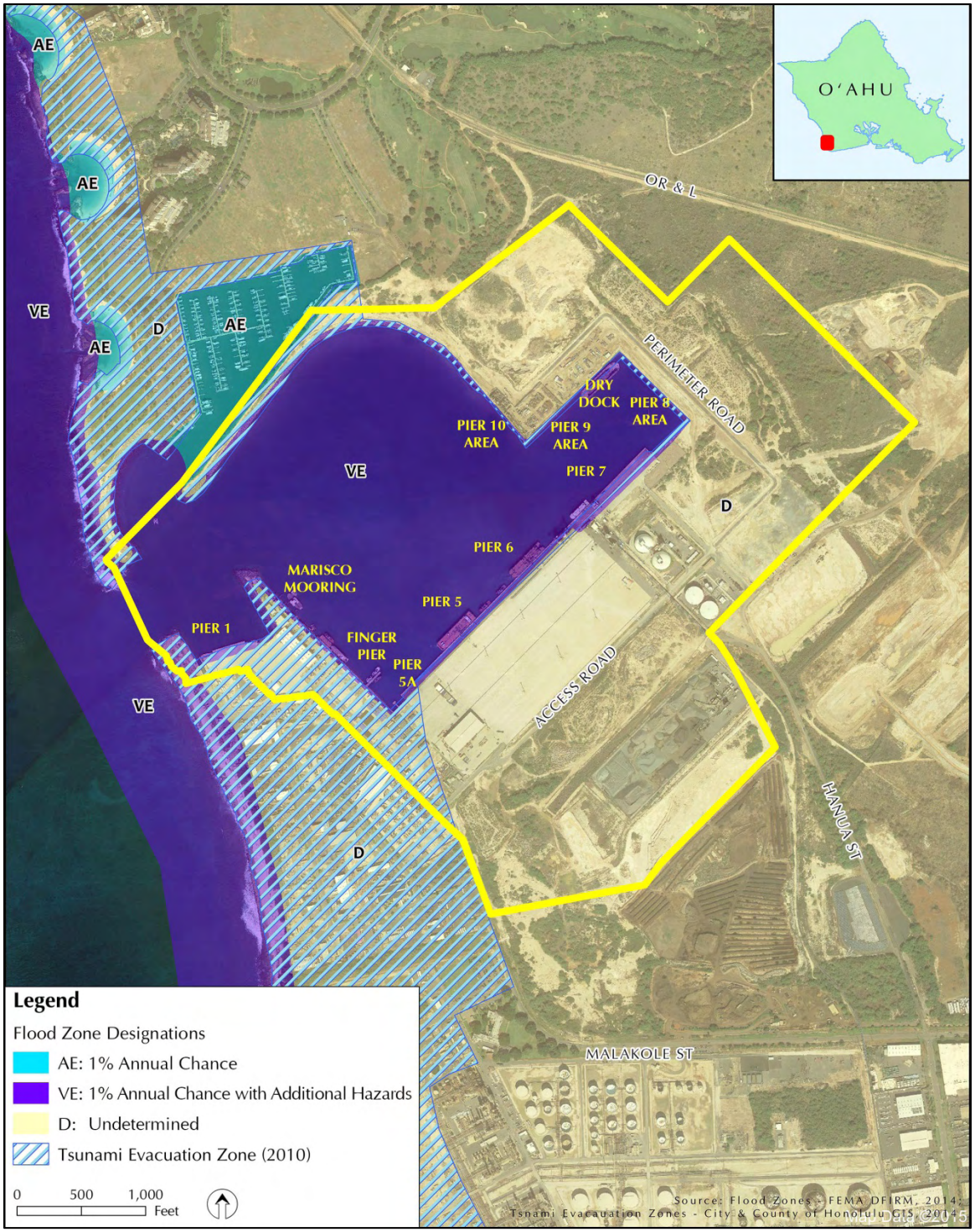


Figure 3.6 – Tsunami and Flood Hazards at KBPH

Surge within the KBPH basin is occasionally a problem. This is a resonance problem, also known as a seiche, which amplifies the currents and tides in the basin of the harbor, adding to the complexity of offloading. This seiche (which can generate as much as 8 feet of vertical movement) causes the cargo ships to move so much that the offloading must be timed correctly with the currents and the tides in order to steady the ship as much as possible. This has also caused damage to fixed bulk unloading equipment from contact with vessels. Surge at Pier 1 during the winter months is dangerous enough that it is not usable approximately three months out of the year *(Figure 3.7).*

Figure 3.7 – High Surge Conditions at Pier 1, January 1995
(Source: Kapalama Container Terminal EIS Public Meeting Presentation, 2012)

In general it is difficult to visually assess environmental factors at KBPH. Determining whether or not it is safe to enter or depart the harbor in large swell conditions is very difficult, and largely based on the local harbor pilot's and/or vessel master's judgement.

Access Channel Limitations

The KBPH entrance channel is narrower than the other entrance channels for Hawai'i's commercial harbors. The KBPH offshore channel entrance measures 3,300 feet long, 450 feet wide and 42 feet deep. The inshore channel is 980 feet long, 450 feet wide and 38 feet deep. Honolulu, Kawaihae, and Kahului harbor entrance channels are 10 percent wider; Nawiliwili's is 30 percent wider; and Hilo's is more than three times the width of the KBPH channel. The unpredictability and strength of the currents on approach to the narrow channel entrance, in combination with the lack of sufficient navigational aids, are the main risk factors when entering KBPH. This restricts certain vessels from entering the harbor, and is particularly a problem for a carrier wishing to operate a liner service with regular, fixed sailing schedules.

Modifications to the harbor entrance have been studied by USACE due to concerns raised regarding cross currents within the harbor's entrance channel, vessel delays, the potential for vessel groundings due to inadequate vessel under keel clearances (UKC), and the demand to accommodate larger vessels. Results of the USACE studies support flaring and dredging of the harbor's entrance channel to increase the margin of safety for vessels transiting in and out of the harbor.

Navigational Aids

According to the Hawaii Pilots Association, KBPH is a very high risk port in terms of navigability compared with the other commercial harbors in Hawai'i. There have been at least two groundings there over the past 10 years (i.e., in 2010 by the vessel *MV Voge Trader* and in 2005 by the vessel *MV Cape Flattery*), versus no significant groundings in the other ports and channels during the same time period. In addition to the risks inherent to the currents and narrow channel entrance, the navigational aids at KBPH need improvement. *Figure 3.8* portrays the markers to the entrance channel. Just outside of the entrance channel are Buoys 2 and 3. Lighted Day Markers 4 and 5 are affixed to the ocean bottom to mark the entrance channel. Lighted Day Markers 6 and 7 are affixed on land at the entrance to the harbor.

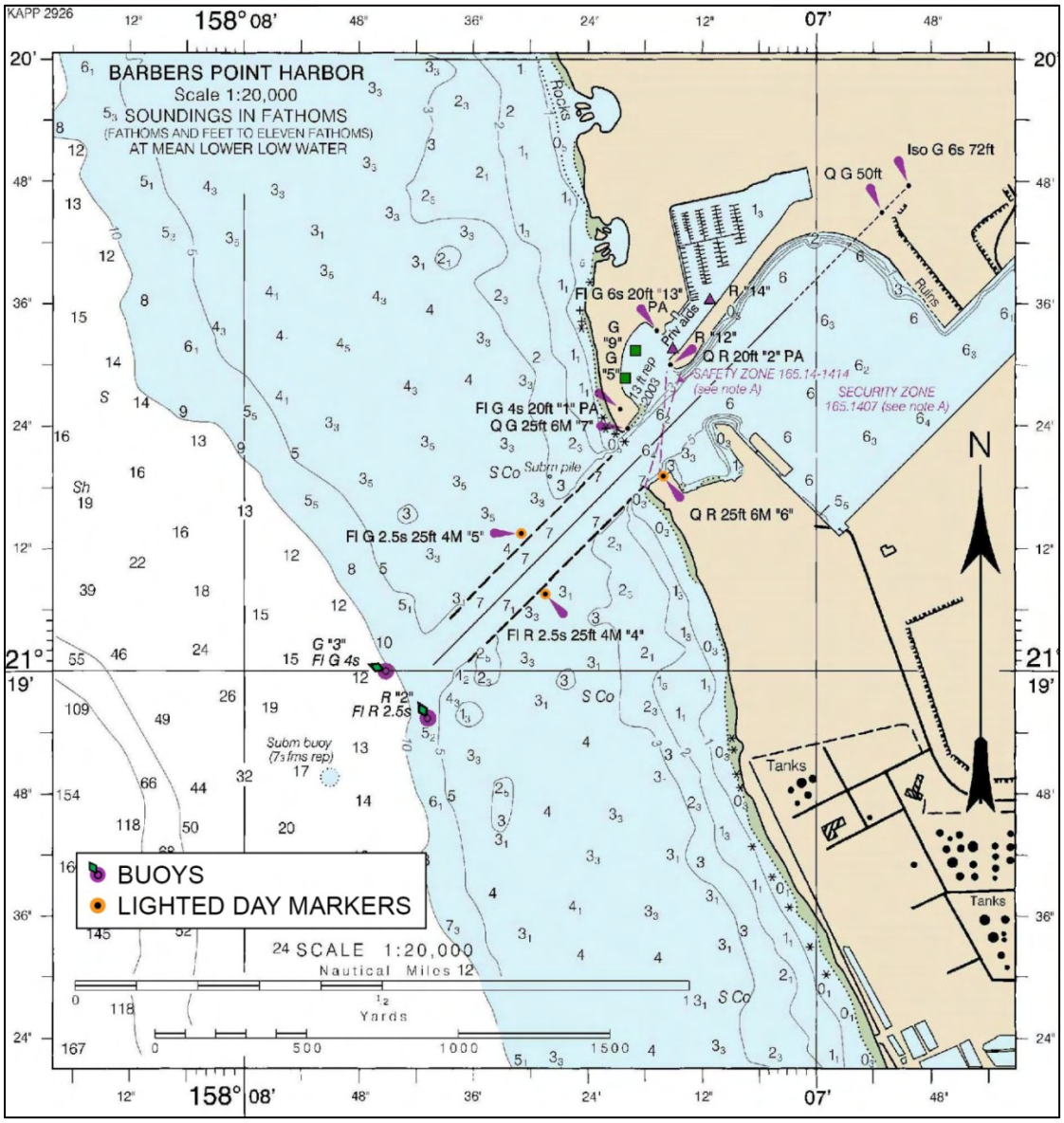


Figure 3.8 – Entrance Channel and Markers to KBPH
(Source: Island of O'ahu NOAA Chart 19357)

According to the Hawaii Pilots Association, the positioning of buoys 2 and 3 that mark the channel entrance are unreliable. When the *MV Voge Trader* grounded in 2010, the ship was hard aground in between the two entrance buoys, about 150 feet inside of buoy 2 *(Figure 3.9)*. In addition, lighted day markers 4 and 5 are positioned 70 to 90 feet outside of the sides of the channel. Visually from above the surface, this causes the channel to appear 30 percent wider than it actually is.

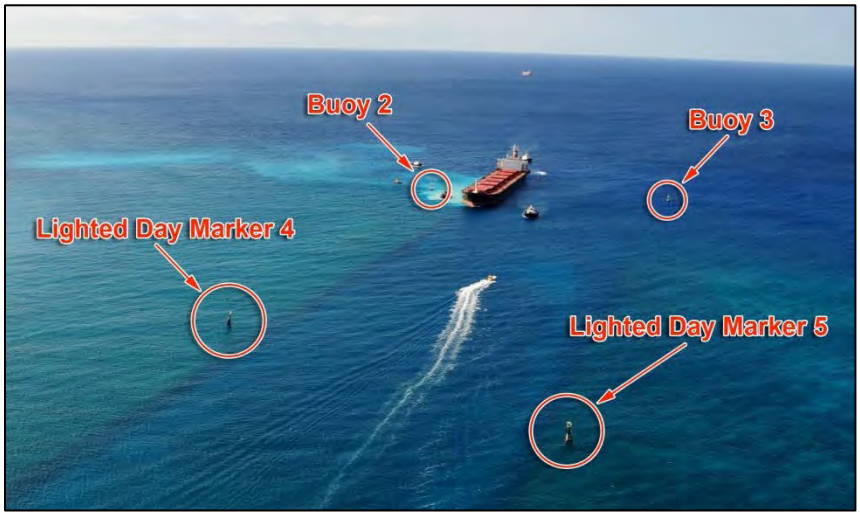


Figure 3.9 – The Coal Vessel *MV Voge Trader* Aground at the KBPH Channel Entrance Inside Buoy 2

KBPH's entrance range lights *(Figure 3.10)* are less sensitive than the range lights for Honolulu, Kahului, Hilo and Nawiliwili harbors, all of which have wider approaches and more predictable currents. Sensitivity depends on the distance between the two range markers. That is, the greater the distance between the two range lights, the greater the sensitivity at a given distance from the range. The Honolulu Harbor range is 35 percent more sensitive than KBPH, Nawiliwili is 80 percent, and Kahului and Hilo harbors are over 400 percent more sensitive than the KBPH range lights.

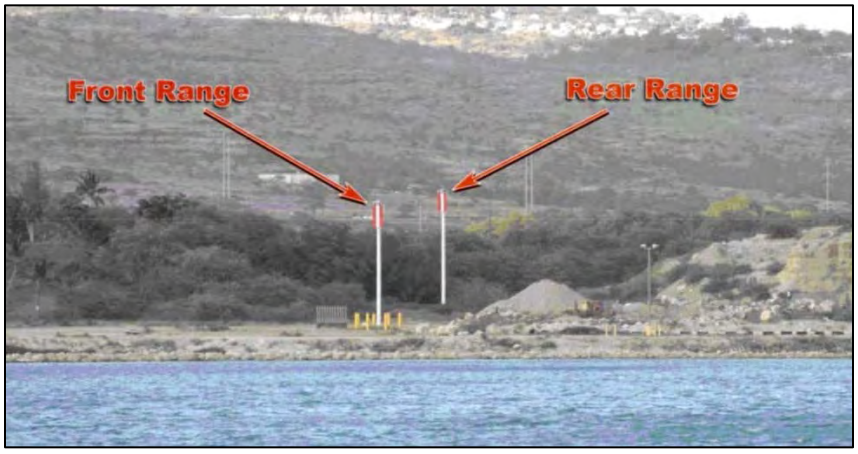


Figure 3.10 – Location of Existing Range Lights
(Source: Barbers Point Harbor, Nighttime Simulation, 2007)

Figure 3.11 – View of KBPH Range Lights from the Bridge of a Panamax Bulk Carrier Inbound Transit at Lighted Day Markers 4 and 5

3.5 Physical Facilities

3.5.1 Harbor Basin

The 92-acre main basin measures 2,300 feet by 1,800 feet, and is 38 feet deep. An expansion area was provided in 1997 by the removal of 15 acres of fill. This area measures 600 feet by 1,100 feet, and is also 38 feet deep.

KBPH was originally designed to accommodate C7-class vessels with a maximum length of 720 feet, beam (width) of 95 feet and draft (depth) of minus 34 feet. Although USACE has recommended a three-foot UKC while navigating through the basin, many harbor vessels are operating at the 36-foot maximum allowed draft, with two feet UKC in the basin. Handymax and Panamax tank ships can have a draft up to 40 or 42 feet, but must have a partial load to accommodate the 38-foot draft. Dry-bulk shippers suggested the need for a deeper draft in the harbor basin to allow for fully loaded vessels.

3.5.2 Piers/Yards

The main piers of KBPH are Piers 5A to 7 *(Figure 3.13)*. They form a continuous wharf approximately 2,700 feet long. Piers 5A to 7 are constructed of reinforced concrete with concrete piles, with a concrete apron surface 58 feet wide. Design loads are a minimum of 1,000 pounds per square foot plus a 30 percent impact load. Pier elevation is +9.0 feet above mean lower low water.

Adjacent to these piers is a supporting concrete-paved storage yard of approximately 47 acres with 45,000 square feet of shed space that is used to store and handle general cargo. The storage yard has hooded lights mounted on 80-foot high poles. Piers 5 and 6 also contain pipelines that carry ethanol and various fuel products, as well as unused LPG lines. At the south corner of the basin is a 150-foot long Finger Pier used as layberth for tugs and other small vessels. The Barge Basin (Pier 1) adds another 255 feet in linear berth. Areas for ship repair and dry dock are located at Piers 3 and 9. The remaining piers are unimproved. The existing piers and tenants at KBPH are shown in *Figure 3.13* and detailed below as well as in *Section 3.7.1*. In recent years, KBPH berths have become increasingly congested, causing berthing conflicts between dry- and liquid-bulk operations.

Boat Ramp / Loading Slip

A haul out slip for a boat ramp is located on the makai side of the Pier 1 turning basin, on the starboard side of the harbor entrance. The ramp is leased to The Phoenician, LLC, a boat and yacht repair company adjacent to KBPH. A traveling boat hoist can be maneuvered over the loading slip to pull boats out of the water for repair.

Figure 3.12 - Super Yacht *Silver Lining* in the Phoenician, LLC Loading Slip
(Source: http://www.thephoenician.net/maps.htm)

Pier 1

Pier 1 is the original Barbers Point Barge Harbor, located at the entrance to KBPH. It measures approximately 255 linear berth feet with a depth of minus 23 feet. Pier 1 has approximately five acres of paved adjacent concrete storage area. This berth provides mooring to load a bulk LPG barge for interisland shipments *(Figure 3.14).* Additional liquid-bulk pipelines are also located at Pier 1, but have not been used since 2008. The pier can also be used to berth tugs and small vessels of shallow draft.

Because of its distant location away from other harbor activities, Pier 1 is also the offloading pier for commercial, Class A high explosives. Movements of such high explosives are limited to a maximum of two, 10-ton containers at any one time. They must be offloaded immediately upon arrival and promptly moved out of the harbor area. Pier 1 is poorly sheltered from incident wave energy. Ocean wave surge conditions affect the utility of this pier during seasonal high surf periods and surge conditions.

Figure 3.13 – KBPH Existing Tenants and Neighboring Landowners

Figure 3.14 – Propane Barge with Tug Assist at Pier 1

Pier 2

The Pier 2 area is a currently unimproved revetment. The primary function of the revetment is to provide inner harbor breakwater protection for the inner harbor's main basin. A recent marine assessment shows a proliferation of corals along the rock jetty slope at this location. This pier area has a very shallow draft and experiences periodic wave surge conditions.

Figure 3.15 – KBPH Unimproved Pier 2 Area Revetment

Pier 3/Marisco Mooring

This area provides unimproved mooring for top-side repair operations by Marisco. The landside improvements include an office, warehouse, machine shop and painting structures totaling 52,950 square feet.

Figure 3.16 – Pier 3, Marisco Mooring Area

Pier 4/Finger Pier

The Finger Pier accommodates mooring of support vessels including tug boats and workboats. This concrete, pile supported pier is approximately 150 feet long by 15 feet wide. One water spigot serves the Finger Pier, but it does not have electrical power or gated access. The Pier 4 landside area consists of 26,468 square feet of asphalt concrete paved parking area, and an unpaved open service area of 21,972 square feet. Spill response and other fuel-related equipment are stored in containers close to the pier face for ease of access and timely response deployment. In the past, this pier was used for excursion vessels and an intraisland passenger commuter ferry.

Figure 3.17 – Pier 4, Finger Pier

T-Pier

Located at the intersection of Piers 4 and 5A, this pier serves to provide a mooring point for two 25-foot shallow draft oil spill boom/response vessels stationed and prepositioned at the port. The pier, which measures 38 linear feet on each side and 26 linear feet at the top of the T, does not have water spigots or shoreside power connections.

Pier 5A

Pier 5A is located in the southwest corner of KBPH and provides mooring for sand, aggregate, neo-bulk (e.g., lumber and building materials), and container vessels. It is a 300-foot extension of the original Pier 5. Pier 5A is a reinforced concrete-decked wharf supported by concrete piles, contiguous with Pier 5. An integrated barge ramp built in Pier 5A can be used for roll-on/roll-off (RO/RO) cargo operations. A Transit Shed containing 45,000 square feet of covered storage is located to the east of the pier on the paved concrete storage area. Sause Bros. shipping company leases a portion of the cargo yard for their container terminal.

Pier 5

Pier 5, also known as Pier 5B, is located north of Pier 5A and provides mooring for sand, aggregate, neo-bulk, container and petroleum tank ships. It is considered a bulk-unloader berth, and an alternative RO/RO berth. The reinforced concrete-decked wharf is supported by concrete piles and provides 800 linear berth feet. A 128-foot x 17-foot heavy lift concrete pad with additional support piles and a thickened dock apron slab for unloading heavy cargos is located at the northern end of Pier 5 and adjacent to Pier 6. The pad at the heavy lift area is rated at 233.5 kips, which equates to 233,500 pounds or 116.75 short tons. Kip is a unit of force used by architects and engineers to measure engineering loads; one kip equals 1,000 pounds. The entire area of the dock apron that comprises the designated heavy lift pad is reinforced, with structural engineered design criteria and an operational lifting layout for the positioning of a 300-ton capacity mobile crane to operate with four stabilizing outriggers. It is anticipated in the future that new-generation mobile cranes will have a lifting capacity of 450 tons.

Pipeline hatches for loading ethanol and fuel products at KBPH are located along the Pier 5 apron *(Figure 3.18),* which is adjacent to the berth that Sause Bros. uses (Pier 5A) for unloading cargo into the warehouse and stacking areas. A fuel barge or tanker ship at Pier 5 often infringes on the berth at Pier 5A. Specifically, the berth length available at Pier 5A is too short for Sause Bros. to bring its largest 438-foot barges and towing unit alongside the berth without the barge overhanging onto Pier 5. Since interisland fuel barges are in port for regular port calls several times a week, Sause Bros. operations and fuel transfer operations experience operational challenges and occasional berthing conflicts with Sause Bros. calls every three weeks. These operational conflicts for Sause Bros. are anticipated to be fully acerbated in the future with their liner service barge frequency projected to increase to every two weeks in the near future.

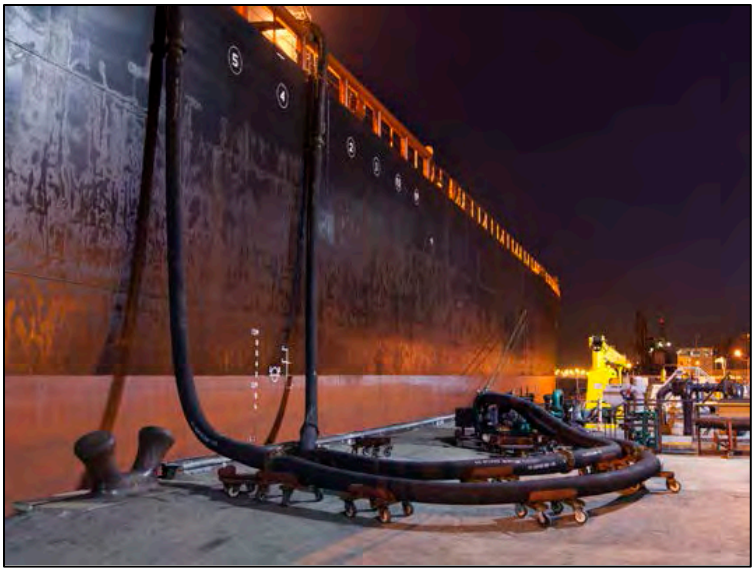


Figure 3.18 – Example of a Fuel Hose Connection

Pier 6

Mooring for dry-bulk, neo-bulk, general cargo, liquid asphalt, scrap metal, coal and petroleum tank vessels is provided at Pier 6. Pier 6 is a continuation of the contiguous pier, located roughly midway along the west edge of the KBPH basin. Pier 6 is a reinforced concrete-decked wharf supported by concrete piles, and provides 800 linear berth feet. Harbor users have expressed concern that Pier 6 is frequently congested. This pier contains a coal bulk unloader/trenched conveyor system *(Figure 3.19)* to allow the offloading and transfer of bulk coal. Unfortunately, the bulk unloader has frequent breakdowns, causing the coal ship to stay at the berth approximately one third longer than it would normally need to. This inefficiency causes berthing problems for other users of the harbor.

Figure 3.19 – The Pier 6 Bulk Unloader Offloads Coal to a Conveyor System. The Pier 7 Cement Unloader is in the Foreground.

A temporary pipeline is constructed for each liquid asphalt shipment. The dock pipeline is designed with an interchangeable orientation that provides for the liquid asphalt transfer at either Piers 6 or 7. This asphalt is pumped through a heated pipe and is stored in two 148,000-barrel capacity, heated, above-ground storage tanks at the GLP Asphalt Terminal.

Pier 6-½

The Hawaiian Cement barge *Punapau* calls between the Piers 6 and 7 (also known as Pier 6-½). The *Punapau*, a weekly (and sometimes two or three times a week) scheduled interisland cement bulk barge, can only berth at this location due to the position of the cement pipeline. Product is loaded from Hawaiian Cement's storage silos and pumped to the cement barge utilizing their dedicated 300 ton-per-hour pneumatic cement loadout hose system. The *Punapau* also uses Pier 6-½ as layberth when it is not in operation.

When moored at Pier 6-½, the *Punapau* pushes vessels at Pier 7 back, limiting gangway access at the vessel's end due to the 100- to 150-foot overhang beyond Pier 7 (towards Pier 8). This configuration with *Punapau* at 6-½ and a vessel hanging off Pier 7 can make it difficult for a fuel tanker to offload at Pier 6, although it does allow a dry-bulk vessel to berth *(Figure 3.20).* If a vessel is properly berthed at Pier 7, the *Punapau* is prevented from loading at Pier 6-½. To further complicate matters, the *Punapau* will soon be replaced with a larger barge requiring additional linear berthing provisions.

Figure 3.20 – A Vessel Overhang at Pier 7. *Punapau* Fits in Between the Larger Vessels and Creates Encroachment on Both Piers 6 and 7.

Pier 7

Piers 7 is located at the northeast corner of KBPH, and provides mooring for dry-bulk, neo-bulk, general cargo, liquid asphalt, scrap metal and cement vessels, and is an alternative RO/RO automobile carrier berth. Pier 7 is a reinforced concrete-decked wharf supported by concrete piles with 800 linear berth feet. Occasionally, surge within the harbor creates vortex conditions within the harbor expansion area adjacent to Pier 7.

Imported cement products are discharged from Panamax-sized bulk carriers utilizing a pneumatic cement ship unloader, which operates on a traveling rail system at Pier 7 *(Figure 3.19)*. A special pump vacuums the bulk cement pneumatically via an underground product pipeline from cargo ships to Hawaiian Cement's two 30,000 ton capacity storage silo domes.

The Pier 7 yard has a narrow paved cargo yard area.

Pier 8

The Pier 8 area is hard sediment coral which was left unimproved after the harbor extension was dredged. The shore is vertical with a depth of minus 38 feet. Shoreside revetment systems were installed by DOT-H at the junctions of Piers 7/8 and 8/9 between 2008 and 2011, to reinforce the corners of the harbor extension against erosion (*Figure 3.21*).

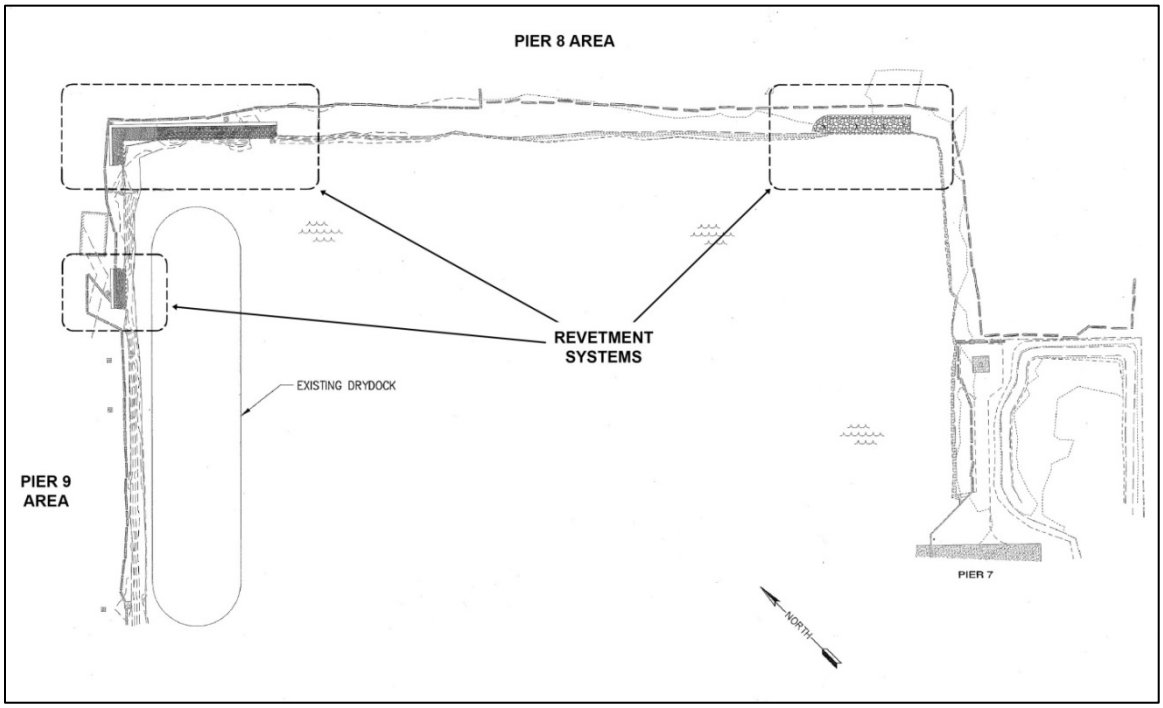


Figure 3.21 – Sheet Pile Embankment Reinforcement at Piers 7/8, 8/9 and 9

Pier 9

The Pier 9 area serves as an unimproved mooring for Marisco's floating dry dock *Lil' Perris*. Shoreside revetment was installed adjacent to the floating dry dock in 2011 to prevent erosion *(Figure 3.21)*. Further reinforcement may be required to maintain integrity of the harbor walls.

The landside area of Pier 9 is used as a storage yard by Marisco (adjacent to the floating dry dock) and Healy Tibbitts Builders, Inc. (Healy Tibbitts) *(Figure 3.22)*. Both Marisco (5,000 square feet) and Healy Tibbitts (93,775 square feet) operate under a revocable permit (i.e., month-to-month) for the storage of equipment, parts and machinery necessary for their operations. The land area is unimproved, therefore, these businesses rely on generators for electricity and temporary restroom facilities. An expanse of land behind the storage yards was the site of a coral stockpile *(see Section 3.5.4)* for many years, and was recently removed.

Figure 3.22 – Pier 9 with *Lil' Perris* Dry Dock in the Foreground and Healy Tibbitts Storage Yard in the Background

Pier 10

The Pier 10 area is hard sediment coral which was left unimproved for approximately 525 feet, where a surge protection revetment begins and continues around the inner jetty (mole) of the harbor basin. The shore is vertical with depths to approximately minus 38 feet. There is some caving and erosion occurring along the face. The Healy Tibbitts storage area also fronts this location.

Figure 3.23 – Unimproved Face of Pier 10

3.5.3 Facilities

Harbor Office

A Harbor Office building and Personnel Shelter, to support DOT-H personnel, are located near the southeastern border of the KBPH property near the corner of Access Road and Malakole Street. This office is approximately 700 square feet, and was originally Hawaiian Dredging's construction office when they were dredging the harbor *(Figure 3.24).* A carport covers two vehicles and provides minimal storage.

Figure 3.24 – KBPH Harbor Office and Carport

The Personnel Shelter consists of a men's and women's restroom, with a covered lanai. Picnic benches and a microwave provide a rest area for maintenance workers and other harbor users *(Figure 3.25).*

Figure 3.25 – Personnel Shelter Adjacent to KBPH Harbor Office

Transit Cargo Shed

A Transit Shed containing 45,000 square feet of storage is located to the east of Pier 5A on the paved concrete storage area. It was built to shelter goods and cargo from exposure to the elements. Power, water and restroom facilities are available. Sause Bros. currently houses their office trailer inside the Transit Shed. DOT-H also stores their maintenance vehicles here.

Figure 3.26 – KBPH Transit Cargo Shed

Marisco Office/Warehouse and Miscellaneous Worksheds

Marisco is a DOT-H tenant that utilizes the landside of Pier 3 for ship maintenance and repair activities. This location includes a pre-engineered metal three-story office building with adjacent warehouse, machine shop, and sandblasting/painting structures totaling 52,950 square feet. The office building is 15,000 square feet on three levels of 5,000 square feet each. The adjacent one level warehouse portion is 30,000 square feet used for ship repair work. The machine shop is a steel pre-engineered building of 4,800 square feet which provides the capabilities to repair the vessels.

Figure 3.27 – Marisco Office Building and Warehouse

Hawaiian Cement Terminal

Hawaiian Cement is a DOT-H tenant that has a 3.5-acre terminal *(Figure 3.28)* at Pier 7 which consists of two 30,000-ton-capacity storage domes, a two-lane truck loadout station, an administrative office, and covered storage.

Figure 3.28 – View of the Hawaiian Cement Storage Domes and Truck Loadout Station

GLP Asphalt Terminal

GLP Asphalt is a DOT-H tenant that has a terminal of approximately 4.5 acres, located east of the Hawaiian Cement Terminal *(Figure 3.29)*. The GLP Asphalt Terminal consists of a tank yard, fuel storage area, heating plant area, and transportation area. The main tank area includes two 148,000 barrel (bbl) capacity above-ground storage tanks (AST) that store asphalt cement. The day tank area includes two 5,000 bbl pumping tanks. The fuel storage area includes two 8,000 gallon capacity ASTs used to store low-sulfur diesel fuel and two 5,000 gallon capacity ASTs used to store extracted heavy asphalt bottoms and heating oil. The transportation area contains an office building, motor control center, maintenance building, parking area, and asphalt cement loading area.

Figure 3.29 – GLP Asphalt Terminal
(Source: http:/hawaiiasphalt.org/about/photo-gallery/)

AES Office Building

AES has a small two-story office at the Pier 6-½ yard area, adjacent to the beginning of a 1.6-mile long overhead coal conveyor system to the AES plant and storage yard in James Campbell Industrial Park.

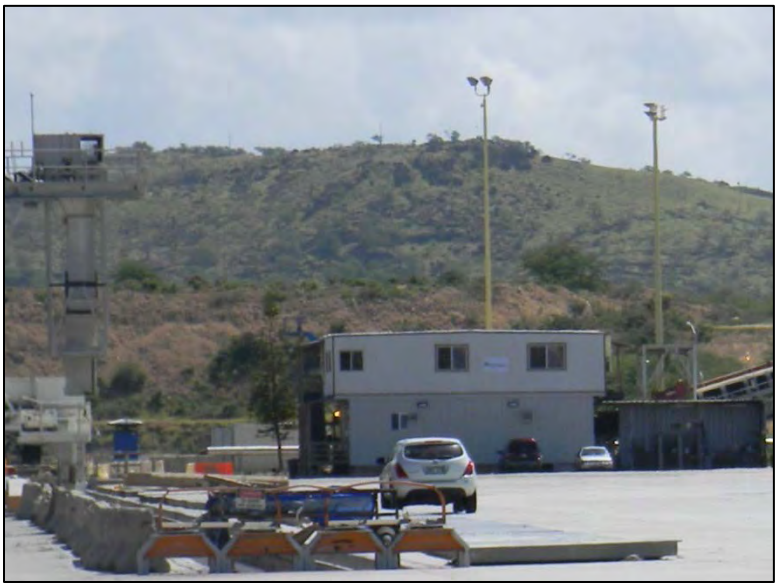


Figure 3.30 – AES Office at Pier 6-½

Grace Pacific Hot-Mix Asphalt Batch Plant

The primary functions of the Grace Pacific facility include hot-mix asphalt (HMA) manufacturing, aggregate storage, and the crushing and screening of reclaimed asphalt pavement. The HMA plant produces over 200,000 tons of asphalt pavement each year for O'ahu's road construction industry. The buildings are all portable and include a guard shack, two offices, two equipment storage containers, a quality control lab, and a one-lane truck loadout station.

Figure 3.31 – Grace Pacific Hot-Mix Asphalt Batch Plant

3.5.4 Coral Stockpiles

Dredging of the harbor basin in the 1980s produced approximately 3 million cubic yards of coral covering 100 acres and forming 30- to 40-foot high mounds. These coral stockpiles are grouped in five locations, primarily to the north and east of the harbor basin *(Figure 3.32)***.** This dredged material remains stored until it is sold for construction and infrastructure improvement projects. Material is withdrawn from the stockpiles for processing at a rate dependent on local demand for construction materials. In view of the high level of construction activities on O'ahu over the foreseeable future, the marketing and sale of these stockpile materials is expected to take five years or less.

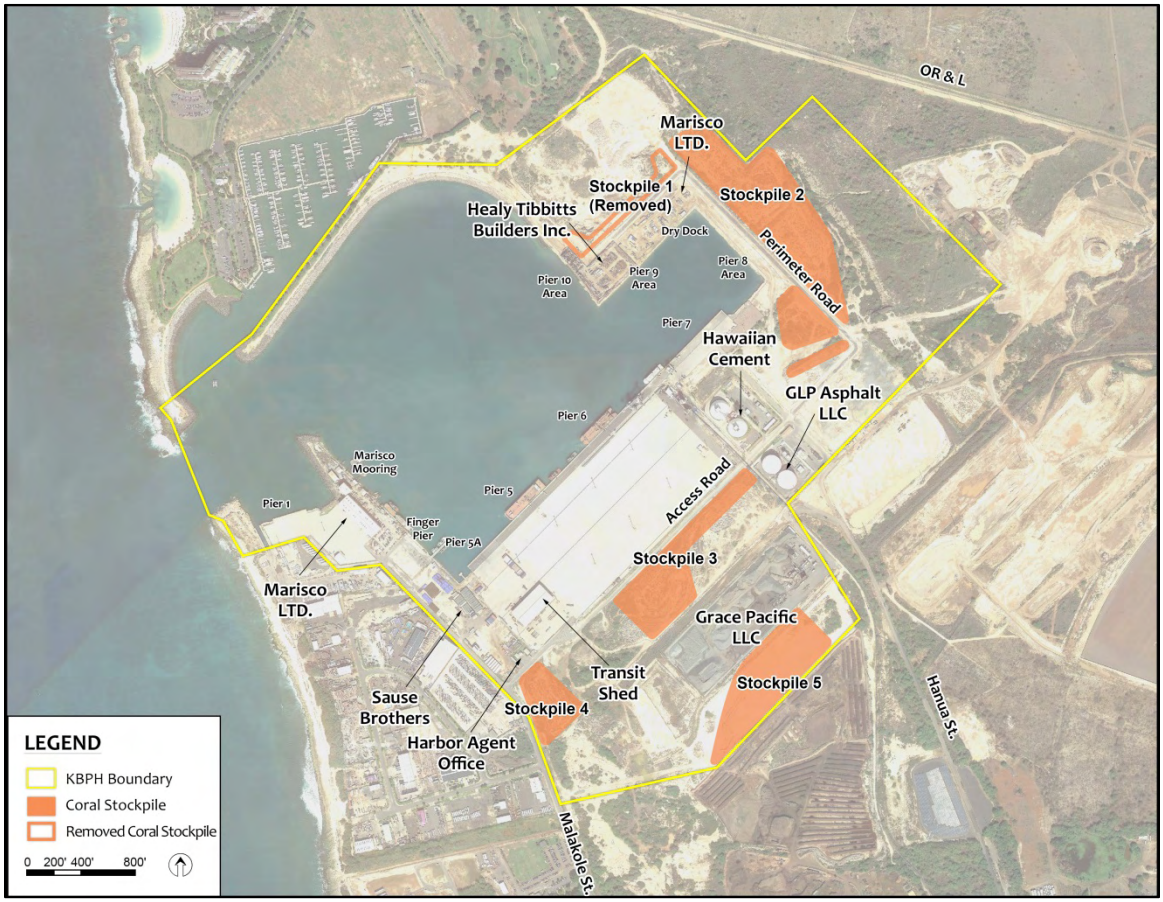


Figure 3.32 – Locations of Coral Stockpiles at KBPH

Stockpile 1 has been completely removed by the James Campbell Company, LLC (Campbell). The western-most quarter of Stockpile 2 *(Figure 3.33)* is almost gone (also removed by Campbell), and now the eastern-most portion of the stockpile is being harvested. This material is inferior because it contains high levels of dredging impurities (such as clay, silt, fine sand, and shells) that reduces its utility. Any construction of facilities in the mauka direction of the harbor must await the removal of most of coral Stockpile 2. Stockpiles 3 and 4 remain *(Figures 3.34 and 3.35),* and are also considered inferior due to impurities. The Department of Hawaiian Home Lands (DHHL) has recently removed portions of Stockpile 5 *(Figure 3.36)*.

Figure 3.33 – Coral Stockpile 2

Figure 3.34 – Coral Stockpile 3

Figure 3.35 – Coral Stockpile 4

Figure 3.36 – Coral Stockpile 5

3.6 Infrastructure

The infrastructure at KBPH is adequate at existing piers but needs improvement in the northern areas. Survey responses received from harbor users indicated the need for water and electrical utilities, primarily at Piers 7, 8, 9 and the Finger Pier. DOT-H provides potable water service to tenants. Other utilities, such as electricity, internet, telephone, wastewater and solid waste services are the responsibility of the tenant.

3.6.1 Power and Lighting

Electrical power for KBPH is provided by two circuits that serve the northern and southeastern portions of the harbor *(Figure 3.37)*. Power on the northern portion of the property is met by the existing 138 kilovolt (kV) Hawaiian Electric Company (HECO) Hanua substation located approximately one mile east of the harbor. HECO installed a 46 kV overhead pole line from this existing switching station to a new 46/12.47 kV substation located within the Hawaiian Cement property in the east corner of the harbor. Currently, the transformer at the substation is at full capacity, feeding the needs of Hawaiian Cement, asphalt tanks at GLP Asphalt, LLC, and one single phase 12.47 kV circuit supporting lights on Perimeter Road, lights along the mole, and a surveillance camera. The circuit runs underground on the Hawaiian Cement property, then overhead along Perimeter Road at Piers 7 and 8, and then underground at Pier 9 out to the northwestern portion of the property. The current single phase 12.47 kV overhead and underground conduit segments are outfitted to support three-phase loads, with manholes along the underground portions.

Current perimeter lighting located on the western side of KBPH along the Ko ʻOlina mole was installed by DOT-H in 1998 and is not maintained by the US Coast Guard (USCG). The mole lighting does not work anymore due to vandalism and the harsh environment, but has been identified as a priority Repair and Maintenance project. *Figure 3.37* gives an example of what the lighting looked like during operation.

Another 12 kV overhead line originating from the Malakole Substation runs along Malakole Street and terminates near the Marisco property. This supplies power to the southern and eastern portions of the property. Underground cables distribute this power via two separate underground ductline/handhole systems which run throughout the harbor vicinity and form two main branches along the southern (Branch #1) and eastern margins (Branch #2) of the harbor property. Branch #1 provides power to Pier 1, Marisco's ship repair facility at Pier 3, and Storage Yards at Piers 1 and 4. Branch #2 provides power to the coal unloader and conveyor system, Piers 5 and 6 and their adjoining storage yards, the Pier 5A Transit Shed, the Harbors Office and associated structures.

Most vessels have on-board generators to provide their own electrical power. Under Hawaiʻi Administrative Rules (HAR) Title 19, Chapter 44-2, when a vessel is docked at a DOT-H facility and requires lighting or other electric current furnished by it, the electricity shall be charged to the vessel at the cost to DOT-H plus a surcharge of 18 percent for furnishing this service.

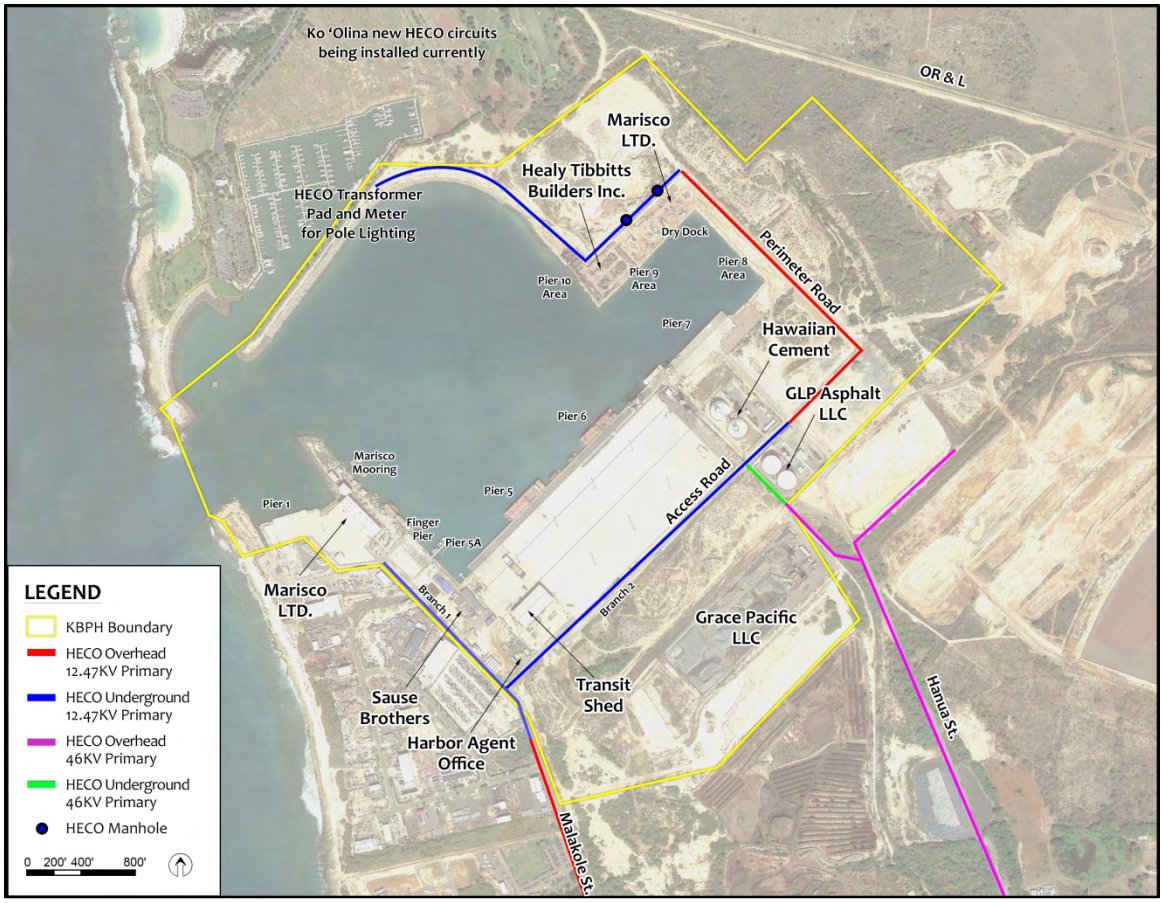


Figure 3.37 – Existing Electrical System at KBPH

Figure 3.38 - Nighttime Photo of Northern Jetty Inside Harbor Area with Existing Lights
(Source: Barbers Point Harbor, Nighttime Simulation, USACE 2007)

3.6.2 Telecommunications

Hawaiian Telcom provides telephone service to subscribing facilities via two branches of underground ductline/handhole systems. Hawaiian Telcom's underground system parallels HECO's system to distribute adequate telephone trunk cables throughout the harbor property.

3.6.3 Roadways and Traffic

KBPH is accessed through Malakole Street, primarily via Kalaeloa Boulevard as well as roads from James Campbell Industrial Park. Both Malakole Street and Kalaeloa Boulevard are privately owned by the region's major developers (Kapolei Property LLC and its affiliates) and the primary neighboring landowner (James Campbell Company and its affiliates). Easements have been established for access along Malakole Street to the harbor and Kenai Industrial Area. Upper Hanua Street east of Malakole is used exclusively for access to the Grace Pacific aggregate mixing terminal on KBPH leased lands.

Parking is available to the public at the Harbor Office and at Pier 4. The large parking lot at Pier 4 was previously used more extensively when the intraisland commuter ferry service was in operation. Parking is also available inside the secured area behind the Pier 5A Transit Shed.

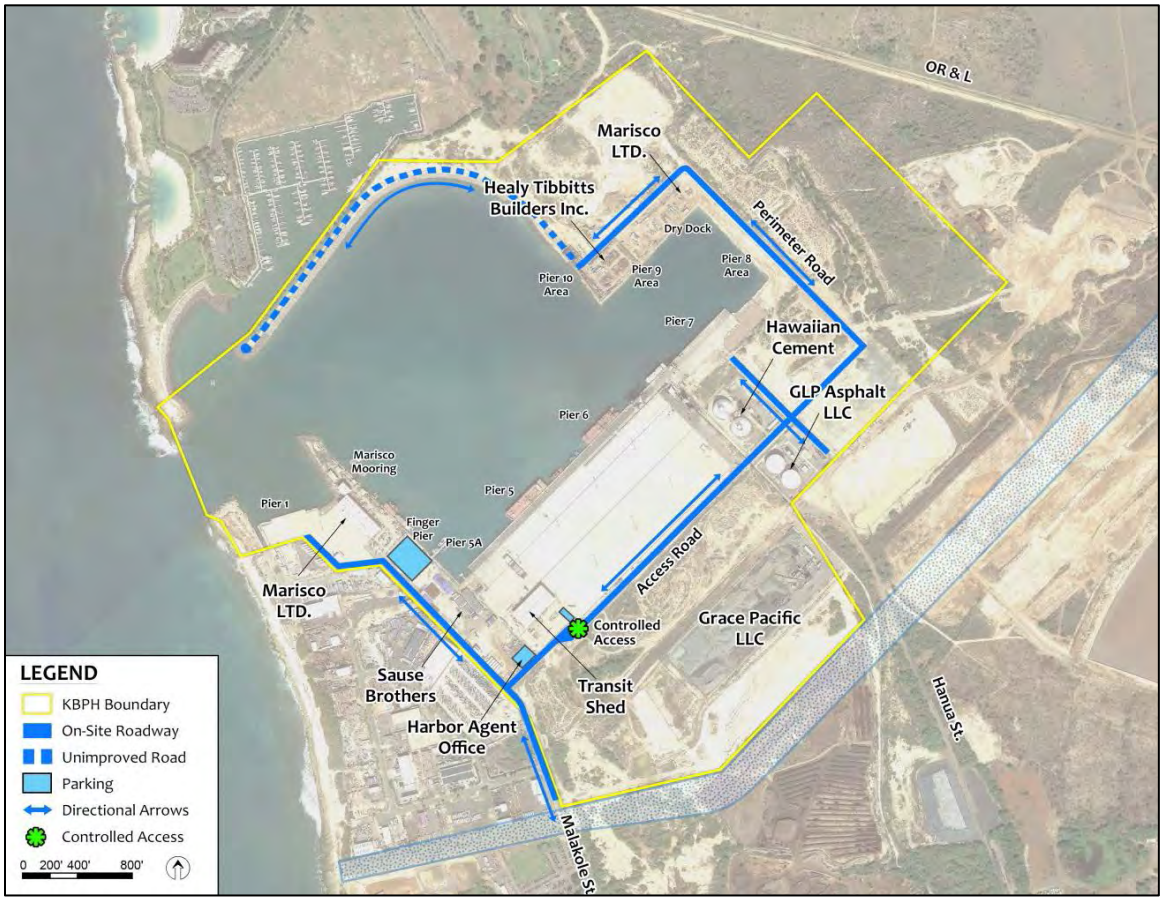


Figure 3.39 – Existing Circulation at KBPH

Traffic conditions around KBPH were documented in April, 2014 by a traffic consultant to inform the DOT-H planning effort. This analysis of intersections from Kapolei Parkway to KBPH shows acceptable levels of service during both morning and evening peak hours of traffic. For the access between Kalaeloa Boulevard and KBPH (including access to Kenai Industrial Park), level of service (LOS) for peak hours is LOS D or higher. LOS D is generally described as approaching unstable flow. LOS drops to E and F at the Kalaeloa Boulevard/Kapolei Parkway intersection for north-bound and east-west traffic (leaving KBPH and James Campbell Industrial Park). LOS E and F are defined as unstable flow (intolerable delay) and forced flow (jammed), respectively.

The current weigh station that services KBPH is on Kalaeloa Boulevard south of the OR&L tracks between Lauwiliwili Street and Opakapaka Street. This location is situated far enough away from KBPH that it does not hinder operations.

The City and County of Honolulu public bus provides service on weekday mornings and evenings. 'The Bus' route number 413 operates between the Kapolei Transit Center, KBPH, Kenai Industrial Park and James Campbell Industrial Park.

3.6.4 Fencing and Security

There are two types of secured areas at KBPH; Unrestricted and Controlled. Access to the controlled areas is limited to those carrying Transportation Worker Identification Credential (TWIC) and Maritime Security (MARSEC) clearances. Access by the public is limited to the unrestricted areas only. The commercial side of KBPH, including Piers 1 and 5A through 7, are designated secured areas and are controlled with security fencing *(Figure 3.40).* A guard is stationed at a controlled access point to the cargo yard along Access Road.

Marisco provides 24-hour security for their leased facilities at Piers 3 and 4, as does Sause Bros. for their fenced storage area near Pier 5A. Healy Tibbitts has temporary fencing around their storage yard consisting of concrete barricades and black windscreen.

Locked gated entries are located at the entrance to Pier 1 at the end of Malakole Street, near the Pier 4 area/Finger Pier parking lot, at Gate 9 across from Pier 6 along Access Road, and at Pier 7. Currently, the controlled access point at Access Road is the only gate available for approximately 40 to 60 trucks to pass through servicing one shipment from Piers 5A to 6. The back locked Gate 9 can also be used, but security to monitor the operation must be paid for separately.

Response to emergencies is provided by DOT-H Harbor Police or the Honolulu Police Department (HPD). While Harbor Police are tasked with primary enforcement, HPD jurisdiction includes KBPH. HPD officers will respond to emergencies instigated through a phone call to 911. HRS Chapter 255-24 confers powers of police officers to the DOT and any officer, employee, or representative of DOT. Such representatives may serve and execute warnings, notices and orders in any commercial harbor area, as well as arrest offenders.

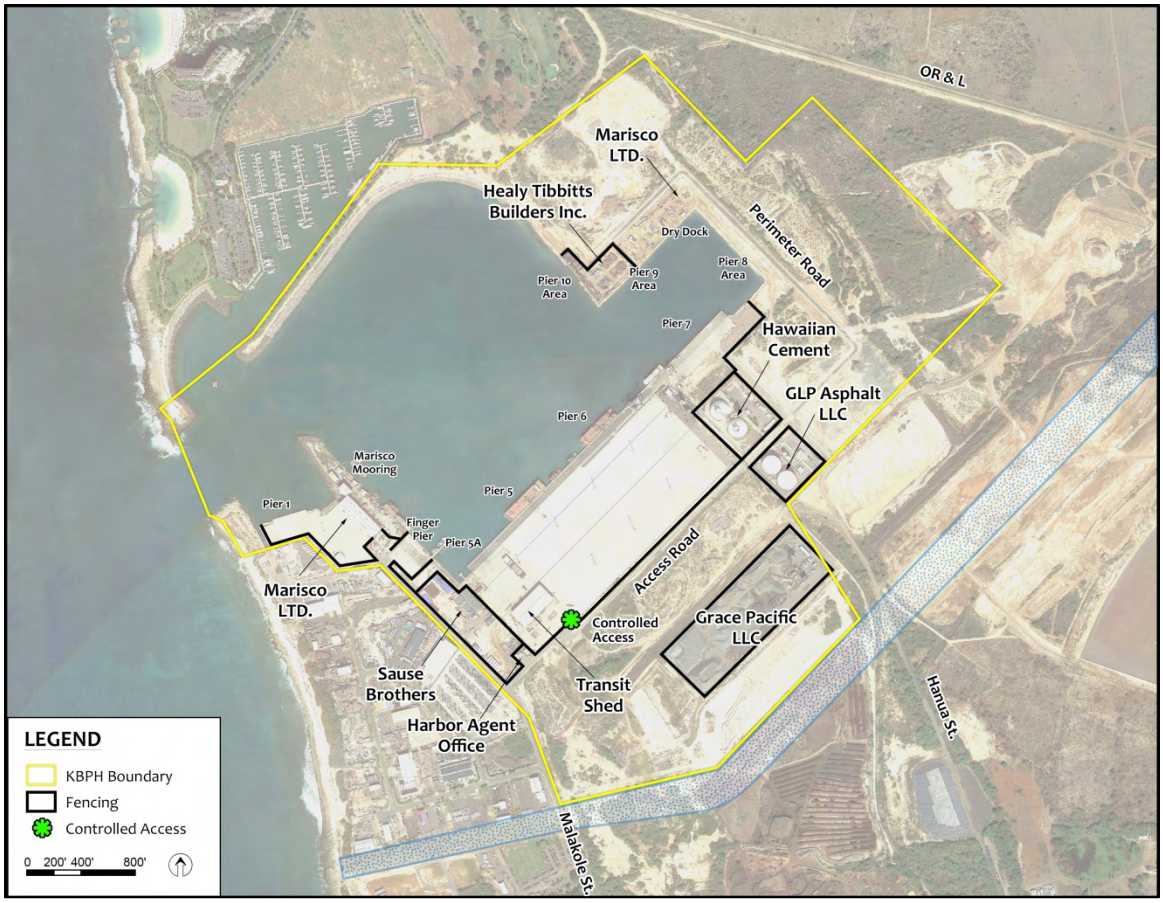


Figure 3.40 – Existing Fencing at KBPH

3.6.5 Potable Water

Potable and fire protection water for KBPH is provided by the City and County of Honolulu's Board of Water Supply (BWS) through a 20-inch water main along Malakole Street. Potable water is provided through a two-inch turbine meter that measures flow. Water for fire protection is currently provided through four, eight-inch detector check meters. DOT-H owns and operates the potable and fire protection water systems that serve the harbor after the water meters.

The existing potable water infrastructure consists of four-inch and six-inch distribution mains with service laterals, providing water service for DOT-H uses, to multiple tenants, and to vessels along the piers *(Figure 3.41)*. An underground pipe network delivers potable water to tenants, and sub-meters allow for a monthly assessment of water use.

Barges and vessels at dock fill potable water tanks at locations along Piers 5, 6 and 7, often loading a 14-day supply for use while at sea. The Harbor Agent installs a temporary water meter at the service lateral to monitor water use. Under HAR Title 19, Chapter 44-1, fresh water from the municipal water system obtained from a port is furnished by DOT-H at cost plus wharfage fee, and a vessel's agent is responsible for payment to DOT-H.

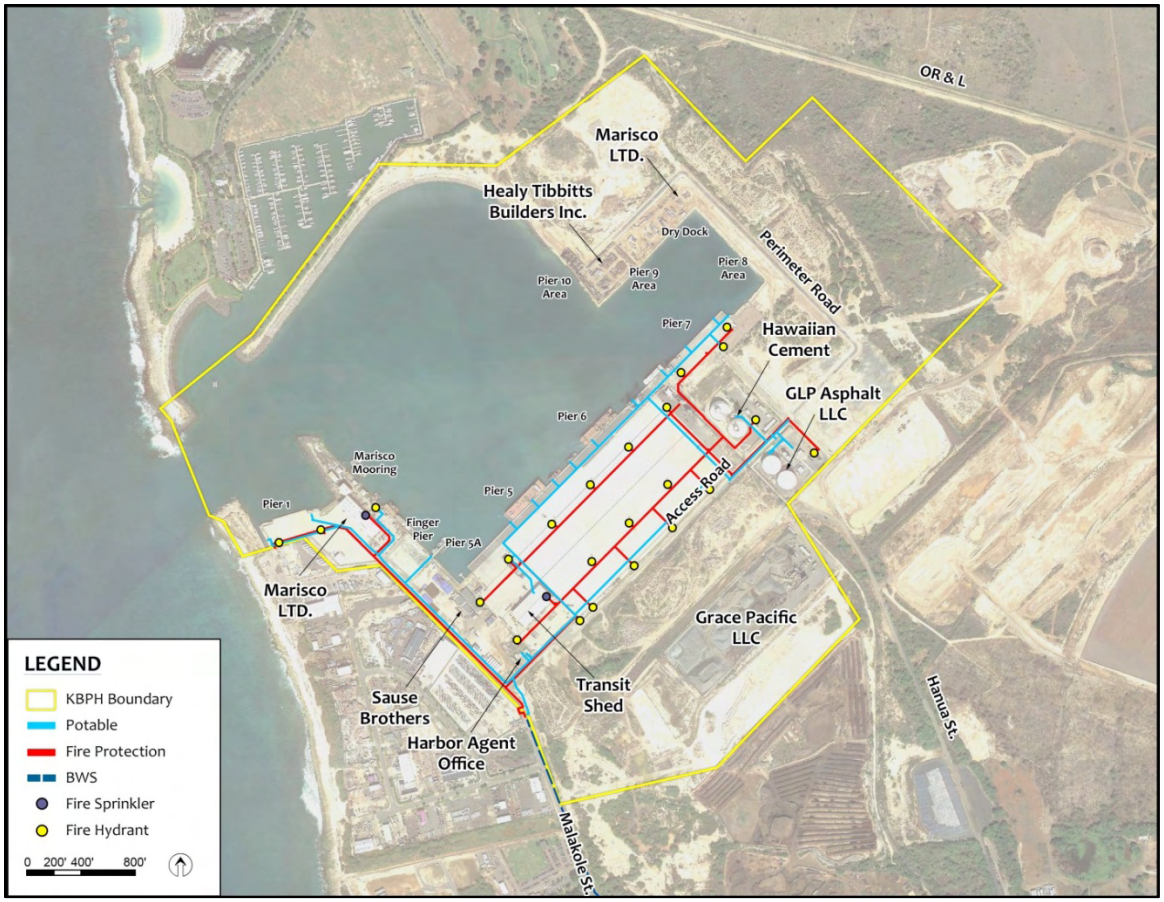


Figure 3.41 – Existing Potable Water and Fire Protection at KBPH

3.6.6 Fire Protection Water

The fire protection water infrastructure within KBPH consists of a 16-inch distribution main that serves the Pier 1 area, as well as a looped system consisting of 20-inch, 16-inch, and 12-inch distribution mains that serve 23 fire hydrants located throughout the harbor. The fire protection system also provides fire sprinkler service to two buildings (i.e., the Marisco Office and the Pier 5A Transit Shed).

3.6.7 Stormwater

Off-site Runoff

Some off-site runoff is conveyed through KBPH. A drainage ditch collects runoff from 1,580 acres of land mauka of Farrington Highway. Runoff from 19 acres just upstream from KBPH also enters the ditch, which enters KBPH property in the vicinity of Hanua Street *(Figure 3.42)*. Runoff is channeled between coral stockpiles and a dry-bulk storage area in the southwest portion of DOT-H property, where it infiltrates or evaporates. During large storm events, runoff may flow onto Malakole Street and continue south towards a drainage channel located south of and adjacent to the Kenai Industrial Park, which discharges to the ocean.

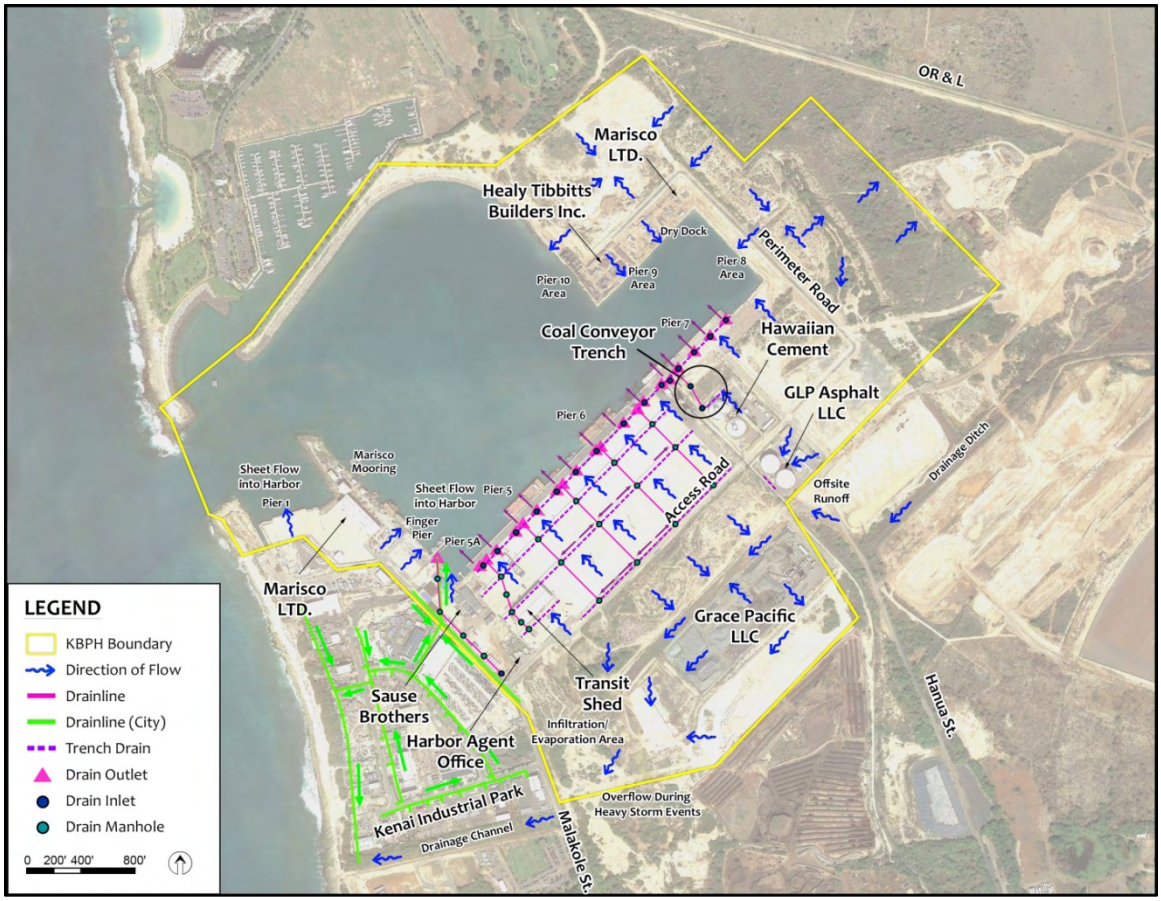


Figure 3.42 – Existing Drainage at KBPH

Onsite Runoff

The following onsite runoff description is based on the City of Honolulu's GIS database, record drawings and as-built drawings obtained from the DOT-H plan room, as well as site visits to KBPH and discussions with various tenants.

Runoff generated onsite either infiltrates into the ground, sheet flows into the harbor, or is collected and conveyed through the KBPH small municipal storm sewer system (MS4), which discharges into the harbor.

Runoff from the area northeast of the basin (i.e., landside of Piers 7, 8 and 9) sheet flows towards the harbor basin. Runoff generated around the coal conveyer trench located between Piers 6 and 7 is captured and retained in the trench, where it is pumped and hauled to the material handling yard at the AES power plant facility for treatment and disposal. An existing drain inlet in the trench has been plugged due to environmental regulations.

Runoff generated onsite for the majority of the area southeast of the basin, including the Pier 5A Transit Shed area and Cargo Yard adjacent to Piers 5A to 6, is collected through drain inlets and trench drains. These drains are then conveyed to lines that discharge into the harbor basin.

Runoff from the Hawaiian Cement property sheet flows to the harbor side of the property where runoff is channeled to a drain inlet located outside of the Hawaiian Cement property, which is then discharged into the harbor.

The GLP Asphalt Terminal property is designed to contain all stormwater generated on their property within their property. Runoff on the GLP Asphalt Terminal site sheet flows to a gravel area behind the tanks, ocean side of the property, where it infiltrates into the ground. In the case of heavy storm events, an overflow drain is located on the west corner of the property, discharging stormwater onto the Access Road. According to the manager onsite, there have not been any cases of flooding on the GLP property.

Runoff generated onsite from the Harbor Office area and the container storage yard sheet flows toward Malakole Street into drain inlets, and is conveyed through an 18-inch pipe that discharges at the Finger Pier. Runoff from Malakole Street sheet flows into drain inlets located along the property line and fence line. Flow collected from the drain inlets along the fence line are conveyed to a 5-foot by 3.5-foot concrete box drain that also discharges at the Finger Pier. This concrete box drain also collects runoff from the Kenai Industrial Park. There is a 16-foot wide drainage easement for the concrete box that is maintained by Kenai Industrial Park.

Runoff captured from the Finger Pier parking lot sheet flows towards the harbor basin through four concrete surface outfalls, discharging into the harbor basin. Filter socks to prevent sediment from flowing into harbor waters are placed across the outfalls. There is a known issue of ponding in the Finger Pier parking lot during heavy storm events.

The Marisco office site has a relatively flat terrain. The site has a 6-inch high concrete berm on the property perimeter, with breaks for surface outfalls at three locations. All stormwater runoff from the perimeter is directed toward dry wells located near the center of the site. In the case of a heavy storm event where the drywells overflow, the overflow discharges to the three surface outfalls. The drywells are not permitted nor documented with the State of Hawai‘i Underground Injection Control (UIC) program. Filter socks to prevent sediment from flowing into harbor waters are placed across the outfalls.

Runoff from Pier 1 sheet flows into the harbor. There is no infrastructure or permanent best management practices (BMPs) utilized in this area.

Runoff Water Quality

DOT-H is authorized to discharge storm water runoff and certain non-storm water discharges (listed under the permit) from the KBPH small MS4 under a notice of general permit coverage (NGPC) issued by the State of Hawai‘i, Department of Health (DOH), file No. HI 03KB488. DOT-H bears responsibility for all tenant storm water discharge, which is included in the NGPC. BMPs are detailed in the *2015 Stormwater Management Plan* (SWMP) *for Honolulu Harbor and KBPH* (URL: http://hidot.hawaii.gov/harbors/library/storm-water-management/), and are employed by tenants and DOT-H. This plan defines programs needed to operate, maintain and manage the harbor stormwater systems to include illicit discharge detection & elimination, construction site runoff control, post-construction stormwater management, and pollution prevention/good housekeeping.

Tenants are responsible to obtain their own National Pollutant Discharge Elimination System (NPDES) discharge permit(s) for any onsite operations generating non-storm water discharge into KBPH's small MS4.

3.6.8 Wastewater Treatment

Currently, onsite wastewater treatment systems are used at KBPH, as no municipal wastewater collection system serves KBPH *(Figure 3.43).* The nearest municipal sewer system is approximately 750 feet north of the KBPH property line at Kekai Place in Ko 'Olina Resort. South of KBPH, the nearest municipal facility is a pump station located more than a mile away, near the intersection of Malakole Street and Kalaeloa Boulevard.

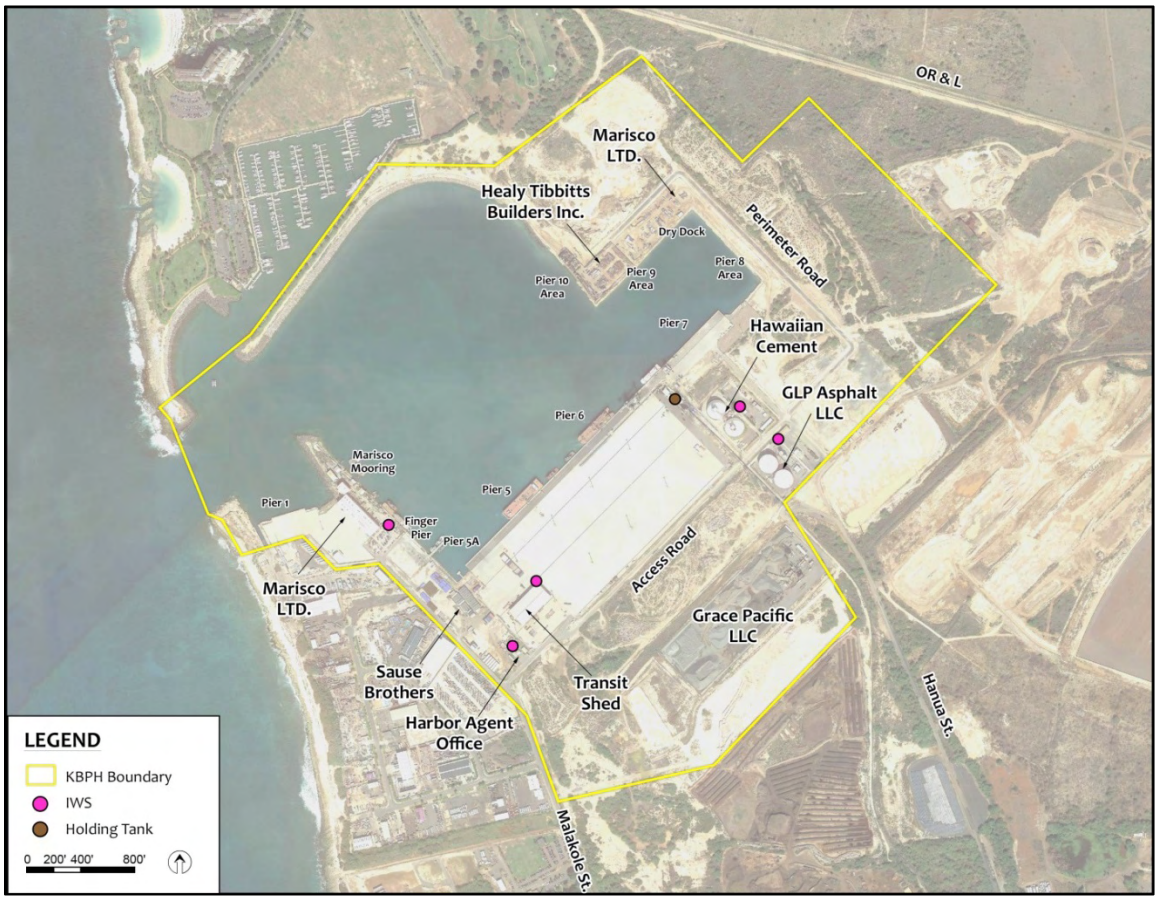


Figure 3.43 – Existing Wastewater Treatment Systems at KBPH

Six on-site wastewater treatment systems were identified at KBPH *(Table 3.1).* Five of the six are individual wastewater systems (IWS), which are generally limited to a capacity of no more than 1,000 gallons per day of domestic wastewater and generate wastewater typical of domestic uses such as restrooms or office kitchens.

Table 3.1 - KBPH Existing IWS Locations and Specifications

Location	Design Flow (Gallons Per Day)	Tank size	Absorption bed/ Leach Field (Feet x Feet)
Marisco*	unknown	unknown	unknown
Storage Shed	200	750 gallons (proposed)	12 x 17
Transit Shed	unknown	6 feet diameter x 4 feet	7 x 61
Harbor Office Personnel Shelter	2,000	1,000 gallons	18 x 32
Hawaiian Cement	unknown	1,250 gallons	15 x 34
GLP Asphalt	330	1,250 gallons	8 x 43
AES Hawaii**	unknown	unknown	--

*No information available with State DOH WWB for IWS
** No IWS; Holding tank pumped and hauled off-site for disposal

Based on available records, the five IWS each consist of a septic tank and leach field or absorption bed. The sixth system consists of a septic tank that functions as a holding tank that is pumped for off-site disposal. Onsite wastewater treatment systems are regulated by DOH, Wastewater Branch (WWB). Four systems are permitted with WWB, one system is neither permitted nor on record with WWB, and the sixth system (holding tank) does not fall under regulation by WWB.

3.6.9 Solid Waste

Domestic waste produced by harbor users is collected in dumpsters and hauled away by a private contractor. DOT-H Grounds Maintenance picks up and disposes potential pollutants left in drop-off areas or discarded illegally by the public to minimize pollution impacts on the environment. This includes abandoned vehicles, discarded vehicle lead acid batteries, scrap steel, discarded used tires, and construction debris. Where possible materials are recycled, such as used batteries, scrap steel, and green waste. A regular sweeping schedule is maintained by DOT-H to prevent pollutants from reaching the storm drain system, and sweeper debris is removed from KBPH grounds for proper disposal.

3.6.10 Fuel Pipelines

Piers 1, 5, and 6 handle fuel products. Fuel hatches at each pier connect with separate pipelines for various fuel products. Hawai'iGAS primarily uses the pipeline at Pier 1 for transfer of bulk LPG. Aloha Petroleum also has a backup petroleum pipeline at Pier 1 that has not been used since 2008. Additional pipelines at Piers 5 and 6 are owned and/or operated by Hawaii Independent Energy (HIE) or Aloha Petroleum.

Pipelines are installed, maintained and owned by the fuel industry. Easement space is leased from DOT-H. The current DOT-H easement is full and there is no room available for new pipelines in the existing energy corridor.

This interconnecting pipeline system moves fuels between KBPH and the Chevron and HIE refineries, and their respective off-site storage facilities. The refineries, in turn, convey fuels through pipelines to power plants, storage elsewhere on O'ahu, and to Honolulu Harbor. Refined petroleum products are also piped back to KBPH for loading on fuel barges and transported to Neighbor Islands. Petroleum products exported to the Neighbor Islands are mostly transported in towed multi-compartment liquid-bulk product barges.

There is currently no fueling of vessels (bunkering) from the pier-side pipeline system at KBPH.

3.7 Harbor Users and Operations

The primary harbor users at KBPH are associated with neo-, dry- and liquid-bulk cargos, as well as the maritime services industry. In addition to the companies that are importing the products, other users include those groups that support maritime operations such as ship agents, pilots, tug operators, stevedores, emergency fuel responders, and ship maintenance and repair. The following is a list of KBPH users.

Dry-Bulk/Neo-Bulk
- AES Hawaii, Inc.
- National Oilwell Varco – Ameron Hawaii
- Sause Brothers, Inc.
- Schnitzer Steel

Liquid-Bulk/Dry-Bulk
- GLP Asphalt, LLC
- Grace Pacific, LLC
- Hawaiian Cement

Fuel Liquid-Bulk
- Aloha Petroleum, Ltd.
- AmeriGas/Oahu Gas Service
- Chevron USA, Inc.
- Hawaii Independent Energy
- Hawaiian Electric Company, Inc. (HECO)
- Hawai'iGAS

Service Providers
- Clean Island Council
- Dae Han Shipping Agency, Inc.
- Foss Maritime Company
- Hawaii Marine Resources, LLC/ P&R Water Taxi
- Hawaii Port Pilots Association
- Hawaii Stevedores, Inc.
- Hawaiian Crane & Rigging
- Hawaiian Tug and Barge/Moana Pa'a Kai
- Healy Tibbitts Builders, Inc.
- Inchcape Shipping Services
- Int'l. Longshore & Warehouse Union
- Kalaeloa Partners, LP
- Kirby Offshore Marine
- Marine Cargo Surveys of Hawaii
- Marisco, Ltd.
- Maritime License Center
- McCabe, Hamilton & Renny Co.
- Norko Marine Agency
- Pacific Environmental Corp. (PENCO)
- Pasha Hawaii
- Sause Bros., Inc.
- The Phoenician, LLC
- Transmarine Navigation Corporation
- Waldron Norton Lilly International, LLC

3.7.1 Current Tenants

KBPH's tenants have varying lease terms, ranging from 30-day revocable permits to 30-year leases. The following summarize the main leaseholders.

***AES Hawaii, Inc.* -** AES is an independent power producer (IPP), which imports coal and burns it to generate electrical power for HECO. Located landside behind Pier 6 ½ , AES maintains and operates a dry-bulk unloader and enclosed conveyor system that transports coal shipments to a storage yard located in nearby James Campbell Industrial Park.

***Aloha Petroleum, Chevron, Hawaii Independent Energy, Hawai'iGAS, and HECO* -** Each of these companies either has a lease for a pipeline easement, and maintains their own private petroleum riser(s) and associated underground pipeline access, or they have a pipeline throughput agreement with Hawaii Independent Energy. These pipelines directly connect Pier 1, 5 or 6 to their respective fuel storage tanks located at their off-site harbor facility.

***GLP Asphalt, LLC* -** GLP Asphalt owns and operates an Asphalt Terminal southeast of Pier 7, directly across from the Hawaiian Cement Terminal. The Asphalt Terminal imports liquid asphalt cement in bulk and provides asphalt cement storage that serves as a distribution facility. The construction of the Asphalt Terminal has prevented a recurrence of the asphalt shortages that affected Hawai'i between 2003 and 2006, and helps to ensure a consistent supply of liquid asphalt cement to meet the state's demand.

***Grace Pacific, LLC* -** Grace Pacific imports and processes aggregate and sand material in bulk used in the production of asphalt concrete for local use, and asphalt recycling operations at KBPH. The Grace Pacific facility includes hot-mix asphalt (HMA) manufacturing, aggregate storage and the crushing and screening of reclaimed asphalt pavement. The HMA plant produces over 200,000 tons of asphalt pavement each year for O'ahu's road construction. Asphalt cement is sourced primarily from the neighboring Asphalt Terminal, operated by GLP Asphalt. The facility is located on KBPH land most recently acquired by DOT-H in 2013.

Hawaiian Cement - Hawaiian Cement imports all of the cement for the state through KBPH, where it has a 60,000 metric ton storage facility and distribution terminal. From here, the cement is distributed statewide to retail and commercial companies, particularly those in the construction industry.

***Healy Tibbitts Builders, Inc.* -** Healy Tibbitts specializes in marine construction, pile driving and deep shoring systems. Their baseyard facility is located at the Pier 9 area, where they store construction equipment associated with the construction of piers and wharves, submarine pipelines and cables, offshore structures, dredging, pile driving, marine heavy lifts, and marine transportation.

***Marisco, Ltd.* -** Located at the Pier 3 area on the southwestern edge of the harbor basin, Marisco maintains and operates a ship repair facility and machine/fabrication shop which provides repair services and dry docking services for small commercial and government-owned vessels. Marisco's floating dry dock, *Lil' Perris,* is located at the Pier 9 area adjacent to their designated shoreside storage and base yard.

Sause Bros. - Sause provides a full range of services from ocean towing, cargo handling, and ship assists. Typical cargo handled by Sause Bros. includes neo-bulk cargos such as: lumber, plywood, paper, petroleum products, chemicals, bulk commodities, containers, and oversized, overweight, and specialty project cargos. Sause cargo fully utilizes the Pier 5A Transit Shed, and also has dedicated paved stack areas at KBPH for storage of plywood, paper, lumber and containers. These storage areas serve both the O'ahu market and transshipping of building materials to the Neighbor Islands via KBPH.

3.7.2 KBPH Cargo Commodities

The primary commodities that were handled in fiscal year (FY) 2012 at KBPH are dry-bulk and fuel products. These two cargos compose 90 percent of the vessel traffic at KBPH. Additional cargos include general cargo (including neo-bulk), gas products, and liquid asphalt. A breakdown of the berth utilization by cargo commodity is shown in *Figure 3.44*, with further discussion of each cargo below.

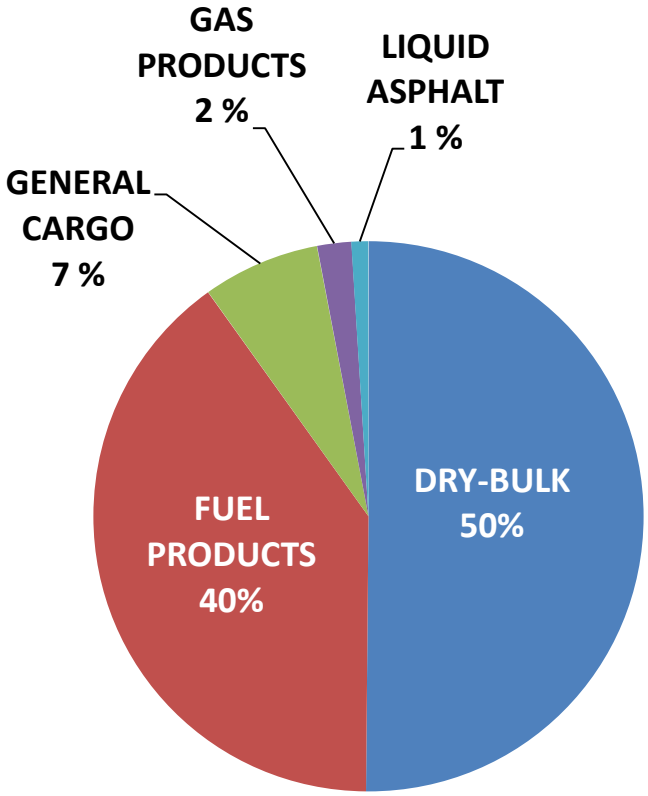


Figure 3.44 - FY 2012 Cargo Berth Utilization by Cargo Commodity

Dry-Bulk, General Cargo and Neo-Bulk

Dry-bulk products are commodities which arrive or depart in bulk (i.e., non-unitized) form. Some dry-bulk cargos (such as coal and cement) are suitable for handling by high speed devices such as marine legs or clam buckets discharging to dockside receiving hoppers or conveyor systems. For example, coal arriving at KBPH is handled by a continuous ship unloader. The coal is conveyed to off-site storage areas. Other dry-bulk products (such as sand and aggregate) are landed onto the cargo yard and hauled away in semi-trucks.

Inbound dry-bulk cargos arrive at KBPH in Handymax- and Panamax-sized bulk carriers. These vessels must be loaded to accommodate a draft restriction of minus 36 feet at KBPH (with conditional acceptance that extends the draft restriction to 36 feet 6 inches with a one-foot rising tide). This results in inefficiencies and cargo dead freight due to a percentage of the vessel's cargo carriage capacity not being fully utilized. Generally, dry-bulk is not transshipped from KBPH to the Neighbor Islands, and is instead delivered directly from its origin. The exception is cement, which is transshipped by a specialized, dedicated cement barge.

Typical dry-bulk commodities include coal, cement, aggregate, sand, and scrap metal. Bulk carriers arrive at KBPH approximately every five to six weeks to discharge cargos of coal imported from Indonesia, Australia and Columbia for the AES electrical power plant located at James Campbell Industrial Park. These ships typically remain on berth for approximately eight days to complete discharge of individual shipments that average over 60,500 short tons.

Bulk carriers with cargos of bulk ground cement manufactured and loaded in South Korea for Hawaiian Cement also arrive approximately every six to seven weeks. These ships typically remain on berth for approximately eight to ten days to complete discharge. Interisland cement barges average one to two transshipment port calls per week to the Neighbor Islands.

Specialized self-discharging aggregate bulk carriers arrive approximately every three months to discharge cargos of crushed rock produced and loaded in British Columbia, Canada, for Grace Pacific – these ships typically remain on berth for approximately a day to complete discharge. Sand ship calls increased from three times a year in the triennium reporting period (2002 to 2005) to once a month during the next triennium (2005 to 2008), possibly due to restrictions enacted in 2007 from removing inland dune sand from Maui, a previous construction sand source.

General cargo at KBPH includes transport trucks and machinery, general merchandise, containers, special project cargo shipments, and occasionally agricultural products. Neo-bulk is a subcategory of general cargo. Neo-bulk cargo at KBPH includes scrap metal, lumber, and dry-wall. Approximately every three months, bulk carriers arrive to load scrap metal for export to steel makers in Asia – these ships typically remain on berth for four days to complete loading. Sause Bros.' overseas neo-bulk freight barges arrive from the US Pacific Northwest, with port calls every three weeks in scheduled liner service. The frequency of this liner service is anticipated to increase to calls every two weeks, in response to increased freight service demands and special project cargo shipments to KBPH.

Fuel and Gas Products
KBPH fuel products that are either imported or exported include diesel, fuel oil, gasoline, jet fuel, LPG (propane), petroleum products, and ethanol.

Piers 5 and 6 allow for exporting refined products produced from crude oil at the refineries on O'ahu to the Neighbor Islands. Petroleum products exported to the Neighbor Islands are mostly transported in towed multi-compartment liquid-bulk product barges. Gas product barges arrive approximately once per month to discharge at Pier 1. The gas barges also occasionally accept imports from LPG ships located offshore via lightering or transfer operations. Ethanol tankers make occasional port calls in conjunction with the discharge of other petroleum products as supply demands necessitate, which average one product tank ship per month. FY 2012 wharfage report filings indicated that approximately 18 percent of ethanol is transshipped out of KBPH to the Neighbor Islands, with the balance of 82 percent for O'ahu's needs. Specialized mothership replenishment product tank ships, which provide bunker fuel to the foreign flagged fishing fleet operating in the Pacific Basin, call to KBPH every other month.

In summary, current (FY 2012) liquid-bulk traffic records inbound tank vessels arriving and discharging one to three times per month, with outbound barges loading and departing semi-weekly.

Liquid Asphalt
In the case of asphalt, all of the liquid asphalt is imported from overseas suppliers by specialized asphalt product tank ships (specialized tankers to carry heated asphalt). These asphalt tank ships arrive three to four times per year at KBPH to discharge full cargos of asphalt typically from New Brunswick, Canada, Venezuela or Southeast Asia. These ships are typically on berth for approximately two to three days. Approximately 35 percent (equating to 140,000 bbls) is laden into specially designed 20-foot ISO-insulated tank containers at the GLP Asphalt Terminal, hauled to Honolulu Harbor and shipped to the Neighbor Islands via Young Brothers on an interisland freight barge.

3.7.3 Maritime Service Industries
The two primary maritime service industries that are located at KBPH include Marisco and Healy Tibbitts. Marisco provides ship repair services including dry docking, machining, welding, blasting, painting, pipefitting, rigging, machinery troubleshooting and repairs. Healy Tibbitts specializes in marine construction, pile driving, and deep shoring systems.

3.7.4 Harbor Vessel Types and Berth Utilization
The maximum vessel size allowed in KBPH is 751 feet length overall (LOA) under ideal navigational conditions, such as clear weather conditions, rising tide, favorable current speed and direction, lighting conditions, and vessel operation. This maximum vessel size can support 58,000 short tons of bulk aggregate material for delivery at the port's present depth. *Table 3.2* below gives an overview of the typical vessels at KBPH during 2012.

Dry-bulk ships were typically present within KBPH over 26 percent of the year. Fuel ships and barges combined were present over 28 percent of the time. Tug boats utilized the KBPH berth 19 percent of the time, and cement barges 12 percent. Additional breakdown of other vessels is shown in *Table 3.3* and *Figure 3.45.*

Table 3.2 – KBPH Vessel Types

TYPICAL VESSEL TYPES	VESSEL FREQUENCY (ANNUAL AVG PER MO)	RANGE OF LENGTH OVERALL (FT)	RANGE OF BEAM (FT)	RANGE OF DRAFT (FT)	CARGO/ DEAD WEIGHT (M/TONS)	CARGO CAPACITY (BBL)
Dry-bulk Carrier Handymax/Panamax	16-20 days	492′-751′	80′ – 106′	30′ – 47′	20,000 - 70,000	n/a
Liquid Fuel Tankship Small Tankships Handysize/Panamax	14-16 days	300′- 450′ 450′ - 751′	50′ - 106′	25′ – 42′	5,300 - 75,000	30,000 - 420,000
Liquid Fuel Tankship Handysize/ ATB Tankvessel	12-14 days	450′ - 650′	80′ – 106′	30′ - 40′	8,000 - 50,000	50,000 - 250,000
Liquid Fuel Double Hulled Tank Barge	16-18 days	250′– 400′	50′ - 80′	15′- 28′	4,000 - 18,000	15,000 - 80,000
Liquid Fuel (LHG) ISO-Container/ Tank Barge	Year-round	300′ – 500′	60′ – 80′	15′ – 25′	1,500 - 3,000	3,375 m^3- 6,750 m^3
Workboat/Tug boat	Year-round	50′ - 120′	10′ – 20′	3′- 12′	100	n/a
Cement Barge (current) Cement Barge (New build – 2017)	14-16 days	184′ 224′	42′ 68′	16′ 24′	1,500 4,500	n/a
Small Commercial/ Excursion Vessel	Year-round	60′ - 232′	15′ - 45′	4′ - 13′	n/a	n/a
Freight Barge Neo-bulk & General Cargo	12-15 days	250′ - 400′	70′ – 105′	20′ – 25′	5,000 - 15,000	n/a
LPG Tank Barge LPG Tankship	4-5 days	230′ – 245′ 525′ – 600′	44′ - 82′	15′ - 32′	1,913 - 20,000	2,094 m^3 - 38,000 m^3
General Cargo Handymax/Panamax Vessel	2-4 days	492′ – 751′	70′ – 106′	25′ - 40′	15,000 – 40,000	n/a
Non-Fuel Ship Liquid-bulk	1-2 days	350′ – 650′	75′ – 106′	20′ - 40′	6,000 - 45,400	39,600 – 300,000
Other Vessels (Military, Government, Small Commercial Vessel)	4-6 days	200′ – 450′	30′ – 70′	15′ - 25′	2,000 - 7,500	n/a

Table 3.3 - Berth Utilization by Vessel Type FY 2012

Total Berthing Linear Length 3,255 ft.*	Vessel Port Calls		Vessel Berth Days	Average Port Call (hours)	Used Berth Foot Days (BFD)	Percentage Overall Berth Utilization (BFD)	Percentage of Vessel Port Call Movements
Vessel Type	Inter-Island	Overseas					
Dry-bulk Ships	0	30	171.1	136.9 hrs.	149,652.3	12.60 %	***26.20 %***
Tugs/Workboats	1,310	40	774.2	13.76 hrs.	109,214.3	9.19 %	***19.12 %***
Fuel Barges	220	3	196.4	21.1 hrs.	84,240.5	7.09 %	***14.75 %***
Fuel Tank Ships	0	59	137.2	55.81 hrs.	78,023.1	6.57 %	***13.66 %***
Cement Barges	65	0	248.7	91.8 hrs.	70,623.9	5.94 %	***12.37 %***
Excursion Vessels	1,332	0	339.4	6.1 hrs.	33,365.1	2.81 %	***5.84%***
Dry/Freight Barges	9	18	36.0	32 hrs.	14,133.5	1.19 %	***2.47 %***
LPG-Barges	50	0	32.5	15.6 hrs.	10,628.7	0.89 %	***1.86 %***
General Cargo Ships	0	5	10.9	52.3 hrs.	8,553.7	0.72 %	***1.50 %***
Non-Fuel Tank Ships	0	2	4.2	50.4 hrs.	2,992.7	0.25 %	***0.52 %***
Other Vessels	52	1	60.5	27.40 hrs.	9,680.2	0.81 %	***1.69 %***
Total	***3,038***	***158***	***2,011.1***		***571,108***	***48.06%***	***100%***

*Does not include dry dock/ship repair activity

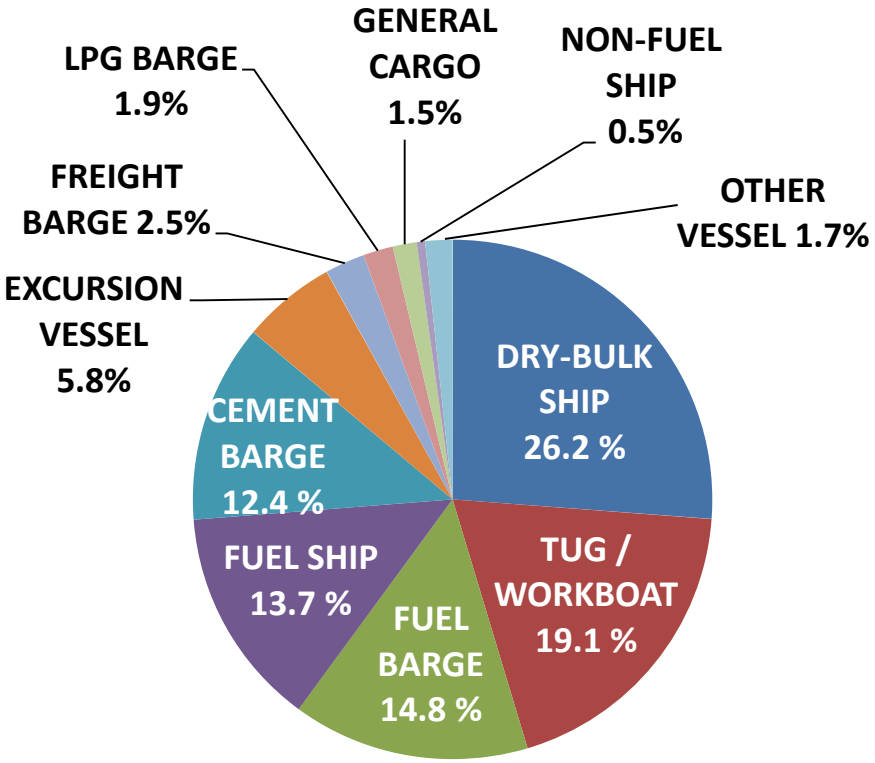


Figure 3.45 – Berth Utilization by Vessel Types FY 2012

3.7.5 Harbor Operations

Transit in and out of KBPH is limited to daylight hours under Harbor Master Notice 7-92 for overseas vessels. Some interisland tugs are allowed to transit the harbor during night hours (after sunset and earlier than 30 minutes prior to sunrise).

In 1996, the USCG Captain of the Port (based in Honolulu) amended federal pilotage waters in the vicinity of the offshore pipeline terminal off Kalaeloa. The area was expanded to be identical to that designated in 1995 for vessels engaged in foreign commerce. All foreign trade vessels and US vessels under registry operating within this area must be under the direction and control of a USCG federally-licensed and state-licensed first class pilot. US vessels engaged in coastwise trade operating within the area must be under the direction and control of a harbor pilot or vessel master holding a USCG federal pilot's license for the port transiting. Pilots are available through the Hawaii Pilots Association.

The port calls of commercial vessels are pre-scheduled with DOT-H for berthing assignment and cargo/port call activities. Mariners are requested to give 24 hours advance notice of arrival, gross tonnage, length and draft of vessel. Upon arrival at the port, vessels approaching KBPH communicate with Aloha Tower Marine Traffic Controllers for clearance to enter KBPH and proceed to their pre-assigned berth. A real-time camera (although with one to two minute delay) is located at the end of the Ko 'Olina mole to allow Aloha Tower to observe KBPH vessel traffic. The entrance channel is a mixed use channel, shared by the KBPH commercial traffic, Ko 'Olina small boats and boats using the Phoenician boat ramp. Not all users of the entrance channel are required to obtain clearance from Aloha Tower.

Berthing at KBPH is operating at its maximum capacity and is congested. Berthing conflicts occur regularly between dry-bulk carriers (coal, cement, aggregate) and fuel tank ships and barges. Interisland fuel shippers with regular schedules can make bookings in advance. However, as aggregate ships are chartered, timing and booking port calls is more difficult to schedule in advance. Therefore, it is not unusual for a dry-bulk carrier to be forced out and back from the berth by an advanced fuel vessel booking. In the past, some foreign vessels have had to wait offshore for a berth to clear, incurring vessel demurrage charges at a cost of over $20,000 to $50,000 per day.

Cargo wharfage reports recording each vessel port call and cargo activity are filed by the individual shipping companies, carriers (both importers and exporters), or ship agents with the DOT-H O'ahu District. This information is input into the DOT-H Comprehensive Information Database System (CIDS). This information is customarily filed by carriers in accordance with the DOT-H Tariff/Rate Schedules.

4.0
Future Facility Demand Assessment

4.0 FUTURE FACILITY DEMAND ASSESSMENT

4.1 Overview of Demand Assessment Methodology

The *Kalaeloa Barbers Point Harbor* (KBPH) *2040 Master Plan (2040 Master Plan)* was developed through a collaborative process using input from stakeholders, including harbor users, government agencies, adjacent land owners and the public. In addition, the *2040 Master Plan* considered relevant planning efforts of the surrounding area.

A technical advisory group made up of stakeholders assisted throughout the planning process. Stakeholder group meetings served as an opportunity for stakeholders to interact and share input with each other as the process progressed. Meetings with individual stakeholders were conducted to understand the needs of the user at a detailed level. In addition, public informational meetings were held at key junctions to ensure the public was provided an opportunity to see the various alternatives develop and to provide input.

Technical studies, forecasts and other analyses were used throughout the planning process to inform, justify and define future needs. Specifically, the following studies identified gaps and needs for the *2040 Master Plan*, which resulted in the development of a range of alternatives that were considered:

1. User demand analysis
2. Fuels market analysis
3. Berth utilization analysis
4. Land requirements analysis

To define berth and land requirements to the planning horizon year of 2040, it is possible to analyze the existing requirements for several types of cargo currently shipped through KBPH and extrapolate forecasted needs based on economic trends, coupled with projected cargo commodity quantity changes. However, history has shown that commodity types and cargo handling technologies can change significantly over time, and changes taking place over a 25-year planning horizon cannot be anticipated with certainty. For example, various fuel cargo methods of transport may transition between bulk delivery via pipeline and cargo delivery in International Standards Organization (ISO)-containers. Therefore, although this section provides facility capacities for different cargo commodities, it cannot be assumed that these capacities will be constant over 25 years. The analyses presented in this section are for the purpose of allocating pier length to accommodate forecasted demand and allocating land for harbor development. They are not intended to set design criteria. Facility design should reflect the requirements and practices of the individual user or users of the facility.

4.2 User Demand Analysis

To understand the current and possible future users of KBPH, extensive outreach was conducted with stakeholders and agencies via a website (http://kalealoaharbor2040.com), questionnaires *(Appendix E),* emails, telephone calls, small group meetings, planning workshops, and public meetings. The planning workshops were held on July 18, 2013 and April 3, 2014 for harbor users and stakeholders. The first workshop provided information and discussion about the *2040 Master Plan* process and timeline, harbor planning history, existing harbor uses and issues, current and potential harbor users, questionnaire results (located in *Appendix F), 2040 Master Plan* goals, opportunities and constraints, and preliminary *2040 Master Plan* alternatives. The second workshop provided dialogue regarding master planning methodology, *2040 Master Plan* objectives, fuels and cargo forecast, berthing analysis, future requirements, a potential bulk liquefied natural gas (LNG) facility, alternatives evaluation criteria, and discussion of alternatives.

An internal user matrix was created to capture the existing, potential and interested harbor users as well as their requirements and functional needs at KBPH. Requirements were gleaned from returned questionnaires and verified with additional communication and research. Forecast analysis enhanced by this information was based on the certainty of the future users, and the likelihood of their operations occurring at KBPH. These users were categorized by Fuels Industry, Dry-bulk Storage, Container/Neo-bulk, Shipyard, Service Provider, Excursion, and Public Service.

Fuels Industry
Prominent users that participated in the fuels industry included Hawaiian Electric Company (HECO), Chevron, Hawaii Independent Energy (a subsidiary of Par Petroleum), Aloha Petroleum, Hawaiʻi Fueling Facilities Corporation (HFFC), HawaiiGAS, AmeriGas, Stanley LNG, Hawaiʻi BioEnergy, Kirby Offshore Marine, Clean Islands Council and Pacific Environmental Corporation (PENCO). Dominant themes that arose from the fuels industry included:

- Not enough liquid-bulk berths available
- Scheduling/berthing conflicts
- Support for dedicated fuel pier construction
- Preference for deeper drafts for more fully laden vessels
- 24-hour tank ship access

Dry-bulk Storage
Prominent users that participated from the dry-bulk storage industry included GLP Asphalt; Zilkha; AES Hawaiʻi; Aloha Consulting, LLC; Hawaiian Cement; Grace Pacific; Ameron Hawaiʻi; Hidden Villa Ranch and EWindfarm, Inc. Dominant themes that arose from the dry-bulk storage industry included:

- Separate fuel pier to relieve scheduling/berthing conflicts
- Deeper harbor basin draft
- 24-hour vessel access
- Median 10 to 15 acres required for laydown area
- Additional pier amenities

Container/Neo-bulk
Prominent users that participated from the container/neo-bulk industry were Sause Brothers, Pasha Hawai'i, and Department of Defense. Dominant themes that arose from the container/neo-bulk industry included those requests by the dry-bulk storage industry, as well as the following:

- Container/neo-bulk tonnage could potentially double
- More office space needed
- 20 acres of additional emergency storage needed

Shipyard
The shipyard industry provides vessel repair and marine construction services. Prominent users that participated from the shipyard industry included Marisco, Ltd., Healy Tibbitts Builders, Inc., Pacific Shipyards International, and BAE Systems Hawai'i Shipyards. The following themes arose from the shipyard industry:

- Hot work would be hazardous near fuel storage
- Additional pier length needed
- Pier amenities (power, water) are inadequate

Service Provider
Prominent users that participated from the service provider industry included McCabe, Hamilton & Renny Co. Ltd; Hawai'i Stevedores, Inc.; Daehan Shipping Agency; Marine Cargo Surveys of Hawai'i; American Marine Corps (AMC)/PENCO; Foss Maritime Company; Inchcape; International Longshore and Warehouse Union; Maritime License Center; P&M Marine Services/P&R Water Taxi and Hawaii Pilots Association. Dominant themes that arose for the service provider industry included:

- Additional personnel shelters needed
- Pier amenities (power, water, fencing, restrooms) are inadequate
- Need for safety equipment/life rings
- Office space needed
- Harbor basin draft and channel need to be deeper
- Navigational aids should be improved

Excursion
The Star of Honolulu Cruises & Events was the only user that participated from the excursion industry. Dominant themes that arose included:

- Excursion pier needed
- More parking needed
- Pier amenities (power, water) are inadequate

Public Service
The users considered under the public service category included Hawai'i Department of Transportation, Harbors Division (DOT-H) staff and federal agencies such as Hawai'i Department of Agriculture (DOA) and United States (US) Customs. Acreage requirements were considered, including the need for a new Harbor Office; base yard for DOT-H maintenance; inspection, quarantine, and treatment facilities for DOA; and an office and inspection area for US Customs.

4.3 Fuels Market Analysis

Fuel throughput volumes for fiscal year (FY) 2012 were analyzed and extrapolated into the future by industry experts *Facts Global Energy (FGE)* and *Amergent Techs*. Together they produced detailed studies of the fuel market in Hawai'i and its potential impacts at KBPH, and made projections for future demand in a number of different scenarios, including those where refinery operations change, renewable energies expand, and liquefied natural gas (LNG, or methane) is introduced to the Hawaiian market.

Hawai'i's historical fuel demand has largely focused on fossil fuel products, but future demand is expected to change significantly. The 2008 Hawai'i Clean Energy Initiative (HCEI) required 70 percent of Hawai'i's energy to come from 'clean' sources by 2030, either by implementing conservation measures or using renewable sources in place of fossil fuels. These aggressive goals were increased in 2015 by Governor Ige to 100 percent 'clean' sources for power generation by 2045. This level of renewables in power generation, with milestones along the way, has been agreed to by the electric utilities as a binding plan, and is referred to as the Renewable Portfolio Standard (RPS). In addition to the RPS, Hawai'i's Energy Efficiency Portfolio Standard (EEPS) has helped reduce Hawai'i's oil demand by decreasing the amount of energy used in Hawai'i.

The following factors make it probable that the fundamentals of fuel demand are being transformed:

- The HCEI, RPS and EEPS will continue to reduce oil demand
- US Environmental Protection Agency (EPA) Mercury and Air Toxics Standard (MATS) aims to reduce air pollution by 2016 from coal and oil-fired power plants, causing HECO to choose between adding expensive scrubbers to their power plants, and altering or displacing their consumption of the current grade of low sulfur fuel oil (LSFO)
- By 2022 or 2025 (depending on the utilities' plan of action), it will be difficult for electric utilities to burn LSFO given the EPA's National Ambient Air Quality Standards (NAAQS) mandate
- LNG imports offer a potentially cheaper alternative, especially in the power sector
- Hawai'i refiners face a challenging business environment, threatening long-term viability

The *Fuels Market in Hawai'i: Current Situation and Future Prospects* (FGE, 2014) study located in *Appendix D* presents four fuel demand scenarios:

1. Business as Usual (BAU)
2. Renewable Portfolio Standard (RPS) falls short
3. RPS succeeds
4. Hawai'i Clean Energy Initiative (HCEI) mostly succeeds

Each of the above was considered with and without LNG, creating a total of eight scenarios. Future demand scenarios for Hawai'i power generation and transportation fuels are shown in *Figure 4.1*. This figure shows demand by product for each scenario in the year 2030 - the original target year for the HCEI goals, and a year far enough in the future that LNG imports (if they come) could be fully deployed.

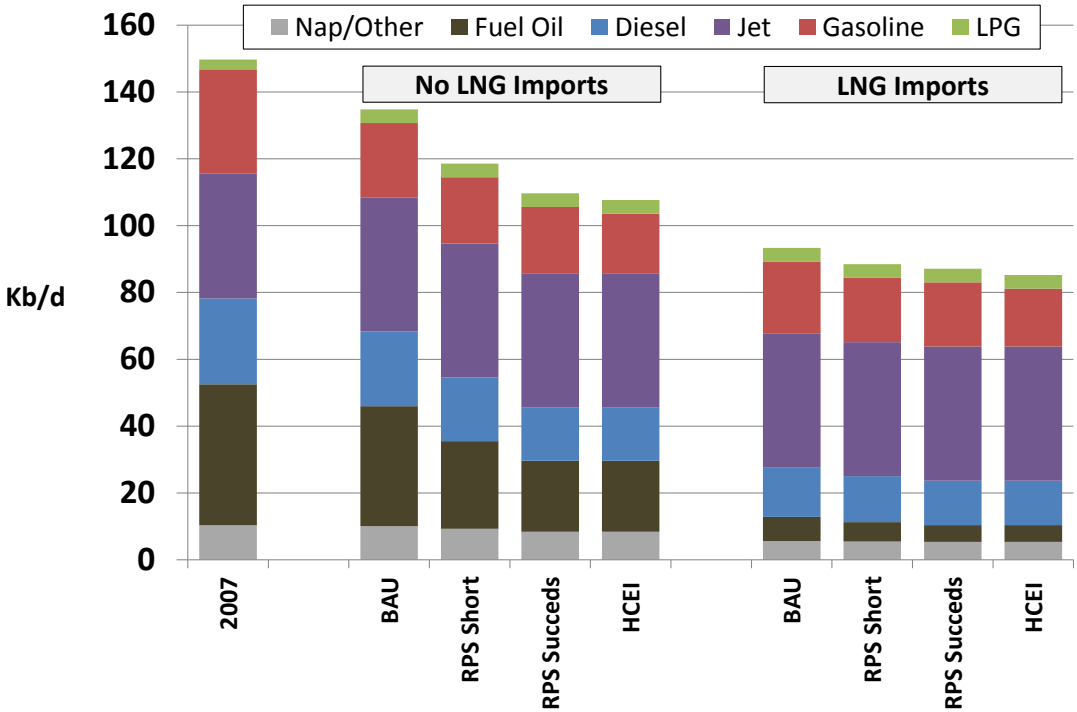


Figure 4.1 - Oil Product Demand in 2030 Under the Eight Scenarios (kb/d)
(Source: FGE, 2014)

The peak oil product demand of 2007 was used as a base year. Even under the Business-As-Usual Scenario with no LNG, future demand is expected to be lower. This is partly the result of higher overall oil prices (at the time of the study), but is also the result of HCEI conservation and renewable measures already undertaken, as well as national measures like the Corporate Average Fuel Economy (CAFE) mileage standards. The other scenarios presented in *Figure 4.1,* with increasing success of the HCEI, continue to decrease oil demand. The underlying energy demand remains relatively vigorous; however it is oil being displaced that is driving the decline. It is also worth noting that it is the power-sector fuels that are affected the most due to the RPS and EPA regulations, followed by road transport fuels. Jet fuel is not affected, and so its importance in the energy mix continues to rise. LNG imports could cause a large decline in oil demand, even in the Business-As-Usual case, where HCEI measures plateau. In this case, fuel oil demand is driven near to extinction, and jet fuel rises close to half of total oil demand.

This is a significant reduction for refined petroleum demand in Hawai'i. If fuel oil is driven out of the power sector but major demands for transport fuels remain, this creates a demand slate that is impossible for the local refineries to match. Refineries are not able to scale down production of one product, such as fuel oil, to produce increased volumes of another product, such as jet fuel. The crude oil distillation process produces various products (i.e., gases, naphtha, kerosene, diesel, fuel oil) based on the boiling point of each liquid. Distillation of an amount of crude oil will generally produce a set ratio amount of products. Additional details regarding refinery operations are presented in *Appendix D.*

Any decrease in fuel oil demand from the power generation sector, whether from conservation or replacement fuels, ultimately results in excess local fuel oil supply by the refineries. With no local market to consume this product, this excess fuel oil needs to be exported by ship or barge to other markets through KBPH. Exporting product reflects poor economics of refinery operations and presents the risk that they will eventually cease operations. In this case, with one or both of Hawai'i's refineries closing, it may be necessary to bring in large volumes of liquid-bulk commodities such as jet fuel, diesel and gasoline through either the offshore moorings or through KBPH. This results in an increase in the number of ships potentially calling at KBPH. Further analysis of this increase is presented in *Section 4.4 Berth Utilization Analysis.*

4.4 Berth Utilization Analysis

To understand the demand for berthing at KBPH, information for all of the port calls for FY 2012 were compiled and analyzed. The berth utilization rates were then calculated for each pier within KBPH. Berth utilization was calculated by dividing the actual observed berth foot days (BFD) demand by the total available BFD at the harbor. A BFD demand is the length of the ship plus its mooring allowance (for safety), multiplied by the number of days at berth. The total available BFD is the length of the pier at which the ship is berthed multiplied by the total number of days in a year.

$$\frac{\text{BFD Demand}}{\text{Total Available BFD}} = \frac{\text{(Length of Ship (ft) + Mooring Allowance (ft)) x Duration (days)}}{\text{Length of Pier (ft) x 365 days}} = \text{Berth Utilization \%}$$

The calculation accounts for unscheduled berthings and berthing limited to daylight hours. Berthing utilization rate results for FY 2012 *(Appendix C)* are presented in *Figure 4.2*. Industry standards indicate that a berth is considered fully utilized when it reaches 50 percent for unscheduled berthing and 60 percent for scheduled berthing. This assumes that the pier cannot be occupied 'back-to-back', and that there will need to be some buffer time between calls for ships to maneuver in and out of the harbor. A berth utilization rate of 40 percent occupancy or lower is considered to be operationally acceptable, reflecting minimal operational delays. Berth utilization rates between 40 percent and 60 percent occupancy indicates periodic conflicts that may limit berthing availability and vessel utilization, due to operational inefficiencies. Sixty to 80 percent berth occupancy rate customarily results in frequent berthing conflicts and delays, reflecting subpar optimization. A berth occupancy rate of 80 percent or higher results in regular conflicts and consistent delays.

In FY 2012, Piers 5, 6 and 7 experienced periodic conflicts, and in particular the Finger Pier (a layberth pier) experienced frequent conflicts *(Figure 4.2).* Piers 5 and 6 are multi-use piers, servicing both dry- and liquid-bulk cargo vessels. These piers are in high demand with varying lengths of vessel stay. Another issue is that a number of overseas vessels call these piers, and their arrival time is uncertain and somewhat unscheduled due to the long distances of travel. In addition, there are times when fuel vessels at Pier 5 infringe on the Pier 5A berth due to the location of the fuel manifold, and vessels that utilize a berth in-between Pier 6 and Pier 7 (Pier 6-½) infringe on the Pier 7 berth.

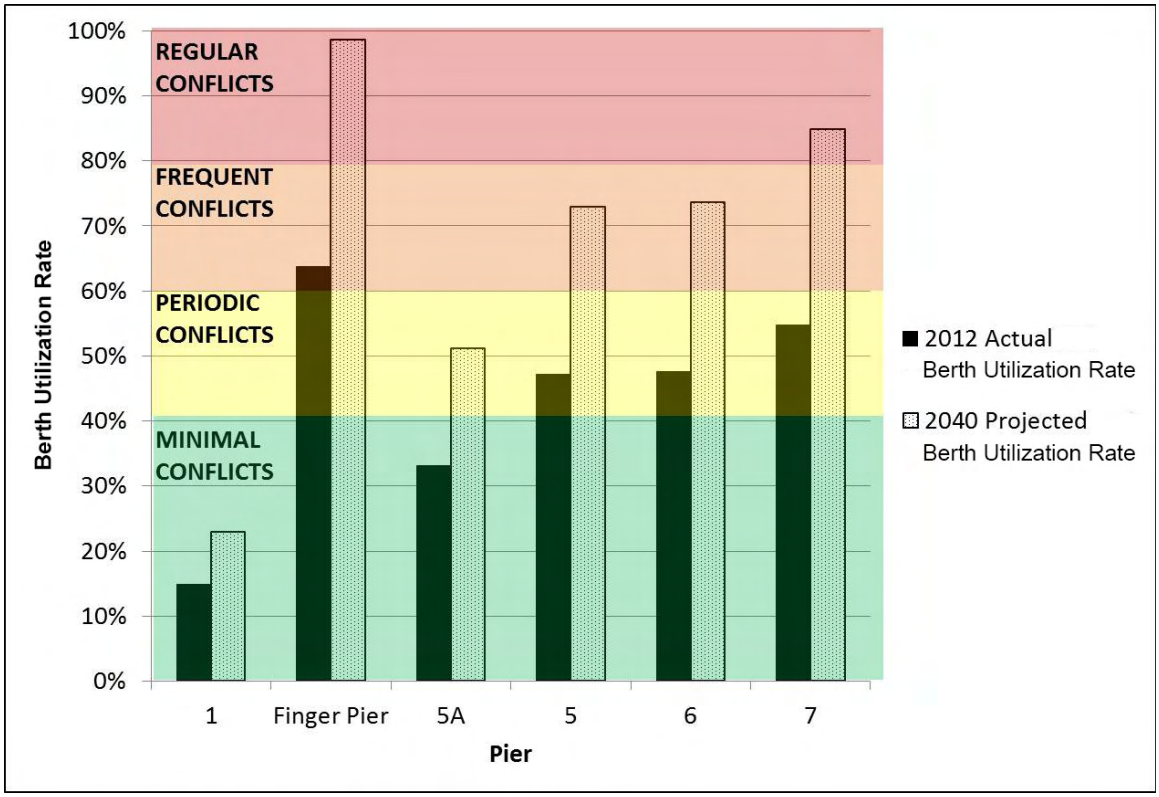


Figure 4.2 – Berthing Utilization Rates at KBPH (2012 and 2040)

The Department of Business, Economic Development and Tourism (DBEDT) real gross domestic product (GDP) (formerly gross state product) for the State of Hawai'i forecasted growth rate (currently at 1.7 percent per year) was used in calculations to forecast berthing utilization in the year 2040, assuming a Business-As-Usual Scenario *(Figure 4.2).* The demand for this finite linear berth space exceeds capacity in 2040. Piers 5 and 6 show the potential for frequent conflicts (60 to 80 percent berth utilization), and the Finger Pier and Pier 7 reach regular conflicts (80 to 100 percent berth utilization).

The GDP was used for this forecast due to its correlation with personal income, which has historically shown a stable relationship with personal consumption. Hawai'i's total personal income is forecast to grow at an annual rate of 1.7 percent in real terms over the projection period to 2040. The growth of GDP depends on demand from local consumption and investment as well as outside the region. This projection also takes into account the large government construction plans that have already been approved and

scheduled for the projection period. These demands will influence bulk construction materials and vessel movement through KBPH, impacting berth utilization rates.

GDP is calculated using the expenditure approach as follows:

$$GDP = C + I + G + (X - M)$$

where C: Personal consumption expenditures
I: Private investment
G: Government spending, including government investment
X: Exports
M: Imports

Population growth was not used as an indicator of economic growth, as per capita personal income will grow at a lower rate than that of total personal income. In particular, the Neighbor Islands are expected to experience relatively low growth of per capita personal income as a result of higher rates of population growth.

The forecasted berth utilization reflects operational congestion and inefficiencies at KBPH which affect Hawai'i's maritime industry and economy. Delayed delivery of cargo increases shipping costs, which are ultimately passed on to the consumer. Shortages from delayed delivery can also cause delayed construction projects, possible interruptions to power supply and transportation fuels, etc. Forecasts show that cargo volumes are expected to increase as the state's economy grows and its population increases. To alleviate current conflict and accommodate future growth, the berthing analysis calculations were used to estimate the required pier lengths needed to accommodate 2040 demand.

First, the FY 2012 utilization rate was determined for KBPH as a whole. Similar to above, the BFD demand was determined by multiplying the duration of the port calls in days with the length of the vessels plus a mooring allowance in feet *(Table 4.1).* Then, the current BFD was extrapolated out to the year 2040 using the DBEDT GDP forecast. For example, the actual 2012 BFD was multiplied by 2.0 percent to forecast the 2013 BFD. The 2013 BFD was then multiplied by 2.0 percent to find the 2014 BFD, as well as the 2015 BFD. The years 2016 to 2020 were multiplied by 1.8 percent, and so on according to the forecast until the year 2040. Finally, a goal was set to achieve efficient utilization levels (50 percent) by 2040. A 50 percent maximum utilization will both increase harbor efficiency and accommodate anticipated increases in traffic. Future pier length requirements were adjusted to reach this goal.

Overall, KBPH is currently experiencing approximately 50 percent berth utilization, with periodic conflicts on some piers (e.g. Pier 7) with increased demand and higher utilization. To remain at or below 50 percent berth utilization for the anticipated 2040 demand, approximately 5,100 linear feet of pier is needed. If all of the available pier length within the harbor were developed (approximately 6,590 feet), this would result in a berth utilization of approximately 40 percent in 2040.

Table 4.1 – Summary of FY 2012 and Projected Berth Demand

	FY 2012	Projected 2040 Demand	Percent Increase
BFD Demand	600,937	929,740	54.72%
Total Available BFD	1,427,150	1,861,500	30.43%
Available Pier Length (ft)	3,910	**5,100**	30.43%
% Berth Utilization	50.05%	50.00%	(0.001)%

Based on 50 percent berth utilization to the planning horizon year of 2040, the total pier length needed for each type of vessel (dry-bulk/container, liquid-bulk, layberth and maritime support service) was calculated *(Table 4.2)*. This was determined by calculating the FY 2012 percentage of total vessel port call movements for each cargo type, and allocating this percentage to the total amount of 2040 berth demand. Vessel port call movements for Maritime Support Service may be low as vessel activity on submerged land (i.e., dry dock) is not always reported.

Table 4.2 – Projected Berth Length by Vessel Type

Vessel Type	Percent of Vessel Port Call Movements in FY 2012	Adjusted Available 2040 Berth Length (linear feet)	2040 Berth Demand (linear feet)
Dry-Bulk/Container	**46%**	**5,100**	**2,350**
Liquid-Bulk	**29%**		**1,500**
Layberth	**20%**		**1,000**
Maritime Support Service	**5%**		**250**

The available harbor piers were analyzed to determine if there was sufficient pier length by vessel need *(Table 4.3).* Although the current pier length available for dry-bulk (Piers 5A, 5, 6, 7) has been calculated as sufficient for 2040 demand, it was determined that the extension of Pier 7 by 200 feet is needed to alleviate conflict from vessels berthing between Piers 6 and 7.

Developing Piers 3, 4A and 4B accommodates the projected liquid-bulk 2040 berth demand. The full build out construction of this Pier (i.e., Phase I consisting of both Piers 3 and 4A, and Phase II with the addition of Pier 4B) will require that the current Finger Pier layberth be removed. This will be replaced with 410 linear feet of berthing at Pier 8 for tugs and other smaller vessels. Pier space of 750 linear feet is available for larger vessels at Pier 10. Pier 9 provides Maritime Support Service providers with 950 linear feet to berth a dry dock and vessels under repair.

Further analysis was conducted to ensure that the construction of a Fuel Pier would be sufficient. The future liquid-bulk demand forecasted by the *Fuels Market in Hawai'i: Current Situation and Future Prospects* (FGE, 2014) report outlines four fuel market scenarios:

1. Both refineries operating,
2. No refineries operating,
3. Chevron only, and
4. Hawaii Independent Energy only.

In addition, two sub-scenarios (i.e., with and without LNG) were considered for each of the four fuel market scenarios. Future scenarios for fuel vessel call activity at KBPH were calculated for kilo barrels per day (kb/d) impact on KBPH. This kb/d was then translated into the number of ships required to transport this amount. For detailed information, refer to *Appendix D.* Forecasted ship counts per month (in addition to approximately five current ship counts) at a harbor basin draft of 36 feet are presented in *Table 4.4*.

The forecasted vessel counts are based on the additional number of 50,000 dead weight ton (DWT) ships that would call each month at KBPH. Technically, both fuel barges (floating storage vessels that need propulsion assistance) and tank ships (vessels designed to transport liquids or gases in bulk) could be used for these fuel transactions. To simplify this vessel forecast calculation, it is assumed shipments will be via 650 feet length overall (LOA) Panamax tank ships (i.e., up to 106-foot wide beam) of 50,000 DWT, loaded to a 36-foot draft with 225,000 oil barrels (bbl) of liquid-bulk product.

Table 4.3 – Vessel Type and Associated Pier Length (Linear Feet)

PIER	CURRENT LF	2040 PLAN LF	INCREASE LF	PROJECTED 2040 DEMAND LF	STATUS LF
Dry-Bulk/Container					
5A	300	300			
5	800	800			
6	800	800			
7	800	1000	200		
Total	**2700**	**2900**	**200**	**2350**	**+550**
					Adequate
Liquid-Bulk					
1	255	255			
3	0	650	650		
4A	0	400	400		
4B	0	275	275		
5	800	0	-800		
6	800	0	-800		
Total	**1855**	**1580**	**-275**	**1500**	**+80**
					Adequate
Layberth (Active and Idle)					
Finger Pier	300	0	-300		
8	0	410	410		
10	0	750	750		
Total	**300**	**1160**	**860**	**1000**	**+160**
					Adequate
Maritime Support Service					
3	275	0	-275		
9	380	950	590		
Total	**655**	**950**	**315**	**250**	**+700**
					Adequate
TOTAL	**3910**	**6590**	**875**	**5100**	**1490**

Table 4.4 – KBPH Incremental Additional Monthly Fuel Vessel Calls Forecasted*
(Based on 50k DWT Tank Vessel @ 225,000 bbl)

		CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
BOTH REFINERIES IN OPERATION	W/O LNG	1-2	1-2	1-3	2-4	1-4	1-5
	With LNG	1-2	1-3	6-7	6-8	6-8	6-8
HAWAII INDEPENDENT ENERGY REFINERY ONLY	W/O LNG	4	4	4-5	3-5	3-5	3-6
	With LNG	4	4-5	5	5	5	5
CHEVRON REFINERY ONLY	W/O LNG	9	8-9	8-9	7-9	7-10	8-10
	With LNG	9	8-9	6	6	6	6
NO REFINERIES IN OPERATION	W/O LNG	14-15	14-15	13-15	12-15	12-16	12-17
	With LNG	14-15	13-15	9-10	9-10	8-10	8-10

Periodic Conflicts Frequent Conflicts Regular Conflicts *(Source: Amergent Techs, Inc., 2014)*

**Note: Utilization colors reflect a future without the Fuel Pier.*

According to *Table 4.4*, each of the future O'ahu refinery operation scenarios results in a different forecast for the additional number of vessel calls to KBPH on a monthly basis.

- In the cases with both or one of the refineries operating, the resulting increase in the number of ships calling at KBPH varies from 1 to 10 per month, with refined product surplus being exported.
- In the case where no refineries are operating and all product demand is met through imports, the number of additional monthly ship calls increases dramatically from 8 to 17 per month (this assumes there would be no crude oil coming in through the offshore mooring system).
- In all scenarios, it is reasonable to consider the offshore mooring system will be retained for product imports. However, many fuel ships may contain multiple fuels, which would offload a portion of the fuels at the moorings, and berth at KBPH to offload the remaining refined fuels.
- The colored conflicts reflected in *Table 4.4* are based on a future without the Fuel Pier, with liquid-bulk vessels continuing to use Piers 5 and 6.

Currently, both liquid- and dry-bulk cargos are handled at Piers 5 and 6 in KBPH. It is challenging to calculate the current capacity for liquid-bulk cargo in KBPH because the Pier 5 and 6 facilities are shared with dry-bulk cargo. Therefore, any growth in dry-bulk volume impacts the volume of liquid-bulk that can be handled at KBPH. However, the peak year of liquid-bulk throughput (since 1995) was in 2002, with approximately 2,180,000 short tons, or 12,111,111 bbl of throughput for the year. This also equates to approximately 54 tank ships per year, or approximately five tank ships per month. The five ships per month was estimated using 225,000 bbl as the average shipment knowing that larger tank ships can carry more volume and barges will carry less. At this level of activity, the Pier 5 and 6 facilities were at the high end of their berth utilization. Therefore, five vessels per month can be used as the liquid-bulk capacity of the current facilities at Piers 5 and 6.

Separation of the liquid- and dry-bulk operational activities from each other will optimize harbor efficiencies by minimizing potential conflicts caused by increases in both liquid- and dry-bulk cargos and facilitate deliveries for both vessel types. With the development of a separate, dedicated Fuel Pier at Piers 3 and 4A (without dry-bulk vessel interference, identical to Piers 5 and 6 in the number of berths and pipeline configuration), the throughput capacity is estimated to be approximately 27,000,000 bbl per year. This could potentially facilitate the movement of approximately 120 vessels per year, or approximately 10 vessels per month, averaging cargo loads of 225,000 bbl per vessel. With nine vessels per month, the fuel pier would begin to see 50 percent utilization. While this would not be sufficient to support the high forecast of 17 additional vessels per month in addition to the current five, or a total of 22 vessels per month, Piers 5 and 6 could still be used for any overflow.

The addition of a third berth (Pier 4B) permitting the fuel pier to accommodate two medium sized product tank ships (i.e., at the completion of the Phase II development) would support an additional 2,250,000 bbl per month. However due to the mix of interisland tank barges and overseas product tank ships, the operational throughput capacity is projected to support a 50 percent incremental increase or an additional 1,125,000 bbl per month. This would reflect a monthly increase in berthing capacity to accommodate an additional approximately 5 product tank ships or 14 interisland tank barges, due to the expanded berth configuration. The fully-developed Fuel Pier with Piers 3, 4A and 4B could *hypothetically* facilitate the unloading of 15 vessels per month, each carrying an average capacity of 225,000 bbl or a varied mix of tank ships and barges (i.e. 10 product tank ships and 14 interisland tank barges per month). This would not be sufficient to accommodate the worst case scenario of an additional 17 product tank ships per month, with both refineries closed and no LNG, and without the full use of one of the offshore mooring systems, should these offshore delivery systems not continue to be operational in the future.

However, one hundred percent utilization is reached with 15 vessels per month at an average port call of 60 to 72 hours and daylight vessel movement limitations. The berthing conflict is most prevalent with the scheduling of the larger overseas product tank ships. These berth scheduling conflicts are further acerbated as a result of primarily trading on inducement and not scheduled liner service. This occasionally creates instances when multiple vessels may simultaneously arrive with both designated fuel berths occupied. This will necessitate the berthing of these vessels at the secondary Fuel Piers 5 and 6. All scenarios identified and evaluated show an increase in berthing utilization with current and future conflicts. It is clear that a dedicated Fuel Pier is needed, in addition to the need for Piers 5 and 6 to remain accessible and in continued operational use as secondary fuel piers.

4.5 Land Requirement Analysis

Determination of land area requirements to support dry- and liquid-bulk operations in 2040 was derived using three separate planning methods. First, detailed cargo commodity throughput data was collected from DOT-H records and projected into the future using computed trend lines *(Figure 4.3).*

In *Construction and Hawai'i's Economy* (DBEDT, 2014), all the economic indicators show that Hawai'i's economy is on a normal growth path. The construction industry will be the main driver of economic growth in 2014 at 12.4 percent, which is expected to be a new record year. The forecast for Hawai'i's construction industry calls for continued growth at 8.3 percent in 2015. There are a number of positive factors that will drive this growth including infrastructure projects, large-scale commercial projects, and residential construction. The two most prominent of these are the Honolulu Rapid Transportation Rail and the Kaka'ako area development projects. Many of the construction materials for these jobs, such as steel, concrete and glass will be imported. Hawai'i also appears to be well positioned to benefit from the military's 'Pivot Towards Asia' policy of redeploying resources in the Pacific Region. One example is the National Defense Authorization Act of 2014, which includes approximately $400 million in military construction projects for the State.

A computer-generated linear trend line forecast of both dry- and liquid-bulk cargo based on historic cargo data from FY 1995 to 2014 supports the DBEDT growth path by showing that dry-bulk cargo is expected to continue to increase while liquid-bulk demand appears to level out *(Figure 4.3)*. Dry-bulk cargo (i.e., aggregate, sand, cement, lumber, scrap metal, vehicles, general merchandise and containers) at KBPH is forecasted to increase by 43 percent from the State's FY 2014, from 1,785,000 short tons to approximately 2,550,000 short tons in 2040. Liquid-bulk cargo (i.e., asphalt, petroleum and chemical products) is forecasted to increase by 22 percent from the current low (compared to other years) of 1,555,000 short tons in FY 2014 to an average of approximately 1,900,000 short tons in 2040. Projected volumes of dry- and liquid-bulk for the years 2015 to 2040 shared in questionnaires by harbor users also predict similar growth rates. The questionnaire results show dry-bulk climbing by 48 percent in 2040, and liquid-bulk flattening out at a one percent growth rate.

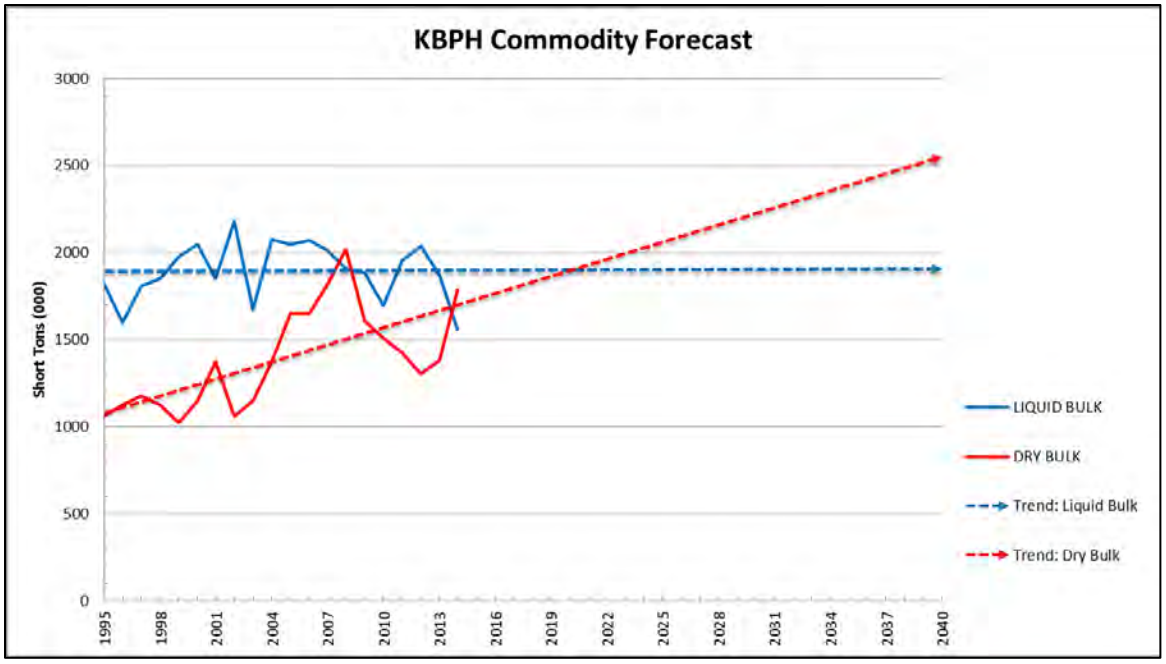


Figure 4.3 – KBPH Commodity Forecast

The amount of land currently associated with these cargo types was extrapolated to 2040 using the percentage increase of dry-bulk (43 percent) and liquid-bulk (22 percent) from the commodity forecast *(Table 4.5).* This gives a rough estimate of land area needed, assuming current allocation is sufficient and fully utilized. The dry-bulk Cargo Yard is included as it is necessary for operations.

Table 4.5 – Forecasted Cargo Yard Area Required by Cargo Type

Area Type	Percentage Commodity Increase to 2040	Existing Land Area (Acres)	Forecasted Land Area 2040 (Acres)
Dry-bulk Storage	43%	29	42
Dry-bulk Cargo Yard	43%	45	64
Liquid-bulk Storage	22%	4	5

The second method used to determine land area requirements relies on input from current and potential users that was collected via questionnaires and in meetings. Projected user demand was recorded in a matrix which summarizes the requirements by land use type *(Table 4.6).* The cargo yard demand expresses the request by Department of Defense for a total of 50 acres of improved area designated as an emergency staging area for disaster response and recovery activities. For dry-bulk, users requested storage primarily for aggregates and containers, either covered or uncovered. Liquid-bulk storage users need space for hoses and oil spill response equipment, ISO-containers, and storage tanks. These liquid-bulk storage areas include safety zones for the associated commodity. The 2040 forecasted throughput in *Table 4.6* captures only that which was reported by users in the questionnaires.

Table 4.6 – Stakeholder Landside Requirements

Use type	User 2040 Forecasted Throughput (Short Ton)	User Forecasted 2040 Demand (Acre)
Dry-bulk Cargo Yard		50.00
Dry-bulk Storage	2,550,000	41.00
Liquid-bulk Storage	1,900,000	36.95
Marine Support Services		12.69
Harbor Operations/Personnel Shelters		3.32
Excursion/Parking		2.00
	TOTAL	**145.96**

The third method for determining sufficient land area uses industry-standard planning guidelines based on commodity type and throughput projections for both liquid- and dry-bulk cargos.

Liquid-bulk Analysis: Although liquid-bulk is currently transported via pipelines and stored off-site, there is a potential need for on-site storage facilities or space for ISO-container storage. Using an industry planning standard for refined petroleum of 1,019,400 bbl per acre per year *(Maritime and Intermodal Planning Guidebook, October 2007),* this method determines that 16 acres is the minimal amount required within the harbor for the amount of liquid-bulk forecasted in 2040 *(Table 4.7).*

Table 4.7 - Liquid-Bulk Storage Area Demand

Barrels/Acre/Year Standard[1]	1,019,400
Converted to Short Tons/Acre/Year	120,289
2040 Forecasted Short Tons/Year	1,900,000
Required 2040 Storage Area (Acres)	**16**

[1] *(Source: Suggested Performance Standards for Cargo Terminals (refined petroleum standard), Figure 4-3. Maritime and Intermodal Planning Guidebook, October 2007.)*

Dry-bulk Analysis: The terminal (or cargo yard) area required for dry-bulk is based on an industry planning standard throughput of 182,820 short tons per acre per year *(Maritime and Intermodal Planning Guidebook, October 2007) (Table 4.8).* This standard suggests 14 acres is the minimal amount of terminal area that will be needed to support the forecasted 2040 dry-bulk projection.

Table 4.8 – Dry-Bulk Terminal Area Demand

Short Tons/Acre Standard Average[1]	182,820
2040 Forecasted Short Tons/Year	2,550,000
Required 2040 Terminal Area (Acres)	**14**

[1] *(Source: Maritime and Intermodal Planning Guidebook, October 2007: Figure 4-3. Suggested Performance Standards for Cargo Terminals (dry-bulk cargo average))*

Another standard based on vessel size can also be used to estimate required dry-bulk terminal and storage areas *(Table 4.9)*. The maximum vessel size allowed in KBPH is 751 feet LOA, which can support 58,000 short tons of aggregate for delivery at KBPH at present depth. According to the industry standard *Planning and Design of Ports and Marine Terminals (2nd Edition, 2004)*, this would require a minimal terminal laydown area of approximately one square meter per metric ton, or about 13 acres. It also gives a rule of thumb that storage area should at minimum be four to six times the largest shipload, which equates to approximately 52 to 78 acres.

Table 4.9 – Dry-Bulk Terminal and Storage Area Demand[1]

Gross Short Tonnage of Maximum Vessel Size (751 feet)	58,000
Metric Tonnage of Maximum Vessel Size (751 feet)	52,617
Required 2040 Terminal Area (Acres) (Metric Ton/Square Meter Standard)	**13**
Required 2040 Storage Area (Acres) (4 to 6 Times Terminal Acreage)	**52 to 78**

[1] *(Source: Planning and Design of Ports and Marine Terminals, 2nd Edition, 2004: Table 8.6 – Bulk-cargo Properties.)*

To be conservative, the worst case scenarios from the above forecasted land area, user demand and liquid- and dry-bulk demand calculations require approximately 78 acres for dry-bulk storage, 64 acres for dry-bulk terminal space and 37 acres for liquid-bulk storage space *(Table 4.10)*.

Table 4.10 – Summary of 2040 Cargo Land Requirements at KBPH in Acres

	Commodity Forecast	User Demand	Standard Calculations	Worst Case
Dry-bulk Storage	42	41	52 to 78	78
Cargo Yard (Dry Terminal)	64	50	13 to 14	64
Liquid-bulk Storage	5	37	16	37

The acreage available for remaining land uses was determined by using the requested landside area requirements from the user demand matrix (summarized in *Table 4.6),* and supplemented with the worst case scenarios for dry-bulk storage and cargo yard, to be conservative *(Table 4.10).* Currently, 172 acres, or 59 percent of the land available at KBPH is unused. The existing acreage and 2040 demand were used to calculate the most efficient use of KBPH land, which is presented in *Table 4.11* below.

Table 4.11 - 2040 Future Harbor Demand: Land Area

USE*	EXISTING (Acres)	2040 DEMAND
Buffer/Open Space	11	N/A
Circulation	12	N/A
Harbor Operations	1.5	3
Multi-Purpose Yard (Excursion/Parking)	2	22
Multi-Purpose Piers	0.25	1
Dry-bulk Storage	24	78
Cargo Yard	45	64
Cargo Piers	4.5	3.5
Maritime Support Services	12	13
Maritime Support Piers	0.25	1
Liquid-bulk Storage	5	37
Fuel Terminal	4	12
Fuel Piers	0.5	2.5
Other (Unused, Coral Stockpiles)	172	0
TOTAL	**294**	**237**

**See Table 5.1 and Section 5.2 for descriptions of each use.*

5.0
Land Use Plan

5.0 LAND USE PLAN

This chapter presents the preferred land use alternative based on the Kalaeloa Barbers Point Harbor (KBPH) Facility Demand Assessment in Chapter 4. Alternatives considered for the locations of these land uses are listed and discussed. This chapter is meant to be a guide for decision makers when determining the placement of future tenants. The following chapters will present the improvement projects proposed within KBPH, including a phasing plan and project development costs.

5.1 Land Use Overview

This KBPH *2040 Master Plan* defines appropriate waterfront industrial use categories within KBPH that will be subject to risk-based performance criteria, grouping similar land uses based on disposition for fire, explosion, or other environmental risks. This is similar to performance-based zoning, which uses goal-oriented criteria to establish review parameters for proposed development projects. This type of land use planning is intended to provide flexibility, rationality, transparency, accountability, and to accommodate market principles along with environmental protection. This approach will help applicants to secure appropriate sites for proposed uses with additional vetting by Hawai'i Department of Transportation, Harbors Division (DOT-H).

Various arrangements of the land use categories were considered, and these alternatives are described in the sections below. The principal criteria for analysis included: balancing competing needs; maximizing capacity, capability, efficiency and operational performance; and using best planning doctrines and principles. The plan makes the most efficient use of berthing space and back-up land, creates efficient relationships among the terminals, provides convenient connections between the terminals and adjacent land uses, and accommodates future expansion. Alternatives were vetted through the planning process, and refined with input from stakeholders and the public. The alternative that best balances the various demands on the harbor was recommended as the preferred alternative. The preferred alternative represents the best interest of the state, based on the aggregate information and data collected from stakeholders at the time of this planning study.

In the *2040 Master Plan,* many uses permitted in a less intensive category are permissible in a more intensive category, barring safety conflicts. For example, under this method, the lower risk Bulk A storage can occur in the higher risk Bulk B area, but Bulk B uses could not occur within Bulk A, unless a risk assessment was conducted and any potential mitigations measures were appropriately addressed to the satisfaction of DOT-H. These use categories are based on functional activities that can be grouped by safety and risk characteristics. See *Table 5.1* for these use categories. The preferred alternative for the configuration of these land use categories is color-coded and correspondingly mapped in *Figure 5.1*. Acreage available for land use categories is based upon the demand analyses found in Chapter 4 and summarized in *Table 5.2*.

Table 5.1 - Master Plan Land Use Categories

Use Type	Associated Uses	Risk
Buffer/ Open Space	An Area of No Development that Minimizes Harbor Impact on Neighboring Uses	**Low Risk** ↑
Circulation	Roadway Network/Facilities for Movement of Trucks, Cars and People	
Harbor Operations	Facilities Related to Harbor Operations	
Multi-Purpose Yard	Layberth and Excursion Support Yard, Equipment Staging, Parking	
Multi-Purpose Pier	Piers for Idle Vessels, Excursion Vessels and Top-side Repair	
Bulk A (Low Risk)	Storage for Dry-bulk, Break-bulk, General Cargo, Biomass, Neo-bulk, Containers, Project Cargo	
Cargo Yard	Transfer Area and Temporary Storage for Dry-bulk/ Container/ISO-containers	
Cargo Piers	Transfer of Dry-bulk, Break-bulk, General Cargo, Biomass, Neo-bulk, Containers, Project Cargo	
Maritime Support Services	Shipyard and Marine Construction	
Maritime Support Pier	Pier for Dry Dock and Top-side Repairs	
Bulk B (Medium Risk)	Storage for Bulk A, Liquid-bulk, Petroleum Products, Gas Products, Chemicals/Ethanol, Non-fuel Products and Biofuels	
Fuel Terminal (High Risk)	Transmission and Storage of Higher Risk Products such as Liquid-bulk Petroleum Products, Gas Products, Chemicals/Ethanol, Non-fuel Products, Biofuels and Liquefied Hazardous Gas	
Fuel Piers	Transmission of Liquid-bulk, Petroleum Products, Gas Products, Chemicals/Ethanol, Non-fuel Products, Biofuels and Liquefied Hazardous Gas	↓ **High Risk**

Figure 5.1 – Kalaeloa Barbers Point Harbor 2040 Master Plan Preferred Alternative

Placement of tenants within the categories of land use shown in *Figure 5.1* will be determined based on the risk profile of the type of cargo the tenant handles and the associated operations, including how the cargo is handled, staged, stored and distributed. It is expected that uses associated with the Multi-Purpose Yard and Bulk A storage are generally non-flammable and low risk. Cargo Yards are designed for temporary storage and transfer of dry-bulk and containerized liquid-bulk, which uses containers certified by the International Standards Organization (ISO) called ISO-containers. Maritime Support Services are an increased risk and must comply with state and federal regulations such as Hawai'i Administrative Rules §19-42, Subchapter 5 Welding and Burning Operations on Piers and Wharves and Aboard Vessels.

High-risk cargos associated with Bulk B storage and the Fuel Terminal will be designated for hazardous materials that have the highest environmental risk and risk factors for fire or explosion. Piers and storage yards for Bulk B items will consist of appropriate construction materials, lighting, fire protection, and fire hydrant access. A primary consideration of the *2040 Master Plan* is to ensure that fuel operations are compatible with other land uses in the harbor. Therefore, protection distances for the Bulk B storage and Fuel Terminal area need to be determined by the tenant applicant in compliance with appropriate regulations.

Table 5.2 represents acreage available for the land use categories based upon the demand analyses found in *Chapter 4.* Generally, the *2040 Master Plan* provides acreage within an acre or so of calculated demand. Some land use categories show a larger increase or decrease, such as the Buffer/Open Space, Multi-Purpose Yard, Cargo Yard, Maritime Support Services, and Bulk B. It was difficult to determine demand for the Buffer/Open Space category, but the location of the buffer became clear with placing the Maritime Support Services land use near a neighboring resort. The buffer was extended from its current location along the mole to span the northwestern boundary of KBPH.

Due to land constraints, the Cargo Yard was unable to fulfill the worst case scenario of 64 acres and falls short at 59 acres. In addition, Sause Bros. currently leases 15 acres of Cargo Yard and is not categorized as separate Bulk A land use. Therefore, actual Cargo Yard demand could be calculated at 79 acres. This additional 20 acres is shown as demand in the Multi-Purpose Yard. This serves as the additional 20 acres of emergency laydown area requested by the Department of Defense. The Multi-Purpose Yard gains 8 acres due to the layout of the land next to Piers 7 and 9.

Additional acreage for the Bulk B land use category allows for multiple protection distances, should more than one type of high risk commodity be stored at this location.

Table 5.2 - Master Plan Land Area Demand Analysis Summary (Acres)

USE	EXISTING	DEMAND	2040 PLAN	STATUS
Buffer / Open Space	11	N/A	16	+5
Circulation	12	N/A	13	+1
Harbor Operations	1.5	3	5	+2
Multi-Purpose Yard	2	22	30	+8
Multi-Purpose Piers	0.25	1	1.5	+.5
Bulk A (Low Risk)	24	78	80	+2
Cargo Yard	45	64	59	-5
Cargo Piers	4.5	3.5	4.5	+1
Maritime Support Services	12	13	23	+10
Maritime Support Piers	0.25	1	1.5	+.5
Bulk B (High Risk)	5	37	46	+9
Fuel Terminal (High Risk)	4	12	12	0
Fuel Piers	0.5	2.5	2.5	0
Other (Unused, Coral Stockpiles)	172	0	0	-172
TOTAL	**294**	**237**	**294**	**+39**

5.2 Land Use and Alternatives

The following guidelines apply to land use categories within KBPH, and are presented in order of least to greatest level of exposure and risk. Alternative configurations considered for these land uses within the harbor are presented to provide context for future decision makers.

5.2.1 Buffer/Open Space

The *2040 Master Plan* recommends the designation of a buffer area along the Ko 'Olina mole and between the Maritime Support Services area and the adjoining property. This undeveloped, landscaped buffer will minimize harbor impacts on adjacent properties by providing distance between activities in the Maritime Support Services and the neighboring resort uses. This transition zone will require extensive and concentrated landscaping using native plants to create an effective green buffer, separation and distance barrier.

5.2.2 Circulation

Circulation within KBPH will consist of roads that can withstand the weight of loaded trucks transporting cargo within KBPH in accordance with state and federal highway standards and best practices. These internal roads are the responsibility of DOT-H, and include Access Road, Perimeter Road, and the future Kalaeloa Harbor Access Road. Kalaeloa Harbor Access Road will serve as the main entrance to the harbor.

Access points within the harbor will control those allowed into sensitive areas of KBPH. Restricted and controlled access to the Fuel Terminal and Cargo Yards will require Transportation Worker Identification Credential (TWIC) and Maritime Security (MARSEC) clearances. Restricted access will also require predetermined permission authorized by the security guard. Areas that do not require this security will be accessible by harbor tenants, employees and the public. An Emergency Access located at the northern portion (Ko ʻOlina side) of the property will be gated, with passage allowed during emergencies only.

Circulation Alternatives Considered

Additional controlled access points were considered at the new main entrance, the junction of Kalaeloa Harbor Access Road/Perimeter Road/Access Road, and Malakole Street/Access Road, which at minimum would have required identification in the form of a driver's license or state identification. Daily workers could be issued harbor identification for ease in access. However, these controlled access points would cause delays. A controlled access was considered at the intersection of Access Road and Malakole Street, but deemed unnecessary due to a controlled access currently located nearby at the entrance to the Cargo Yard. This controlled access would block workers trying to access other areas of the harbor, and could be circumvented by entering through the new main entrance.

5.2.3 Harbor Operations

Harbor Operations include those facilities necessary for coordinating harbor procedures and conducting associated business.

Harbor Office

The Harbor Office will provide offices for KBPH staff and security. Additional land is available for other offices, including the Hawaiʻi Department of Agriculture and United States (US) Customs and Border Protection (CBP), for conducting biosecurity and inspection services. The Harbor Office site will also accommodate harbor maintenance support functions and service requirements, as well as provide parking for the public and harbor users.

Personnel Shelters

Personnel Shelters are an important part of harbor operations. These shelters will be open and available to all harbor users. These facilities would be beneficial for stevedores to find refuge from the elements, and for ship crews to relax off the vessel and re-connect (via phone or computer) with family and friends. Personnel Shelter facilities at the Fuel Terminal will only be available to liquid-bulk terminal users, while those at Piers 5/6 areas and Pier 7 will be available to those harbor users within those controlled areas. Personnel Shelters located at Piers 8/9, Pier 10 and the renovated Shelter at the current Harbor Office (located outside the secure areas) will be available to the remaining harbor users and the public.

Weigh Station

Upon the initial dedication of Kalaeloa Harbor Access Road to DOT, Highways Division (DOT-HWY), Kapolei Properties, LLC will convey approximately two acres of land adjacent to KBPH to be used as a DOT-HWY truck weigh station. The *2040 Master Plan* recommends the weigh station be located on the southern side of Kalaeloa Harbor Access Road *(Figure 5.1).*

Weigh Station Alternatives Considered

Early plans for the location of the weigh station were on the eastern side of the main Kalaeloa Harbor Access Road between the T-intersection coming out of the harbor and the intersection with Road A *(Figure 5.2).* However, since it was uncertain whether DOT-HWY could control truck traffic on adjacent roads to prevent the trucks from bypassing the weigh station, this location was dismissed to another location closer to the new harbor entrance on an exclusive access route.

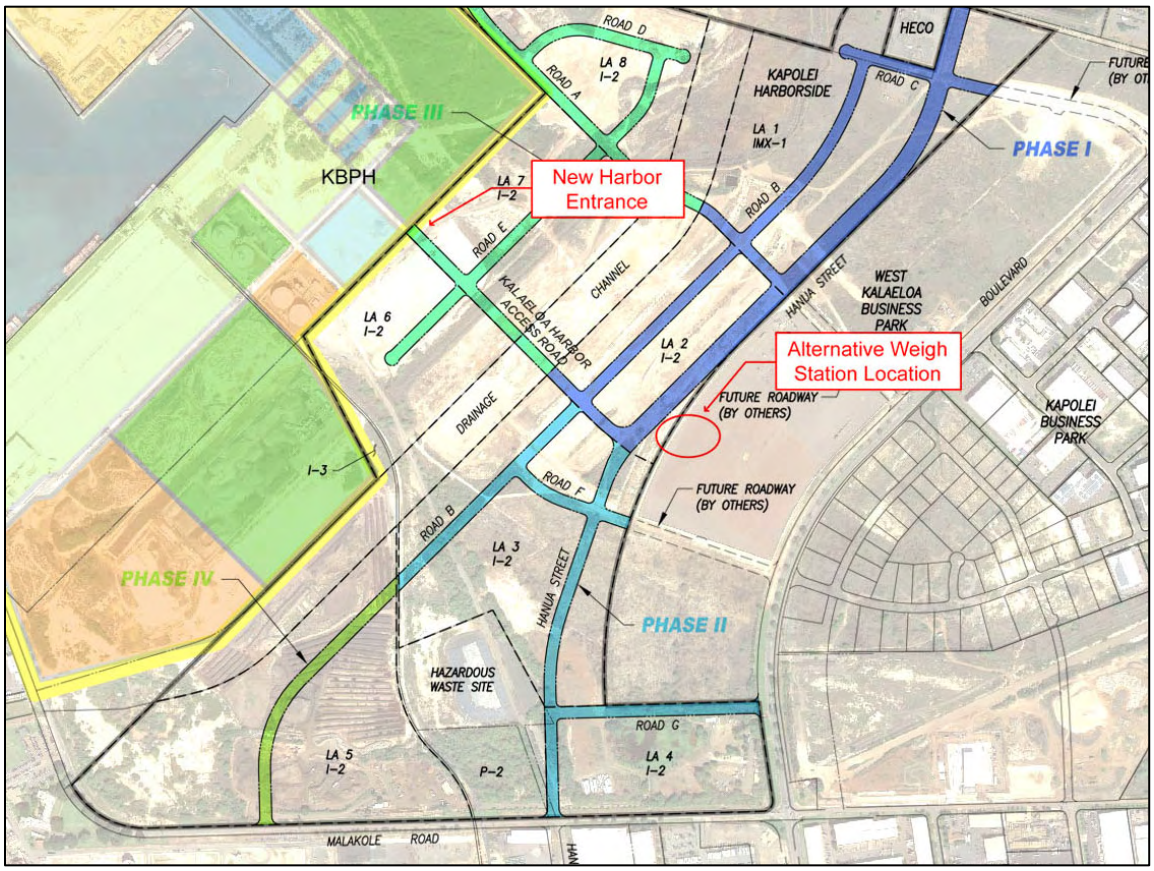


Figure 5.2 – Alternative Considered: Weigh Station Location

5.2.4 Multi-Purpose Yard

The *2040 Master Plan* recommends a Multi-Purpose Yard at Pier 8 to provide layberth support, truck and emergency relief staging, and parking for harbor personnel. Multi-Purpose Yards adjacent to the Cargo Yard and Maritime Support Services are flexible areas that can be used interchangeably. The *2040 Master Plan* also provides for potentially siting excursion vessels (dinner cruises, sightseeing) at Pier 8. Previous excursion boats have relocated to Waiʻanae Harbor due to their small size relative to commercial vessels and

difficulties with van and security clearances into the KBPH area. However, ferries and excursion boats too large for Waiʻanae Harbor may be accommodated at KBPH. If excursion vessels are allowed in the harbor, Pier 8 will require support facilities, such as restrooms and a parking lot for staging vans and buses. Access to the pier would need to be provided for these public excursion vessels.

5.2.5 Multi-Purpose Piers

The *2040 Master Plan* recommends the construction of additional layberth piers to accommodate the required vessels commensurate with the projected increase in vessel calls. While a ship or barge is loading or unloading cargo, tugs and other idle support vessels need a nearby location to moor and/or standby. Generally no loading or unloading of heavy cargo will take place at these piers, although pier design will ultimately determine pier function. Excursion and fishing vessels may also use the Multi-Purpose Piers. Should a berth be available, top-side repairs may take place at these piers.

Finger Pier and T-Pier

The Finger Pier currently provides a layberth for tug boats, workboats, and excursion vessels. The Finger Pier will remain as a layberth until Phase II of the Fuel Pier construction when it will be demolished and layberth is reassigned to Pier 8. The nearby T-pier provides a berth for oil spill response vessels, and will not be affected by the Fuel Pier construction or operation.

Pier 8

Pier 8 will become the layberth for marine support vessels at KBPH when the existing Finger Pier at Pier 4B is demolished to allow full build out of the Fuel Pier. This will provide 110 additional feet of pier length than is currently available at the Finger Pier. During incremental periods of increased berthing demand, the berthing capacity can be further supplemented with the doubling-up of vessels moored abreast of each other, and/or with bundled support vessels moored with their sterns to the pier face.

Pier 8 Alternative Considered

The *Oʻahu Commercial Harbors 2020 Master Plan* (1997) recommended a harbor expansion project of 1,100 feet x 1,100 feet, creating Piers 7, 8 and 9. The first phase was completed in 1999, expanding the harbor 600 feet x 1,100 feet. The second phase of the expansion has not yet been completed. Analysis of forecasted berth length demand in *Section 4.2.3* has determined that the *2040 Master Plan* will meet pier requirements, therefore it is not recommended to complete the remainder of the expansion project.

Pier 10

In fiscal year (FY) 2012, Piers 5A and 7 had more than 31 ships and barges in idle layberth status for a total of 60 days, adding to periodic conflicts at these piers. To give priority for active cargo transfer at Piers 5A and 7, creation of layberth space in the vicinity of Pier 10 will provide temporary space capable of mooring the largest vessels authorized to enter KBPH. Currently 751 feet, these larger vessels would not be able to berth at Pier 8 due to pier length and configuration. Top-side repairs may also take place at this layberth.

5.2.6 Bulk A

The *2040 Master Plan* recommends establishing a Bulk A storage area located in the southeastern and northeastern areas of the harbor (yards S-A1 and S-A2). These areas will be designated for the storage of lower risk products, including dry-bulk, break-bulk, general cargo, biomass, neo-bulk, and containerized cargo. Piers 5A, 5, 6, and 7 primarily accommodate vessels offloading dry-bulk commodities, and Bulk A storage areas can be accessed via the Access Road or Perimeter Road. The S-A1 area should be utilized before expanding into S-A2. The S-A1 and S-A2 areas can be graded for emergency staging purposes and then developed further upon tenant interest. Tenants wishing to utilize Bulk A will be responsible for constructing their own improvements.

Bulk A Alternatives Considered

Locating Bulk A at the corner of the Pier 7 Cargo Yard (S-7) and the Multi-Purpose Yard was also considered *(Figure 5.3),* giving this alternative a dry-bulk storage focus. However, the location of these yards is adjacent to Piers 7 and 8, and would not facilitate the optimal use of pier side land, which is to provide temporary storage and facilitate transport of cargo. Yards adjacent to piers are best used as open cargo transfer areas, not permanent storage structures.

Figure 5.3 – Alternative Considered: Dry-Bulk Focus

5.2.7 Cargo Yard

The existing Cargo Yards S-5A, S-5 and S-6 at KBPH total approximately 50 acres. The expanded cargo yard at Pier 7 will add an additional 13 acres of paved area, providing additional staging space, and allowing maximum flexibility of use for large dry-bulk cargo loads, in addition to accommodating any increase in neo-bulk/container vessel traffic. The cargo yards will also be available as staging, receiving, storage and distribution areas, in support of large construction events or emergency relief efforts in the case of disaster where a large staging and laydown storage area is required. ISO-containers will also be accepted for staging in the cargo yard.

Figure 5.4 – Temporary Storage and Removal of Dry-bulk Cargo at KBPH

Cargo Yard Alternatives Considered

Relocating the current Access Road further southeast to the boundary of the most recent land acquisition was considered to extend the existing cargo area for an increased contiguous yard *(Figure 5.5)* in the case of increased container shipments. However, the dry-bulk demand assessment did not require expanding cargo yard area at Piers 5 and 6. The Department of Defense (DoD) request for an additional 20 acres of contiguous parcels of additional emergency staging areas to augment the cargo yard during catastrophic disasters will be fulfilled with the construction of the S-7 and Multi-Purpose Yards. If forecasted cargo demands increase, this expansion could be considered. Bulk storage areas closest to the cargo yard should remain open until the back southeastern bulk storage areas are full to maximize flexibility for this alternative.

This alternative in *Figure 5.5* also reflects a large Bulk B area to facilitate storage of biofuel products. Large-scale liquid biofuel operations may serve the Hawaiian Electric Company's power generating facilities on O'ahu, which would necessitate liquid biofuel deliveries using ISO-containers. Biomass products (e.g., wood pellets) require large lay-down space or container storage area to facilitate bulk biomass shipments and storage.

Figure 5.5 – Alternative Considered: Container/Biofuels Focus

5.2.8 Cargo Piers

Piers 5A, 5 and 6

To optimize harbor efficiencies, the *2040 Master Plan* will locate new fuel risers at the Piers 3 and 4 dedicated Fuel Pier and recommends prioritizing liquid-bulk cargo at that location. Piers 5 and 6 are still multi-use piers and will serve as backup fuel piers, providing berthing redundancy in the event that the dedicated Fuel Pier is not available. Piers 5A, 5, and 6 will be prioritized for dry-bulk use, including cargos such as sand, aggregate, neo-bulk, grain, biomass, and containers. In addition, Pier 6 will continue to accept general cargo, liquid asphalt, scrap metal, and coal. The large cargo yard located adjacent to these piers facilitates the loading and un-loading of these dry-bulk products, and is not necessary for fueling operations.

Piers 5A, 5, and 6 may also accept ISO-containers. Their proximity to the Bulk B storage area is ideal. Currently, Sause Bros. operates barges and transfers containers and flat racks via a top-pick lift, transferring them via a dock-to-vessel ramp system. ISO-containers can be handled in the same way. In other instances, with containers delivered via barge, containers are transferred using a 'pass-pass method', with a top-pick lift onboard the barge supported by a complementary top-pick on the dock.

For those vessels which are not equipped with cargo handling gear, a shoreside mobile crane will be needed. When a shoreside mobile crane is employed, the vessel must be berthed at the designated heavy lift pad situated between Piers 5 and 6 *(Figure 5.6)*. The operation and arrangements to use the heavy lift pad is evaluated by DOT-H on a case-by-case basis, taking into consideration the myriad of variables of the equipment to be utilized to affect the lift and the cargo to be handled. As a standard operational practice and requirement, the operation of the heavy lift pad with a mobile crane requires a written request and prior special arrangements to be made with DOT-H to include a structural engineering analysis/load data, with a corresponding lifting plan for the type of mobile crane to be used, along with particulars on the cargo to be handled and the transfer equipment to be utilized.

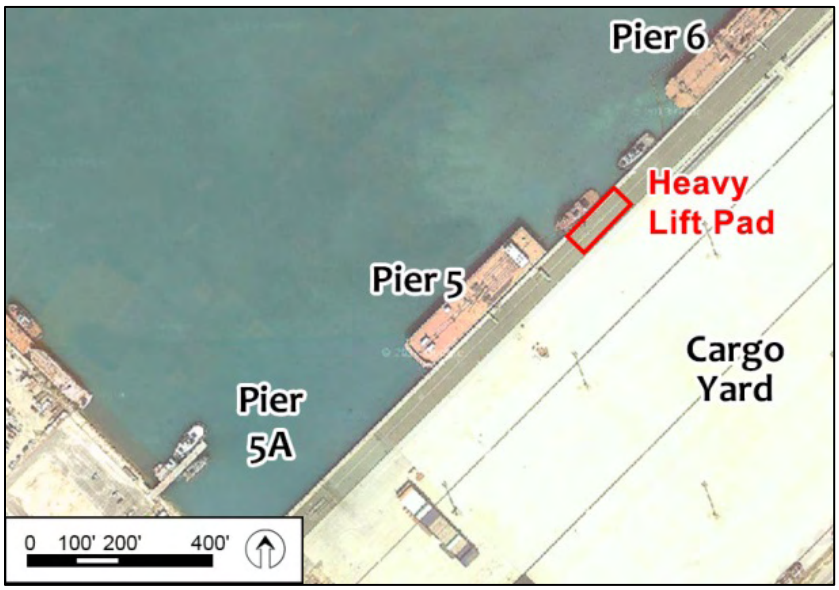


Figure 5.6 – Heavy Lift Pad Location Between Piers 5 and 6

Pier 7

Pier 7 provides mooring for dry-bulk, neo-bulk, general cargo, liquid asphalt, scrap metal, and cement vessels. A pneumatic pump unloader transfers the cement to storage silos. Pier 7 also provides an alternative roll-on/roll-off (RO/RO) automobile carrier berth to Honolulu Harbor and will accommodate ISO-container cargo. Extension of Pier 7 will allow for increased utilization of this pier and alleviate congestion at Pier 6.

5.2.9 Maritime Support Services

The *2040 Master Plan* recommends establishing a Maritime Support Services area that accommodates maintenance and repair of vessels and maritime-related heavy lift equipment. Uses permitted in this category include sandblasting, painting, welding, steel fabrication, crane and rigging, pipe fitting, mechanical, machining, electrical, dry docking, and top side repairs. Additional activities include tank cleaning and pumping, insulation work, marine carpentry, marine flooring, electronics, staging and containment, and sheet metal work.

Two existing tenants, Marisco Ltd. (Marisco) and Healy Tibbitts Builders, Inc. (Healy Tibbitts), both currently utilize this Pier 9 area on a revocable permit (i.e., month-to-month) basis for the storage of equipment, parts and machinery necessary for their operations. The majority of Marisco's operations currently occur at Pier 3. To allow development of the Piers 3 and 4 area for the Fuel Pier, the company's operations will consolidate with its floating dry dock at Pier 9. Siting of Maritime Support Services at the Pier 9 location in the northern portion of the harbor was proposed in 1997 in the *O'ahu Commercial Harbors 2020 Master Plan.* To help mitigate against impacts to adjoining landowners from Marine Support Services, the northernmost portion of the harbor will be separated by a landscaped buffer.

Maritime Support Services Alternatives Considered
Since Maritime Support Services are on the high risk end of the harbor land use spectrum, a possible alternative location would be adjacent to the Fuel Terminal. This would consolidate all of the higher risk uses in one corner of the harbor, with the medium risk cargo yard serving as a transition between high- and low-risk land uses. This location would also site Maritime Support Services land use further away from the adjacent resort area. However, these uses are not compatible. The types of activity that occur within a Maritime Support Area, including the use of an open flame, are not recommended within close proximity to highly flammable products located within the Fuel Terminal and nearby Bulk B storage area.

The location of the floating dry dock is also a factor when determining the location of the adjacent Maritime Support Services. The availability of the storage yard and machine shop in close proximity to the floating dry dock increases ease of logistics and is economically practical. Other locations within the harbor were not deemed suitable for the dry dock and are discussed below.

5.2.10 Maritime Support Pier

The *2040 Master Plan* recommends that Pier 9 be used as the Maritime Support Pier, allowing for dry dock and top-side repair activities. The current location of the floating dry dock is in the northeastern corner of the harbor expansion area. It is recommended that the floating dry dock be positioned at the makai end of Pier 9, at the junction with Pier 10, without overhanging and encroaching on the operational berthing/layberth area of Pier 10. The future positioning and berthing location of a proposed, to be built, new larger floating dry dock at this location provides the least interference for vessels utilizing Piers 7, 8 and 10.

A barge ramp, which is suitable for pulling barges/workboats out of the water to repair and maintain them on land, is a desired improvement by Healy Tibbitts. Although this would be a tenant action, the location of the ramp has been analyzed within the *2040 Master Plan* to ensure that it does not conflict with other users. The recommended location for this ramp is the mauka end of Pier 9 to facilitate the complementary co-sharing of waterside access fronting Pier 9. Alternative locations are described below.

Maritime Support Pier Alternatives Considered
Multiple alternative locations for the placement of Marisco's floating dry dock were evaluated. Locating the floating dry dock at the Pier 8 area is not an option, as there would not be sufficient room for a ship to navigate into an open end of the floating dry dock, and would negate the extension plans for Pier 7. The Pier 10 area was reviewed as an option, as no other uses had been determined for this location at the time. However, this location was dismissed due to:

1. Potential encroachment of a floating dry dock into the Federal Project Line if it is wider than the US Army Corps of Engineers (USACE) berthing allowance of 108 feet, and
2. Potential difficulty in shifting a floating dry dock to another berth in a timely manner should harbor surge action warrant this action.

A third alternative would be the berthing of the floating dry dock on the inner end of Pier 9, and the barge haul-out ramp on the seaward end of Pier 9. This alternative is not operationally preferable as it would preclude optimizing the full potential linear berthing for maritime support vessels at Pier 8.

Additional locations were analyzed for the barge ramp. One potential location was at the end of Pier 7, at its juncture with the Pier 8 area. However, the land-side area would better serve a Cargo Yard for Pier 7 rather than a maritime support services yard. It would not be feasible for a barge to be transported up the ramp and across Pier 8 for service at the Marine Support Services area. An alternate location considered for the barge ramp is north of the Pier 10 area, within the wave-energy absorbing revetment. Due to the protective nature of the revetment system and the federal ownership of the structure, consideration of the placement of the ramp at this location requires consultation with USACE. A USACE Section 408 permit would also be required.

5.2.11 Bulk B
The *2040 Master Plan* recommends locating high-risk product storage at Bulk B, in a southeastern location of KBPH sited away from future residential and existing resort land uses. Appropriate cargo for storage at Bulk B includes all of the cargo allowed in Bulk A, as well as higher risk cargo such as liquid-bulk, including petroleum products, gas products, chemicals (such as ethanol), non-fuel products, and biofuels. The *2040 Master Plan* recommends that the Bulk A storage area be fully utilized prior to allowing Bulk A cargo to be stored within the limited Bulk B space. Bulk B lands can be accessed via Access Road, and can be used for liquid-bulk storage in large above-ground tanks as well as in ISO-containers. Leased lands within Bulk B would include the appropriate safety buffers for the quantity and type of storage used. Signs should be visibly posted identifying hazardous materials, locations, or objects within the Bulk B storage area.

Bulk B Alternatives Considered
An alternative location for Bulk B was considered in the now designated Bulk A S-A2 area in the northeastern portion of the harbor. However, this location for Bulk B storage was determined to be too close to future proposed residences and moved southwest to its current location. Another location for Bulk B was considered to span the current S-B1 and

S-A1 area in the southwestern portion of the harbor, when the Cargo Yard was being considered for further southeast expansion. However, the Bulk A storage yard was then sited exclusively at S-A2, an inconvenient and much further distance from the dry-bulk piers.

5.2.12 Fuel Terminal

The *2040 Master Plan* recommends that the Fuel Terminal be located at the Piers 3 and 4 area. This location has been identified in numerous planning documents *(Chapter 2.6, Literature Review)* as the best location for the facility. A primary advantage of this location for a Fuel Pier is the distance from future proposed residential areas to the north of KBPH. The Piers 3 and 4 locations will consolidate the high-risk activities within the industrial area. This location also has undeveloped pier infrastructure and its development will result in a significant increase in berthing capacity for the harbor.

The potential to develop the Piers 3 and 4 areas for uses other than a dedicated Fuel Pier is limited due to the constrained available land area. Piers dedicated to liquid- and gas-bulk cargo can be fully functional using less extensive yard facilities than dry-bulk or containerized cargo. Fuel loading and offloading operations only need transfer pipes to connect to the mid-section of the fuel barge or ship, not large yards for offloading cargo. Piers 3 and 4 are also in close proximity to existing fuel pipelines that enter KBPH, minimizing construction costs to the fuel industry to extend pipelines to the Fuel Pier. Additional fuel storage is also located in nearby James Campbell Industrial Park.

The Fuel Terminal will include the facilities necessary for safe transmission of liquid-bulk products. Industry-standard infrastructure will be installed with the latest safety features to create a modern facility. The Fuel Terminal may allow for liquid-bulk storage as space permits, however off-site storage is recommended and encouraged. Spill response and other fuel-related equipment will remain situated at their current locations at Pier 4 in special purposed containers adjacent to the pier face for ease of waterside harbor access.

Product quality assurance and security-related facilities for a Marine Fuel Terminal Operator will be located at the Fuel Terminal. A designated Marine Fuel Terminal Operator could help in the fuel terminal scheduling, may charge a throughput fee and be responsible for the coordination of emergency response, including any spills. Fuel pipelines to convey fuels between the Fuel Pier and off-site storage are essential to the utility of the Fuel Pier. The pipeline will either connect with existing lines near Pier 5 or will run within a designated easement along Malakole Street.

A Bulk Liquefied Natural Gas (LNG, or methane) Terminal operation could potentially be sited at Piers 1 and 3 when there is sufficient information available to evaluate the feasibility, proposed land requirements, operational needs, and specific impacts on other users within the harbor. This location was identified after several other locations within the harbor were considered (see *Fuel Terminal Alternatives Considered,* below). It is challenging to site a bulk LNG transfer and storage facility within the harbor due to the safety buffers and associated regulatory requirements. As with other operations within the harbor, an LNG facility must not significantly deter other harbor operations or individual user operations.

Fuel Terminal Alternatives Considered

Regarding Bulk LNG storage and transfer operations, the *2040 Master Plan* evaluated a number of potential locations. The original location was considered at Pier 6, as this area is open and the safety buffer would be wholly contained within DOT-H property. However, this location was deemed unacceptable, as it does not optimize harbor efficiencies by separating liquid-bulk from dry-bulk operations. LNG storage at Pier 6 would effectively remove the ability to use the area for other cargo operations. In addition, trenching or other containment of the LNG pipelines would block other users from access across the pier face.

Pier 8 was also evaluated as a Bulk LNG Terminal site, due to the assumed minimal impacts to current and future users, and because of its relatively isolated location. Although outside of the safety buffer for ignitable equipment, Maritime Support Services located at Pier 9 would be downwind of the LNG vapor dispersion zone, and the safety buffer would fall outside of DOT-H property, diminishing evacuation control. It would also be difficult for an LNG ship to berth at Pier 8 due to the constrained pier length between Piers 7 and 9, and pier orientation.

The Piers 9 and 10 area would provide a more isolated location for a bulk LNG storage facility, and possibly a dedicated LNG pier that other harbor users would not need to access *(Figure 5.7)*. However, siting a bulk LNG facility at Piers 9 and 10 will increase the proximity of the facility to nearby resorts and proposed future residences. In addition, it would preclude the opportunity for Maritime Support Services at this location. Relocating these Support Services to another pier such as Pier 7 would not be acceptable, because it would effectively remove a dry-bulk cargo vessel berth. Berthing an LNG vessel at Pier 10 in direct alignment with the inbound transiting channel would most likely be denied by the US Coast Guard (USCG) for safety and navigational reasons.

Figure 5.7 – Alternative Considered: Energy Focus

Given the above, a dedicated Fuel Terminal at Piers 1 and 3 emerges as the only potential location for a Bulk LNG Terminal facility. This Bulk LNG Terminal location at the Fuel Terminal would allow for a majority of the safety buffers over the water. Further evaluation must be conducted for this site to determine land area requirements, compliance with corresponding regulatory requirements, control of associated safety buffers, land tenure conditions, compatibility with Fuel Pier operations, and potential effects on other harbor operations. Bulk LNG Terminal operations at Pier 3 would likely not affect Piers 5, 6 and 7, and may allow Pier 4 to remain operational for other fuels. See *Appendix G* for further details.

5.2.13 Fuel Piers

Pier 1

Pier 1 is currently used for bulk liquefied petroleum gas (LPG, or propane) imports and small vessel layberth. Additional reserve liquid-bulk pipelines are also located at Pier 1, but have not been used since 2008. Because of its distant location away from other harbor activities, Pier 1 is also the offloading pier for commercial, Class A high explosives. Movements of such high explosives are limited to a maximum of two, 10-ton containers at any one time. They should be offloaded immediately upon arrival and promptly moved out of the harbor area. Ocean wave surge conditions affect the utility of this pier during seasonal high surf periods and surge conditions.

Pier 2

There are no plans for developing this unimproved area. The Pier 2 area experiences periodic wave surge conditions, impacting operations and has a very shallow draft. The primary function of its revetment is to provide breakwater protection for the inner harbor's main basin. A recent marine assessment shows a bio-diverse array of marine life along the rock jetty slope at this location. In addition, planned uses for Piers 3 and 4 preclude the need for a working berth at Pier 2.

Piers 3 and 4

To increase berthing capacity and reduce current berthing conflicts, liquid-bulk transfers will be separated from dry-bulk transfers at Piers 5 and 6 and moved to Piers 3 and 4. A dedicated Fuel Pier will also increase operational safety during fuel transfer operations. With prevailing trade winds coming from the northeast, the Piers 3 and 4 locations provide the ability to confine accidental fuel spills at the fuel berth. The oil spill response team will be staged at Piers 3 and 4 to contain spills within the harbor by deploying booms across the harbor entrance to prevent escape to the ocean. Spilled fuel is likely to be contained under typical trade wind conditions. A fuel spill would not drift into the inner harbor, thereby minimizing the environmental and operational risks.

New pipelines could potentially handle fuels such as gasoline, jet fuel, fuel oil, naphtha, diesel, biodiesel, ethanol, and liquid hazardous gases (LHG). It is anticipated that a pipeline from the Fuel Pier will connect to LPG storage off-site at Pier 1, supplementing for periodic surge conditions that make Pier 1 inoperable. This reassignment will be of increased importance as this Fuel Pier will also be able to accommodate LPG tank ships at KBPH. Currently, LPG transmission is limited to interisland LPG barges and not available for the LPG tank ships that import overseas LPG to Hawai'i.

The liquid-bulk pipelines may be installed, owned and operated by the tenants or a designated Marine Fuel Terminal Operator/Co-Op. An alternative would be for DOT-H to build the Fuel Pier and the pipelines within KBPH boundaries, and then have a Fuel Terminal Operator take over the operation.

Liquid-bulk fuel is transported to and from nearby refineries and storage areas via the energy corridor. To accommodate future increases in liquid fuel transport, DOT-H will need to create a new pipeline easement within KBPH property, as the existing easements have reached capacity.

Phased construction of the Fuel Pier enables retention of the Finger Pier until Phase II is deemed necessitated, funding is in place and a compatible replacement pier (Pier 8) is constructed. Implementation of the second phase will require demolition of the existing Finger Pier at Pier 4B. Pier 8 has been identified as the replacement layberth location for harbor tugs and support vessels within KBPH.

Fuel Pier Alternatives Considered

According to the berthing analysis conducted for the harbor, Pier 1 has the lowest percentage of utilization at KBPH (14 percent), or 2.3 percent of the entire activity of KBPH. Therefore, additional uses were considered. One possible repurposing of the area was to fill in the barge basin to expand the fuel terminal and accommodate a Bulk LNG Terminal, should one be proposed. However, marine life would be affected, and the berth at Pier 1 would be completely eliminated. Fuel bunkering services were also considered for small commercial vessels at Pier 1; however, the adjacent Ko ʻOlina Marina already operates a fuel dock that serves the West Oʻahu area.

Retaining the priority of liquid-bulk at Piers 5 and 6 was also considered. Those tenants that currently have manifolds at Piers 5 and 6 may incur the cost of maintaining the current pipelines as well as having to install new pipelines at Piers 3 and 4. This may double the cost to maintain their lines while reducing their priority berthing at Piers 5 and 6. However, Piers 5 and 6 currently experience periodic berthing conflicts, and a forecast of berth utilization to the year 2040 predicts frequent conflicts (approximately 75 percent). Due to these berthing conflicts, both liquid- and dry-bulk vessels may incur additional costs as they are waiting for a berth to be accessible. Increased costs may be passed on to consumers and may adversely affect the economy of the state, in addition to contributing to critical product storages, a significant issue on the Neighbor Islands during periods of supply disruption and/or delivery delays. By removing the liquid-bulk traffic from these piers and directing it to Piers 3 and 4, utilization rates at Piers 5 and 6 will fall below 40 percent and would significantly reduce and minimize the number of berthing conflicts.

Retaining Piers 5 and 6 as the Fuel Pier for KBPH, and instead moving the dry-bulk operations was also considered. However, the cargo yards at Piers 5 and 6 were built at a considerable expense, and would be useless to those vessels only delivering liquid-bulk. In addition, the backlands available at Piers 3 and 4 are not sufficient to support customary dry-bulk, neo-bulk or container cargo operations.

To ease the transition, an underground vault with manually operated valves could be constructed that would be designed to accommodate the connection of current pipelines with the new dedicated Fuel Pier. As plans advance for the build-out and operation of the dedicated Fuel Pier at Piers 3 and 4, a transition date for priority berthing should be determined for the use of Pier 5 and 6 as a dry-bulk cargo and container terminal. The fuel transfer facilities at Piers 5 and 6 should remain as a secondary redundant system.

6.0
Development Plan

6.0 DEVELOPMENT PLAN

Chapter 6 contains an overview of the improvements necessary to efficiently implement the projects which will benefit Kalaeloa Barbers Point Harbor (KBPH) and are consistent with the land use plan. It defines the specific elements within the categories of Piers and Cargo Yards, Maritime Support Services, Harbor Operations, Circulation, Infrastructure, Utilities, Navigational Aids and 24-Hour Access. The last two sections of this chapter address Development Constraints and Maintenance required.

6.1 Development Plan Overview

The *2040 Master Plan* recommends improvements for the harbor that will optimize overall harbor efficiencies and benefit Hawai'i's bulk cargo industry. KBPH will be prepared for forecasted conditions with the addition of new piers to accommodate both active unloading and layberth vessel activities, separation of uses that have conflicting operational requirements, and improvements to facilities that will alleviate current challenges.

The cornerstone project for the *2040 Master Plan* is construction of a dedicated Fuel Pier at Piers 3 and 4. Development of a Fuel Pier was one of the priorities identified in KBPH planning efforts as early as 1977. The Fuel Pier will add 1,325 linear feet of berth space, which is the capacity needed to meet future demands and optimize cargo handling efficiencies. The development of the Fuel Pier will displace an existing maritime support services tenant at the Pier 3 area and will require the demolition of a Finger Pier currently used for harbor support vessels. The tenant is anticipated to be relocated to Pier 9, and a 410-foot layberth will be constructed at Pier 8 to replace the Finger Pier.

For additional berthing capacity along the main cargo wharf (i.e., between Piers 5A and 7), Pier 7 will be extended approximately 200 feet. The Pier 7 Cargo Yard (S-7) will also be expanded by approximately 13 acres in alignment with the Pier 6 Cargo Yard (S-6). This will increase the accommodations for cargo operations at KBPH. Pier 9 improvements will facilitate berthing for Maritime Support Services. Construction of a vessel layberth at Pier 10 will provide additional large vessel berthing capacity of approximately 750 linear feet.

A new Hawai'i Department of Transportation, Harbors Division (DOT-H) Harbor Office building and parking will be constructed at the new Kalaeloa Harbor Access Road entrance. This location will allow the public to conduct business at the Harbor Office without entering secured harbor areas. The Perimeter Road will be relocated further northeast to provide for a larger contiguous yard at Pier 8 and northwest to provide a larger area for Maritime Support Services. Personnel shelters will be located throughout the harbor to accommodate harbor users during and between vessel operations. Remnant coral stockpiles from early dredging efforts will be removed as needed to accommodate new improvements. Utilities such as electrical power, communication systems, potable water and fire hydrants will be extended to the northern harbor area to support maritime tenants and harbor users. Electrical power and potable water will also be provided at key sites along the piers. The following *Table 6.1* provides a summary of recommended improvements.

Table 6.1 - Summary of Kalaeloa Barbers Point Harbor Improvements

Location	Action
PIERS AND CARGO YARDS	
Finger Pier and T-Pier	Minor improvements - water spigots, shoreside power connections, and gated access
Piers 3, 4A, 4B	Fuel Pier (1,325 feet) and Terminal Construction
Pier 6	Bollard installation
Pier 7	Pier extension (200 feet) and Cargo Area expansion (13 acres)
Pier 8	Layberth Pier (410 feet) and Multi-Purpose Yard Paving
Pier 9	Pier (950 feet) and Barge Ramp Improvements (by tenants)
Pier 10	Pier (750 feet) improvements
S-7, A1, A2, B1, Multi-Purpose Yard and Maritime Support Services	Remove coral stockpile areas/Site preparation for bulk storage areas
MARITIME SUPPORT SERVICES	
Fuel Terminal to Maritime Support Services	Relocate Marisco operations
HARBOR OPERATIONS	
Harbor Operations	Harbor Office/Parking Construction
Various	Personnel Shelters
CIRCULATION	
Kalaeloa Harbor Access Road	DOT-H connection from Perimeter Road/Access Road to Kalaeloa Harbor Access Road
S-A2, Multi-Purpose Yard, Maritime Support Services	Relocate Perimeter Road
Maritime Support Services	Restricted Emergency Gate Installation
INFRASTRUCTURE AND UTILITIES	
Fuel Terminal	Additional lighting, shore-based electrical power and potable water for vessels, upgraded individual wastewater system (IWS), fire suppression system, parking, fencing
S-7, Multi-Purpose Yard, Maritime Support Services	Grading and drainage improvements, install power, lighting, telecommunication, wastewater, water, fire protection and hydrants.
Harbor	Landscaping
NAVIGATIONAL AIDS AND 24-HOUR ACCESS	
Entrance Channel/Basin	Channel Deepening, Flaring/Basin Deepening (USACE)
Harbor	Navigational Aids: Relocation of lighted day markers, real-time monitoring, increased range light sensitivity (USCG)
Ko ‘Olina Mole (Pier 10 out to jetty)	Update perimeter lighting (24-hour access)

6.1.1 Piers and Cargo Yards

According to 2040 berthing demand projections calculated in Chapter 4, linear berthing capacity must increase from the current 3,910 feet to a minimum of approximately 5,100 feet. With the *2040 Master Plan* recommendations, construction of the Fuel Pier (Piers 3 and 4), Piers 8 and 10 layberth, extension of Pier 7, and use of Pier 9 by Maritime Support Services will exceed the projected berthing demand by providing approximately 6,600 linear berth feet *(Table 6.2).* This will allow for minimal berthing conflicts within the pier and more efficient operations.

Table 6.2 - Master Plan Berthing Analysis Demand Summary

USE	EXISTING	DEMAND	2040 PLAN	STATUS
Layberth – Finger Pier, Piers 8 &10	300	1,000	1,160	+160
Dry-bulk/Container (multi-use) – Piers 5A, 5, 6, 7	2,700	2,350	2,900	+550
Maritime Support – Piers 3 & 9	655	250	950	+700
Liquid-bulk – Piers 1, 3, 4A, 4B, 5, 6	1,855	1,500	1,580	+80
TOTAL	**3,910**	**5,100**	**6,590**	**+1,490**

Engineering and alternatives evaluation of pier designs are being examined for Piers 3 and 4 in the *Fuel Pier Development Plan*. This analysis will also be needed for Piers 7, 8, 9 and 10 before construction, as only general pier designs are offered in this *2040 Master Plan*. Design features which will be common to all KBPH piers include but are not limited to:

- Bull rails spaced properly along the edge of the piers that will not obstruct loading and offloading operations,
- Bollards and double bitt moorings located along the edge of the piers that are sized and spaced at approximately 64-foot intervals to serve vessels up to 751 feet and barges to 400 feet, and
- Fendering systems for vessel and dock protection.

Pier 1

Pier 1 is currently used for liquefied petroleum gas (LPG, also known as propane) shipments, but experiences periodic wave surge conditions. This is prominent especially during winter months, as northerly wave energy enters the harbor's entrance and impacts maritime operations. It has not been fully evaluated and will require further analysis to determine if and how wind-wave conditions could be improved at Pier 1 in response to the harbor deepening project. Currently, there are no other improvements suggested for Pier 1, and berthing will remain restricted during periods of high wave surge.

Pier 2
There are no plans for developing this unimproved area. This is a critical wave absorber, and surge conditions can limit vessel operations.

Finger Pier and T-Pier
The *2040 Master Plan* recommends minor improvements to the Finger Pier and T-Pier including installing water spigots, shoreside power connections, and gated access. This will improve the maintenance service capabilities for tugs, spill response and other support vessels in the interim until the new facilities at Pier 8 are constructed.

Piers 3, 4A and 4B and Fuel Terminal
The *2040 Master Plan* recommends the development of a dedicated Fuel Pier at the Piers 3 and 4 area in association with the Fuel Terminal for transferring liquid-bulk products. New fuel pipelines, which will be installed, owned and operated by the fuel industry, could be capable of handling a range of fuel types including, but not limited to: gasoline, jet fuel, fuel oil, naphtha, diesel, biodiesel, ethanol, and liquid hazardous gas (LHG). LHG includes, but is not limited to, LPG (propane) and liquefied natural gas (LNG, or methane).

Liquid-bulk fuel is transported to and from nearby refineries and storage areas via the energy corridor, a right-of-way managed by DOT-H where interested parties can install infrastructure such as pipelines. The alignment connects the James Campbell Industrial Park area to power generating plants at Honolulu and Pearl Harbor.

Land-side Improvements
Land-side components of the Fuel Terminal at Pier 3 require removal and relocation of an existing tenant's warehouse and ancillary buildings. A qualified hazardous materials consultant will be required to evaluate the presence of residual chemicals in the soil. If necessary, an environmental remediation contractor will be retained to remove and transport the chemical by-products of ship maintenance activities off-site for proper disposal. These actions, if needed, are the responsibility of the current tenant.

A new building will be constructed in the Pier 3 vicinity to house product quality assurance and security-related facilities required to support the Fuel Terminal transfer operations. This Fuel Control building will house a Fuel/Marine Terminal Operator and contain fuel pump controls, storage, offices and restrooms. Up to three small 8-foot x 8-foot covered individual shelters, either fixed or portable on a trailer, will be stationed at the dock near the transfer manifold. These structures will provide shelter with a desk and chair for each tankerman Person-in-Charge (PIC) per vessel. The PIC monitors the fuel transfer process, and performs emergency shut downs when/if necessary in the most expeditious and safe manner as possible. With the Fuel Terminal situated near the entrance of the harbor channel, a real-time camera(s) will be located at Pier 3 to allow the Aloha Tower Marine Traffic Controller and DOT-H's Central Control Center at Honolulu Harbor to view channel and harbor operations, in addition to the current camera at the end of the Ko 'Olina mole. At this time, the vessel traffic does not warrant siting a Marine Traffic Controller at KBPH in addition to Aloha Tower. Spill response and other fuel-related equipment will be stored at their current locations at Pier 4B in containers close to the pier face or in a maintenance building for ease of access and timely response deployment.

The Fuel Terminal will be subject to strict security, safety and environmental requirements. The focus of security will be: a) strict access control, b) capable responses to fire and explosion risks, c) containment and recovery of released agents, and d) segregation of threat potential from other harbor operations. The potential dangers of a malicious attack or malfunction of fuel facilities are significantly higher than other forms of cargo. Because of this, the Fuel Terminal will be a secure facility equipped with perimeter security fencing and a video monitoring system. Access to the facility will be restricted with a security gate, requiring Transportation Worker Identification Credential (TWIC) and Maritime Security (MARSEC) security clearances, with predetermined permission for access. Parking will be provided for approximately 25 to 30 personnel working at the Fuel Terminal. The entire area may be given a hazardous area designation, including required signage, determination, site specific area classification, electrical isolation of energized electrical systems, certification, and other measures near the transfer point.

Additional infrastructure to be incorporated into the Fuel Terminal design includes lighting, shore-based electrical power, potable water for vessels, and a fire suppression system. Shore-based power, also known as cold iron, allows vessels to shut off onboard generators when berthed. Potable water is used to supply fresh drinking water to vessels. A fire suppression system designed to comply with regulations for fire protection of marine terminals and piers will be installed to provide protection against loss of life and property. The City and County of Honolulu municipal sewer system does not extend to KBPH; therefore, an Individual Wastewater System (IWS) will be utilized.

Fuel Pier Alternatives Considered

The *KBPH Fuel Pier Development Plan* identifies three conceptual fuel pier design alternatives. The first design alternative utilizes a protruding segmented pier configuration. The second alternative is a full-length, continuous pile-supported platform wharf. The third alternative is a solid vertical continuous sheet pile bulkhead. Phased construction of the pier will enable retention of the Finger Pier until Phase II of the Fuel Pier is constructed. Implementation of the second phase will require demolition of the Finger Pier *(Figure 6.1)*. Pier 8 has been identified as a replacement layberth location for harbor tugs and support vessels that service KBPH, and will be constructed before the Finger Pier is demolished.

Fuel Pipelines

Fuel transmission pipelines will convey fuels between the Fuel Pier and off-site storage. Pipeline manifolds and valves will be placed at key points along the pier to coincide with the most common fuel vessel offload transfer points. New pipelines capable of handling various fuels will be installed, which will be owned, operated, and maintained by fuel industry and/or a designated Fuel/Marine Terminal Operator or consortium. The pipelines within the Fuel Terminal will be routed aboveground in a pipeline rack system to facilitate any changes or future expansion in pipe configurations and to allow for routine visual inspection and maintenance *(Figure 6.2)*. An aboveground system will also protect the piping from the corrosive environment under the pier or in the ground. This configuration is unlike the underground hatch configuration of Piers 5 and 6, which is necessary to support the multi-use function of the piers. In addition, the pipeline rack system will be raised for passage underneath in select areas to accommodate the circulation of vehicles and equipment within the Fuel Terminal.

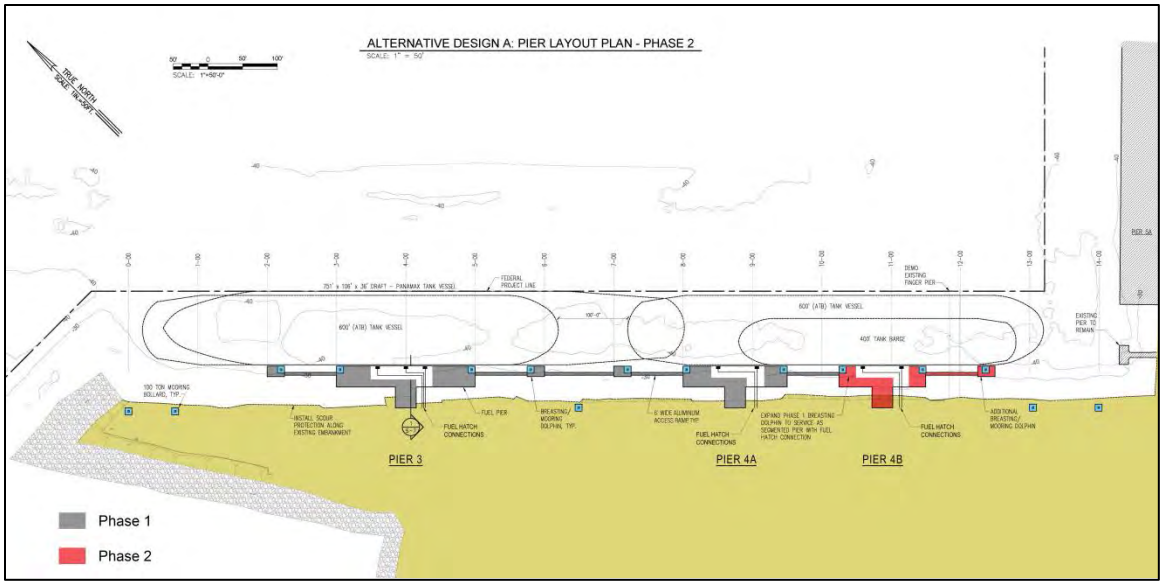


Figure 6.1 – Segmented Partial Piers Layout Plan (Phases I and II)

The pipelines will then go below ground in a gallery vault and be connected to the existing underground pipes near the junction with Pier 5A. To allow for redundancy, new pipelines can also be routed separately along Malakole Street.

Figure 6.2 – Example of a Fuel Terminal with Aboveground Pipelines

New Pipeline Easement
The *2040 Master Plan* recommends that additional pipelines be routed separately from the current pipeline easement within KBPH, as there is no room available for new pipelines in the existing corridor. Pipelines within DOT-H property would require an easement through DOT-H. The new easement would follow immediately southwest of Pier 4A to Malakole Street, running parallel to the road at a setback of 40 feet, and then joining the wider energy corridor outside of KBPH property *(Figure 6.3).*

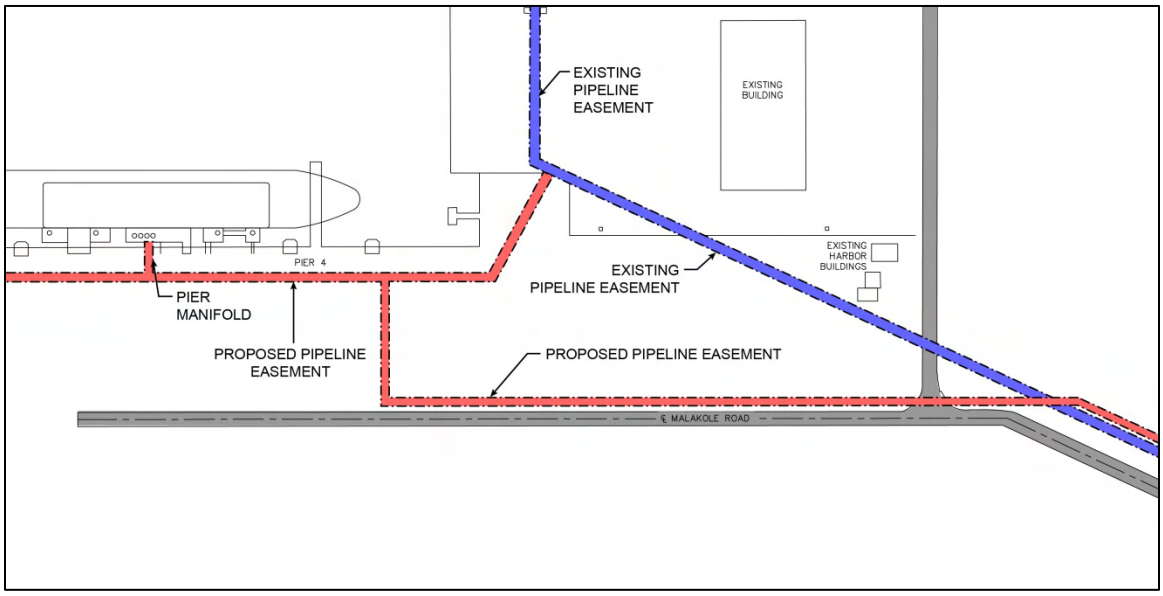


Figure 6.3 – New Pipeline Easement

Piers 5A, 5 and 6
The *2040 Master Plan* does not recommend any improvements at Pier 5A. Piers 5 and 6 currently have a heavy lift pad in support of unique oversized special cargo such as windmills or turbines. The heavy lift pad is designed to allow for the use of one or two cranes, based on type of crane, cargo and crane usage. However, the size of the pad is limited, sometimes causing the ship to re-position at berth in order for the heavy cargo to unload onto the pad. Expansion of this heavy lift pad has been requested by a harbor user. Although this would facilitate safety and operations when large loads of heavy equipment are being offloaded, the need to close the berth during construction and the expense required may not support the infrequent special cargos (such as windmills) that would benefit from an expanded heavy lift pad.

The *2040 Master Plan* recommends one minor improvement at Pier 6. Vessels exceeding 730 feet length overall (LOA) would ideally utilize the 1,900-foot mark bollard for mooring, in addition to the bollard at the 1,840-foot mark. In practice, this is often not possible as this configuration causes the 1,900-foot mark bollard mooring lines of the Pier 6 vessel to conflict with, and encroach upon, the bow of the Hawaiian Cement barge *Punapau* (that calls between the Piers 6 and 7). During periods of inclement weather and harbor surge, these vessels must run an additional three to four mooring lines to the only stern bollard at the 1,840-foot mark. This causes significant stress on the bollard by exceeding the single weight design loads. The *2040 Master Plan* recommends the

installation of an additional bollard at, or in close proximity to, the 1,880-foot mark, where the dock structure is best-suited to bollard placement.

Pier 7 and S-7 Cargo Yard

The *2040 Master Plan* recommends the extension of Pier 7 as a high priority due to periodic berthing conflicts between Piers 6 and 7. Vessels often overhang or extend beyond the end of Pier 7 by 100 to 150 feet when all other berth spaces are occupied, and cannot currently move further north due to lack of gangway support and adequate safe mooring allowances. Without the ability to move further north, the *Punapau*, a weekly scheduled interisland cement bulk barge, is prevented from loading at Piers 6 and 7. This barge can only berth at this location due to the position of the cement pipeline. In addition, this interisland barge will soon be replaced with a larger barge requiring additional linear berthing provisions. The *2040 Master Plan* recommends extending the current 800-foot long Pier 7 by an additional 200 linear feet, approximately 125 feet from the Pier 8 intercept point. The Pier 7 extension will increase the berth capacity to allow the interisland barge to berth with two Panamax-sized vessels (e.g. 720 feet LOA ships) at Piers 6 and 7 simultaneously.

A reinforced concrete deck structure supported on a system of concrete pilings (similar to existing Pier 7 design) is recommended for the extension *(Figure 6.4).* The concrete surface would be contiguous with the existing Pier 7, match the finished pier width, and have a finished elevation of +9.0 feet above mean lower low water (MLLW). A segmented pier, which can provide platforms at key points for gangway landings, would not provide sufficient apron for dry-bulk cargo.

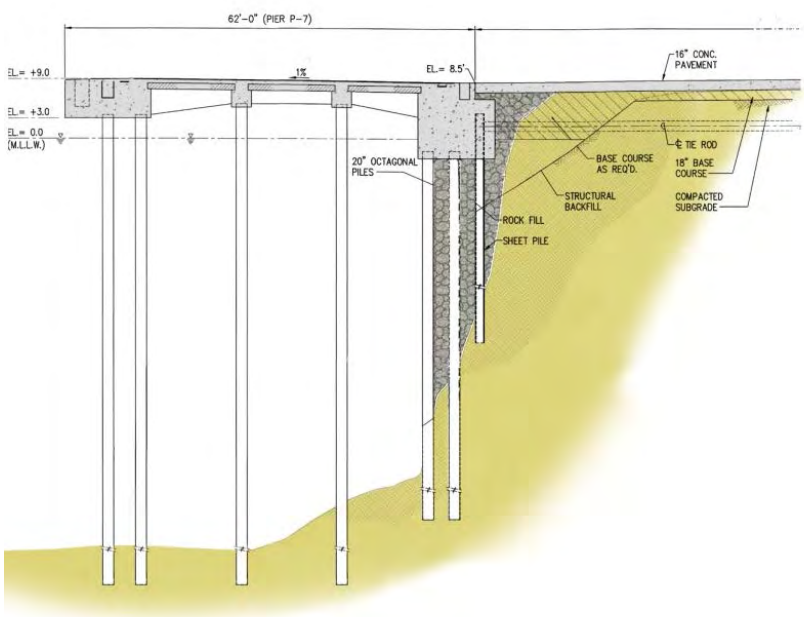


Figure 6.4 – Pier 7 As-Built Plans

To complement the Pier 7 extension, the *2040 Master Plan* recommends expanding the Pier 7 Cargo Yard (S-7) by approximately 13 acres, and squaring off the parcel in alignment with the Pier 5 and 6 Cargo Yards. The new cargo yard will be matched with the development and grading surface similar to the current S-7 Cargo Yard, with a paved concrete hardstand area to support heavy loads. Typically, heavy lift pavement is built using 18-inch thick concrete. Other technologies may be available and the selection of material will be determined during the design phase.

This cargo handling and storage area will extend from the pier face and square off in alignment with the new Kalaeloa Harbor Access Road. Cargo yard lighting and fire protection system and hydrants similar to Piers 5 and 6 Cargo Yards will also be added. Users also requested the construction of a Personnel Shelter at Pier 7 with restrooms, water and electrical services.

Pier 8 and Multi-Purpose Yard

To offset the loss of the Finger Pier at Pier 4B, the *2040 Master Plan* recommends that the Pier 8 area become the new layberth for marine support vessels displaced from the demolition of the Finger Pier. Approximately 410 linear feet is available along this harbor wall, assuming a vessel is berthed at the extended Pier 7 and a floating dry dock of up to 150-foot width is berthed at the Pier 9 area. One pier design option is a pile-supported T-pier structure, similar in construction to the Honolulu Harbor Pier 37. The concrete wharf is approximately 10 feet wide and placed parallel to the shore, offset from the revetment bank approximately 45 feet to permit the inside berthing on the pier face for smaller vessels *(Figure 6.5).* A perpendicular pier configuration similar to the current Finger Pier is not considered a reasonable alternative here as such a protrusion would pose a navigational hazard to vessels accessing Piers 7 and 9. A pile-supported T-pier will have minimal effect on wave action within the harbor.

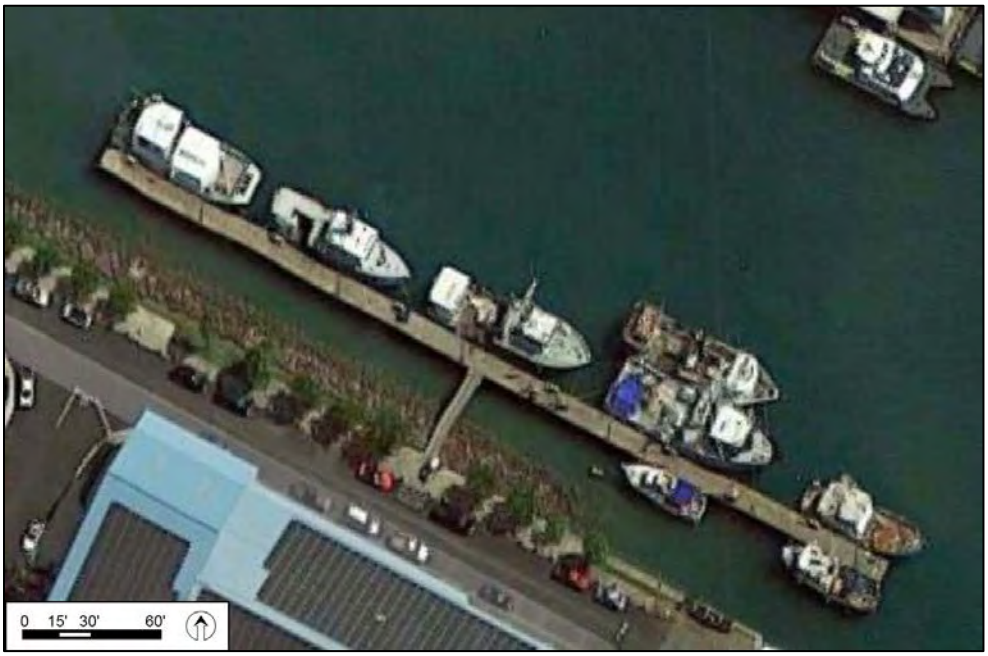


Figure 6.5 – Example Pile-Supported T-Pier Layberth

A continuous pile-supported platform wharf is another option. This pier would be similar to the existing Pier 7 design, with minimal piles and a narrow apron *(Figure 6.6).* A wider apron would not be necessary as Pier 8 would not be a cargo pier. This design would keep costs down while retaining the wave absorptive characteristics of the area.

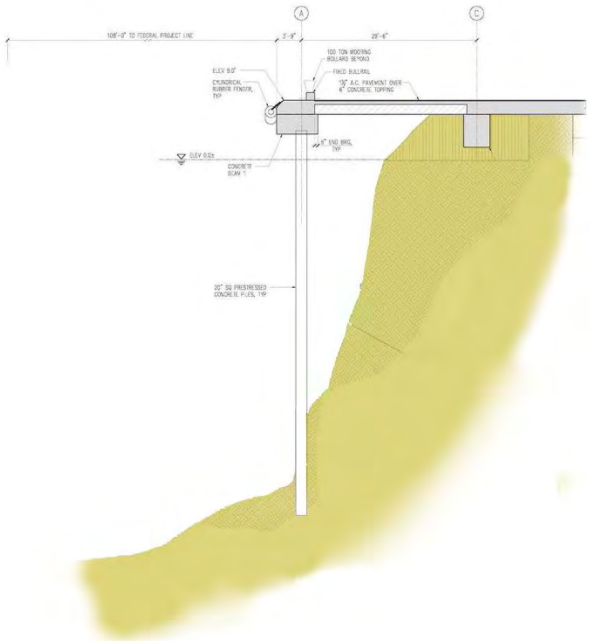


Figure 6.6 – Continuous Pile-Supported Pier with Narrow Apron

A continuous sheet pile bulkhead pier design can also be considered. Interconnected sheet pile (either steel or concrete) would be restrained from outward movement by installing steel anchor rods and concrete deadman anchors. However, depending on the retained depth and soil, a deadman anchor may not be needed. Another option is a cantilever sheet pile with drilled-in king piles. The space between the shoreline and the bulkhead would be backfilled with coarse aggregate material. This alternative has an added benefit of hardening the harbor edges to reduce erosion. See *Figure 6.7* as an example.

Another alternative uses heavy duty floating docks accessed by ramps *(Figure 6.8).* Floating docks are pontoon structures anchored to the seabed by spud piles or mooring lines, and connected to the shore by bridges or ramps. A floating dock may limit the type and size of vessels that can use the pier, excluding larger barges or vessels. However, this type of pier would accommodate the smaller tugs and service vessels by rising and falling with the tides, allowing for ease in mooring. A lower dock height is preferred to provide safer access to and from tugs and workboats with lower freeboard. This alternative would also be most economical. An analysis of wind and wave action should be conducted to determine the service and stability of the most appropriate floating dock.

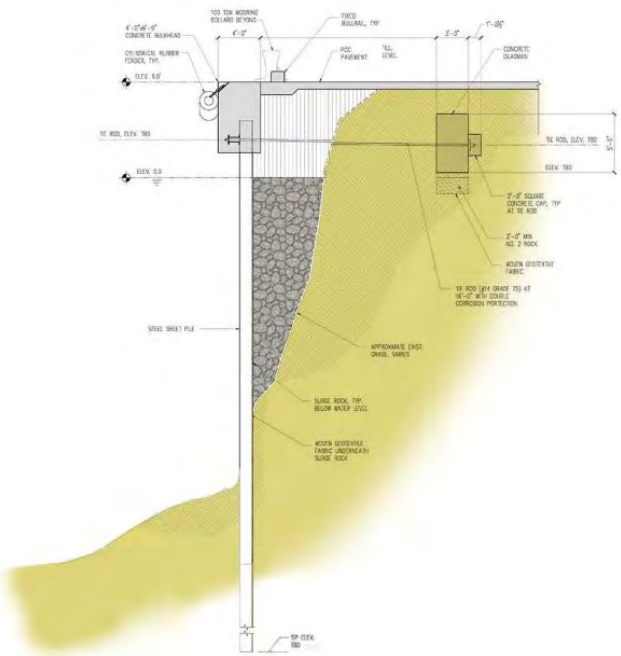


Figure 6.7 – Sheet Pile Bulkhead Concept

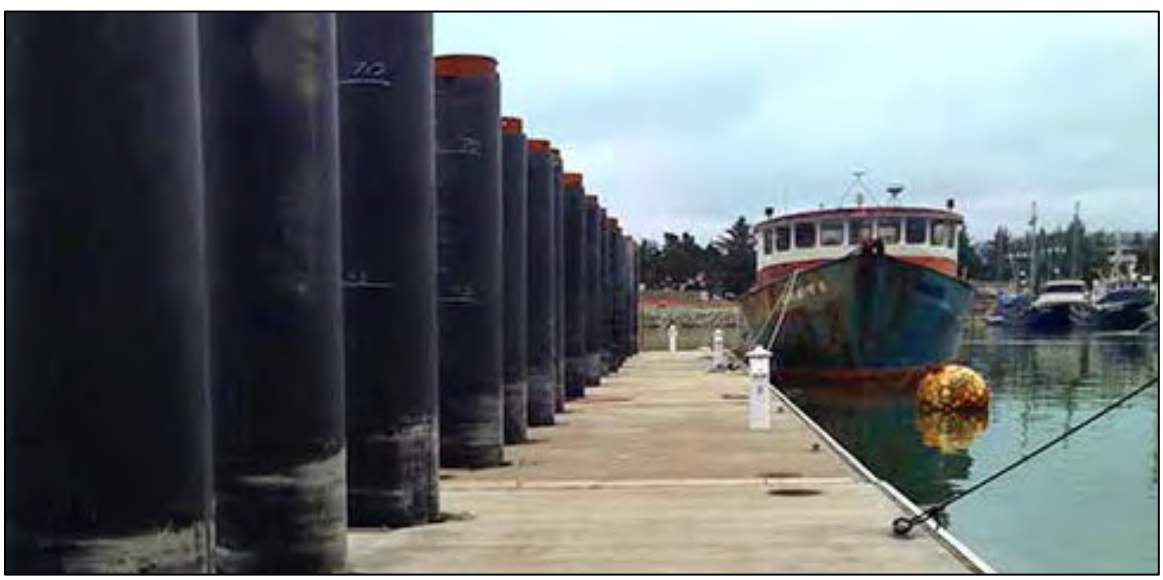


Figure 6.8 – Example of Floating Dock Concept

The Multi-Purpose Yard adjacent to Pier 8 is an open area that is intended to maximize flexibility and preserve space adjacent to Piers 7, 8 and 9 in case it is needed for cargo movement in the future. It will primarily serve as parking space for vehicles and staging equipment, parts and replenishment of provisions, coupled with vessel maintenance and repair of vessels at the layberth. This area could also be used in an emergency situation for overflow equipment staging. This Multi-Purpose Yard will primarily work as a light duty area (for passenger cars, light trucks and occasional heavy trucks), and can be

accommodated with a typical four-inch thick asphalt concrete over a base course material. A paved concrete hardstand is not as critical here as emergency heavy loads would be infrequent, but could potentially be located in the flex areas by Maritime Support Services and Pier 7 Cargo Yard (S-7) for emergency storage.

Added amenities include a designated parking area for service vehicles and harbor workers (typically not more than 500 feet from the pier), potable water spigots, shoreside power connections, lighting, and gated access. The Multi-Purpose Yard will incorporate a covered, open air Personnel Shelter at Pier 8 near the dry dock at Pier 9 that includes fixed tables with benches, an emergency life-ring, first aid station, emergency communication, water fountain, restrooms, and electrical services.

If excursion vessels are allowed at Pier 8, the parking lot would also be needed for staging vans and busses. Access to the pier would need to be available for these public excursion vessels. Sewage pump outs will not be available for these excursion vessels, as KBPH is not currently connected to the City and County of Honolulu sewer system. Posted signage with numbers to local pump truck companies would be helpful.

Pier 9

Pier 9 will be used to support Marine Support Services operations. The floating dry dock will be moored in place by either mooring lines with associated mooring bitts or an A-frame type of dolphin post mooring system. Marisco, Ltd.'s (Marisco's) current dry dock *Lil' Perris* has a LOA of 360 feet x 88-foot beam with a deadweight lifting capacity of 3,500 tons. Marisco plans to replace their current floating dry dock with a larger floating concrete dry dock measuring approximately 560 feet LOA x 150-foot beam, not including a DOT-H approved, appropriate mooring system (furnished by the tenant) to accommodate their floating dry dock.

To prevent erosion, Pier 9 may need either a partial-depth bulkhead or full-depth sheet pile as reinforcement *(Figure 6.7)* along the unfinished edge. A portion of Pier 9 along the current dry dock was previously reinforced with sheet pile and stone revetment.

Healy Tibbitts Builders, Inc., a current marine construction tenant at the southwest end of Pier 9, has identified a barge ramp as a desirable improvement. This would allow them to pull barges out of the water to repair and maintain them on land. An initial concept proposes to build a 100-foot wide ramp along the tenant's current 400-foot waterfront boundary at Pier 9. A gradual incline from harbor waters to approximately 230 feet inland would be created, with sheet-pile walls reinforcing the ramp edges perpendicular to the harbor wall. Installation of power to allow night work at the ramp would also be installed.

Pier 10

The *2040 Master Plan* recommends developing Pier 10 to provide a layberth capable of mooring barges (250 to 400 feet LOA), Coast Guard cutters (350 to 400 feet LOA), and Handymax/Panamax sized vessels (up to approximately 750 feet LOA). Susceptibility to seasonal wave action and harbor surge conditions will need to be evaluated, and any pier development in this area may need to include wave absorption features characteristic to this portion of the harbor.

Erosion has occurred in the northernmost section of Pier 10 where the existing revetment ends. Protection methods may require installation of sheet pile (Figure 6.7) or other bulkhead measures. Plans for the proposed layberth could incorporate the embankment repair, e.g. in a bulkhead pier, or could employ a separately designed mooring structure or segmented pier configuration. Several mooring dolphins (Figure 6.9), constructed of either timber or concrete pile, could be spaced along the Pier 10 area in sufficient depth to allow a Handymax/Panamax sized vessel (up to approximately 750 feet LOA) to berth alongside. Shore access could be incorporated through the construction of access ramps. Alternatively, the vessel could deploy skiffs or be accessed by support vessels in KBPH.

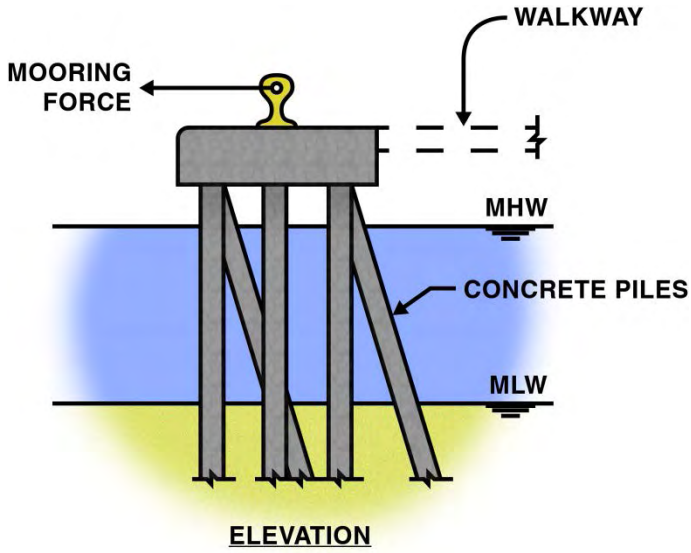


Figure 6.9 – Mooring Dolphin
(Adapted from US Department of Defense UFC 4-152-01, 2012)

The segmented pier configuration *(Figure 6.10)* would incorporate breasting and mooring dolphins, with platforms for gangways and shoreside access. Required elements would include:

1) A breasting centerline dolphin with two double bitt mooring bollards (Not a significant large structure, with limited access alongside vessel amidships)
2) Two mooring/breasting dolphins with one double bitt mooring bollard on each dolphin (with pedestrian walkway for access during mooring and unmooring)
3) Two off set mooring bollards (single post).

All mooring bollards are recommended to have a minimal safe working load of 100 tons or greater. Ultimately, the pier should be constructed in a way that there is minimal overhang on the southeasterly side at Pier 9, and built so that vessels will not berth within the designated federal project line.

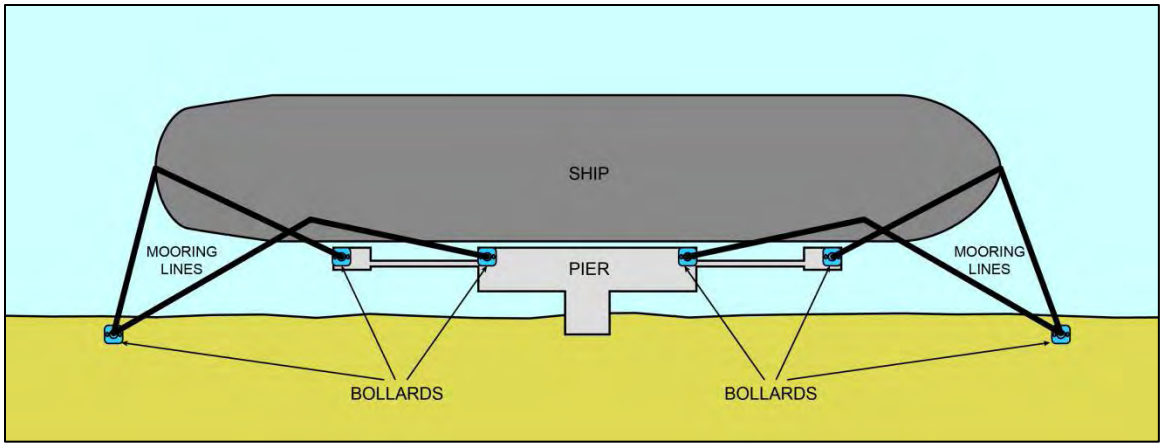


Figure 6.10 – Example of Possible Berthing Configuration for Pier 10

Pier 10 landside will require connection to the Perimeter Road, with approximately 40 feet width for trucks to pass each other, and approximately five parking spaces. Pier 10 will also include a Personnel Shelter for those at layberth.

Storage Yards A1, A2, B1

Bulk A (S-A1 and S-A2) and Bulk B (S-B1) storage areas will be improved by users based on their needs. Coral stockpiles remaining in the Bulk A and B storage areas will require removal before development can proceed. The stockpile disposal process is described in the DOT-H *Dredge Spoil Stockpile Management Plan* (January 2015).

The current DOT-H strategy for managing the KBPH stockpiles focuses on disposal (i.e., removal) through sales and reuse of the dredge spoils materials. The remaining stockpile will be stabilized through the use of temporary and permanent best management practices (BMP). In view of the high level of construction activities on O'ahu over the foreseeable future, the marketing and sale of these stockpile materials is expected to take five years or less. The sale and stabilization strategy is outlined below:

1. Annual Milestones
    a. Verify remaining amounts of materials in each stockpile
    b. Analyze geotechnical properties for determining potential reuse and value
    c. Conduct a market analysis to identify prospective users and buyers.
2. Sale and Removal
    a. Actively market stockpile material to public agencies and private agencies
    b. DOT-H goal is to remove twenty percent of the stockpile materials each year, with existing stockpiles completely removed by 2020
    c. If market interest for dredge spoils materials is greater than expected, complete removal may occur sooner.
3. Grading
    a. Upon removal of stockpiles, the entities removing the material are required to grade the area with the objective of minimizing runoff and maximizing infiltration through use of BMPs until development occurs.
    b. Stormwater drainage will be in conformance with the *2015 Stormwater Management Plan for Honolulu and Kalaeloa Barbers Point Harbors* (January 2015)

Not all storage areas will be leased immediately, but these areas may be prepared by DOT-H for occupancy. Coral stockpile removal, grubbing and grading will facilitate temporary activities such as truck staging and emergency relief efforts. Once demand presents itself, the storage yards can be further developed.

6.1.2 Maritime Support Services

The *2040 Master Plan* recommends that Marisco, the current Maritime Support Services tenant at the Pier 3 area, be relocated to the Pier 9 area. The plan also recommends separating this area from adjoining properties by a landscaped buffer to mitigate the effects of industrial activities.

Marisco has provided marine support and industrial services at KBPH since 1986 under a lease from DOT-H. As per the terms of the tenant lease agreement, Marisco has been offered space in the Maritime Support Services area of similar size to its current Pier 3 operations (3.4 acres of fastland, and 1.5 acres of submerged land). Marisco also services vessels at a dry dock moored at Pier 9 under a revocable permit, on 0.76 acres of submerged land and 0.1 acre of fastland.

To maintain their existing maritime support services and ancillary industrial machine shop activities, Marisco has agreed to consolidate its operations by relocating on fastland at the Pier 9 area. Grading and grubbing to install foundations for their buildings will be undertaken by Marisco, with prior approval by DOT-H. Installation of an individual wastewater system (or connection to a neighboring landowner sewer system) will be required, as will trenching for power and potable water. Additional power to supply this area has been requested from Hawaiian Electric Company (HECO). Parking for approximately 150 employees, 50 contractor/visitor vehicles and related Marisco support vehicles, as well as security features for the Marisco work yard, will also be incorporated into the project by Marisco.

6.1.3 Harbor Operations

Harbor Office Facilities

The *2040 Master Plan* recommends the Harbor Office be relocated adjacent to the new main entrance roadway along Kalaeloa Harbor Access Road. The Harbor Office facilities will be similar to the Nawiliwili Harbor Office complex on Kaua‘i, on a one-acre site. The KBPH Harbor Office could potentially house ten personnel, one-third less than the fifteen personnel at the Nawiliwili facilities. The KBPH Harbor Office building will be sized accordingly with a 2,500 square-foot one-story structure. It is recommended the Harbor Office be built according to Act 96, Session Law of Hawai‘i 2006 Buildings and Facilities, with ADA compliance. A second story observation deck/office will be approximately 1,300 square feet and available to employees only. Located in this administration building will be the general offices for DOT-H staff and security, a conference room, and any additional office requirements. Public facilities including restrooms, a first aid station, and a communications center will also be located here.

Figure 6.11 – Example of Harbor Office Facilities *(Nawiliwili Harbor)*

The one-acre Harbor Operations site is available to accommodate harbor maintenance support functions and service requirements, a storage yard and designated open parking for the public and harbor users. Similar to the Nawiliwili office, a covered maintenance shop building (approximately 4,500 square feet) with roll up doors will also have an adjoining employee/shop break room with restrooms (approximately 950 square feet). A covered garage (approximately 1,400 square feet) will house work vehicles, and a small 200 square foot shed will be available for hazardous materials storage. A portion of the maintenance area will include a vehicle garage and one-bay large vehicle wash-down pad/rack, with provisions for preventing pollutants from entering the storm drain system and the harbor waterway.

The remaining four acres will provide parking and other harbor offices for the Department of Agriculture and United States (US) Customs to conduct biosecurity and inspection services, if needed. These agencies will install their own improvements.

Personnel Shelters

The *2040 Master Plan* recommends that new Personnel Shelters be located at Pier 3 (within the fuel control building), the Piers 4/5 area (renovating the current personnel shelter and realignment of the harbor perimeter fencing), the Piers 5/6 area, Pier 7, Piers 8/9 area, and at Pier 10 *(Figure 6.12).* Those Personnel Shelters located at Piers 5/6 and Pier 7 should be located adjacent to the light poles at these locations for ease of access to harbor users and minimal disturbance to the open cargo yard. These covered, open air shelters will be multi-purpose areas providing protected space, with limited amenities including an emergency life-ring, first aid station, emergency communication, electrical outlets, fixed tables with benches, and restrooms/water fountain when water supply can be made available.

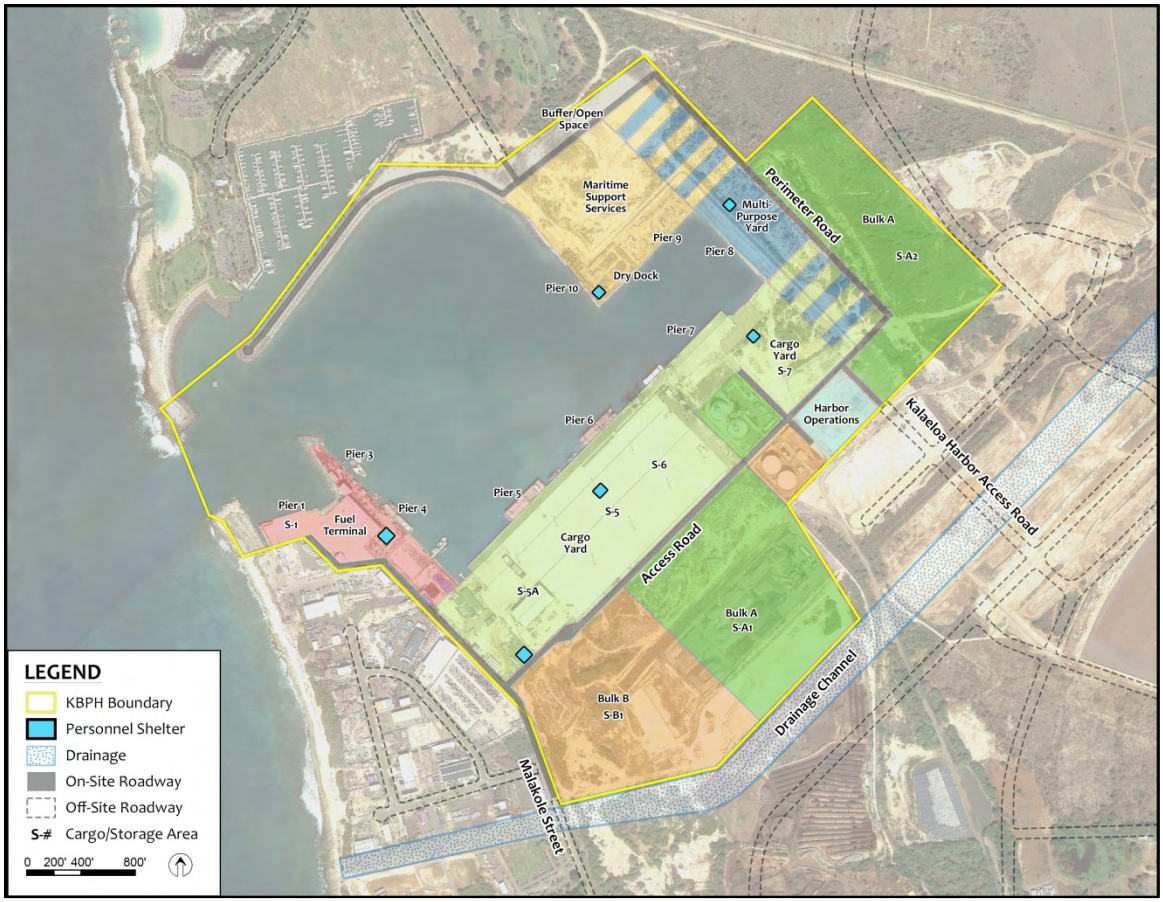


Figure 6.12 – Personnel Shelter Locations

6.1.4 Circulation

The *2040 Master Plan* recommends to relocate the current harbor entrance at Malakole Street to north of the GLP Asphalt Terminal landside of Pier 7. This new entrance will be named Kalaeloa Harbor Access Road, linking to Hanua Street and Kapolei Parkway. The Harbor Office and associated facilities will be constructed at a site adjacent to the planned Kalaeloa Harbor Access Road. Once the Harbor Office is relocated, this entrance will serve as the primary entrance, including provisions for security that will serve the harbor. *Figure 6.13* indicates the proposed road network layout for the harbor.

Kalaeloa Harbor Access Road will include the requisite lighting and overhead clearances, linking to Hanua Street and Kapolei Parkway. The neighboring landowner, Kapolei Properties, LLC (KPL) is working closely with DOT, Highways Division (DOT-HWY) regarding design and construction of Kalaeloa Harbor Access Road off harbor property. Kalaeloa Boulevard is expected to have the capacity to accommodate traffic generated by the anticipated growth of harbor facilities and operations. Kalaeloa Harbor Access Road will have a 120-foot right-of-way, which will include 10-foot wide sidewalks on each side of the roadway to provide added pedestrian safety. The portion of Kalaeloa Harbor Access Road leading into Kalaeloa Harbor will be designed for four lanes and have no on-street parking. At full build-out, there will be two incoming truck lanes and two outgoing truck lanes servicing KBPH.

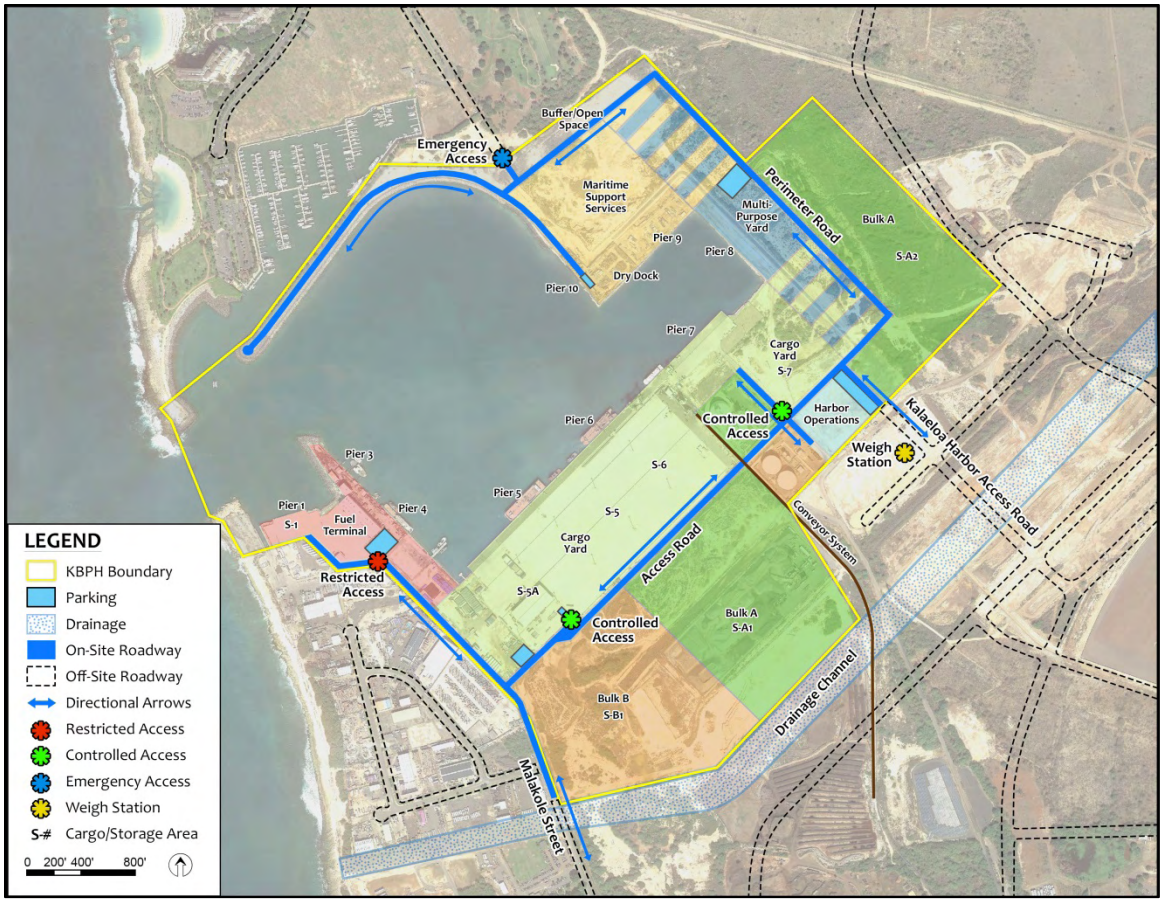


Figure 6.13 – KBPH Circulation and Parking Plan

The interior Perimeter Road on harbor property will be relocated further northeast and northwest. This action will provide for a larger contiguous area at the Multi-Purpose Yard and a larger area for Maritime Support Services. Relocating the Perimeter Road outside of potential tenant property will avoid access issues to utilities running underneath the road. Due to the expected increase in number of employees and types of activities in the northern areas of the harbor, the *2040 Master Plan* recommends an emergency evacuation and response connection to Ko ʻOlina through Kekai Place, with a controlled gate and passage allowed during emergencies only. There is currently not a gate between KBPH and the neighboring KPL land, but a gate exists on the other side of the Kapolei Property at the Ko ʻOlina Marina boundary. The emergency access would require right-of-entry agreement and insurance with KPL and Ko ʻOlina Marina. A service road along the Ko ʻOlina mole allows for maintenance of the lights, camera and landscaping.

Additional internal roadway improvements will be made to serve newly developed terminal storage areas (Bulk A and B), as constructed by tenants. Access will most likely commence at Perimeter Road, as the coal conveyor constrains access to Bulk A (S-A1) from the northeastern direction. Internal roads will conform to subdivision regulations. In addition, safe traffic patterns will be established during the design phase for vehicles (including cargo hauling trucks, taxicabs, repairmen, etc.) and pedestrians (crewmembers, stevedores, and other authorized personnel) crossing the pier apron and cargo yard areas.

This will also be important at the Multi-Purpose Yard for the public that may be accessing excursion vessels at Pier 8. Roadway crossings will be well-marked and lighted to avoid potential accidents involving large equipment working and/or traversing in the area.

Parking

The *2040 Master Plan* recommends providing six parking areas for harbor visitors, stevedores and other people who service the terminals and vessels. New parking areas at the relocated Harbor Office, Pier 10 layberth, Multi-Purpose Yard, and Fuel Terminal will be sized, paved, and striped according to federal and local regulations *(Figure 6.13).* Parking areas behind the Pier 5A Transit Shed and at the current Harbor Office will be retained. Tenants will be responsible for parking within their leased area.

Weigh Station

Upon the initial dedication of the Kalaeloa Harbor Access Road to DOT-H, KPL will convey approximately two acres of land adjacent to KBPH to be used as a DOT-HWY truck weigh station. The *2040 Master Plan* recommends the weigh station be located on the southern side of Kalaeloa Harbor Access Road. DOT-HWY will be responsible for the design and construction of this facility.

Many states now use a weigh-in-motion (WIM) system to alleviate some of the truck traffic through the weigh station. A WIM station will increase the efficiency of operations and prevent overweight trucks from damaging roads. WIM devices are designed to capture and record axle weights and gross vehicle weights as vehicles drive over a measurement site. Unlike static scales, WIM systems are capable of measuring vehicles traveling at a reduced or normal traffic speed and do not require the vehicle to come to a stop. This makes the weighing process more efficient, and allows commercial trucks under the weight limit to bypass static scales or inspection. The weigh station will include small offices for the inspectors, the computerized WIM system, and a parking area to inspect overweight vehicles. The WIM system itself includes a low to medium-speed WIM scale, detectors to check for vehicle presence, and directional signals *(Figure 6.14).*

Figure 6.14 – Example of a Medium Speed, In-motion Axle Weighing System
(Source: www.World Highways.com, 2014)

6.1.5 Infrastructure

The amount of infrastructure required to sustain forecasted harbor needs was carefully considered and is presented in this section. Infrastructure, including electrical power, potable water, and fire protection infrastructure will be extended to the northern harbor area for tenant use. Shoreside electrical power and potable water will be extended to key sites along the piers for harbor support vessels at berth.

Power and Lighting

The existing power provided to KBPH is insufficient for future needs in the northern portion of the harbor. Another 46 kilovolt (kV) primary service line will be needed as soon as possible to support the Marine Support Services users *(Figure 6.15)*. To support this need, HECO will need to conduct a circuit analysis and consider surrounding power sources. Options for HECO power sources include: an extension from an existing Ko 'Olina Substation, a 46 kV line along the OR&L route, or the installation of a new substation.

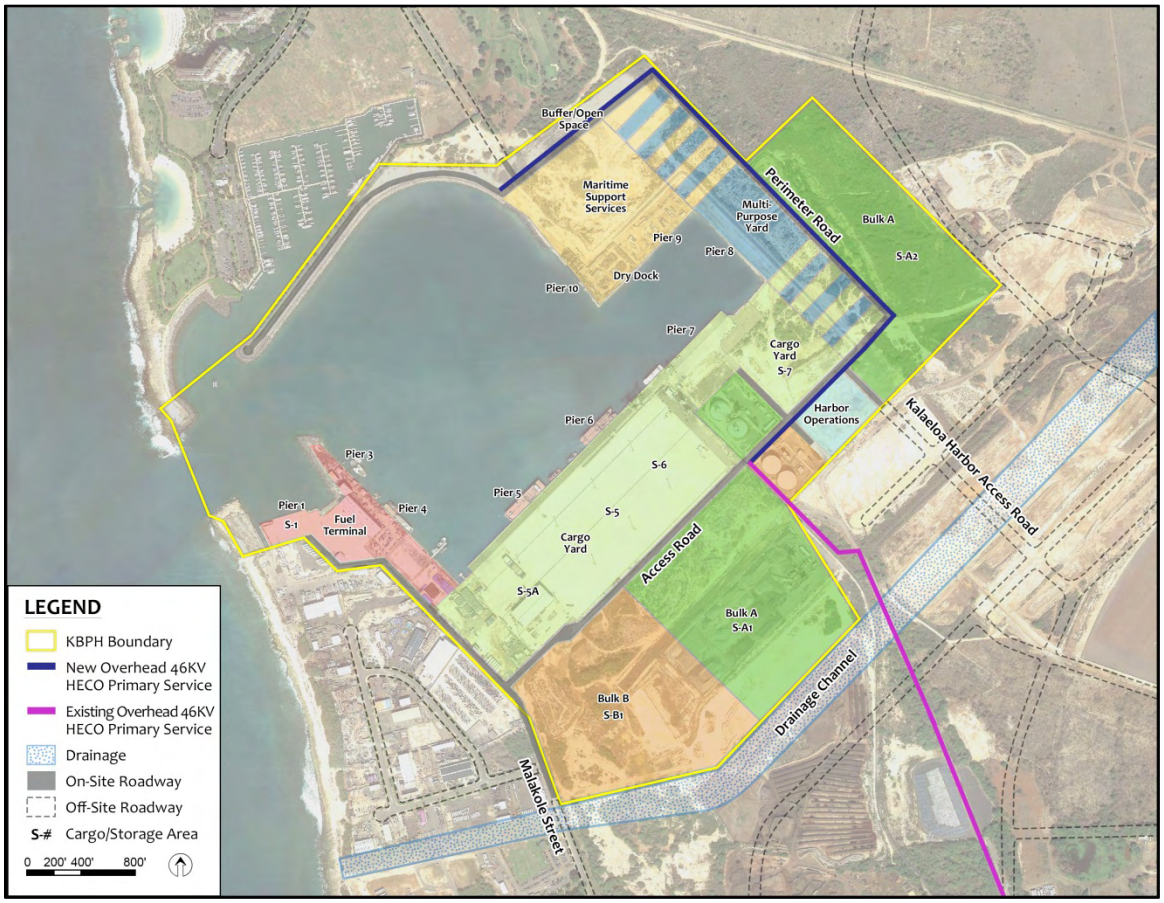


Figure 6.15 – KBPH Power Plan

The addition of this increased power to KBPH will require a service request. In order to develop KBPH in the most efficient and cost-effective way, the design and phasing of the electrical systems should not only provide adequate capacity for the short-term projected loads of the current project, they should also be designed with the proper phasing and long-term projected loads of all proposed projects. This power request will require 6.55 megavolt-amperes (MVA) to cover the current and imminent power needs of the northern area of the harbor, including Pier 7, S-7 Cargo Yard lighting, and the needs of the Maritime Support Services tenants. Other future needs in the area (such as power for a Personnel Shelter at Piers 7, 8 and 10, shoreside power for the new Piers 8 and 10, the Harbor Office, Weigh Station and new Kalaeloa Harbor Access Road lighting) are included in the load requirements.

Initial power lines may extend overhead following a relocated interior Perimeter Road, moved closer to the edge of the harbor property. Relocating Marisco operations to the Pier 9 area will cause an access issue if the road remains at its current location. These overhead lines can go underground at the tenant locations. The transformers and primary cables will be furnished and installed by HECO. DOT-H will furnish and install the ductlines, manholes, and concrete pads necessary for the pad-mounted transformers. Tenants will be responsible for infrastructure tying into this system.

The power needs for the remaining projects in the *2040 Master Plan* may be met with the current power infrastructure of 12.47 kV. These include electrical service needs at the Fuel Pier, Sause Bros. office, Personnel Shelter at Piers 5/6, and future users of the Bulk A and B areas. Electric power will be provided dockside for both vessel and equipment for stevedoring operations.

Lighting for the Pier 7 Cargo Yard (S-7) will be provided by 75-foot poles with a 5-foot concrete base and sets of energy efficient floodlights that meet Hawai'i Occupational Safety and Health (HIOSH) standards. With a maximum height of 80 feet, each pole should be sited to provide a 5 foot-candle illumination level on the ground for the piers and harbor backup areas. Lighting installation will occur with the development of the paved storage areas. Under the *Endangered Species Act of 1973* and *Migratory Bird Treaty Act*, all lights, including street lights, must be shielded so the bulb can only be seen from below and use the lowest wattage bulbs possible that satisfy the requirements of the area.

Telecommunications

Telephone communications to KBPH will be provided by Hawaiian Telcom or similar capable provider(s) and will tie into a James Campbell Industrial Park substation via lines on Malakole Street. An underground telephone service system within KBPH will parallel the electrical power duct system and will service all major structures as well as provide dockside hookups for vessels. Communications will include telephone facilities in all buildings and pier areas.

The underground telephone distribution system will be extended in a similar manner to the electrical system with concrete encased ductlines, telephone manholes and telephone service cabinets furnished and installed by DOT-H. The fiber optic cables will be furnished and installed by Hawaiian Telcom or similar capable provider(s).

A third underground distribution system will be provided to the southern portion of KBPH to accommodate an additional Closed Circuit Television (CCTV) System. This CCTV system will be located at the Fuel Pier as an additional camera to that located at the end of the Ko 'Olina mole, and will be monitored by Marine Traffic Controllers situated at the Aloha Tower and DOT-H's Central Control Center at Honolulu Harbor. Cable television and internet service will be installed at tenant discretion.

Fencing and Security

To address port security and safety concerns, sensitive operations within KBPH will be secured via fencing and gates, and monitored with security cameras and personnel. Security fencing of approximately 500 feet will separate the Fuel Terminal from the Pier 5A Cargo Yard (S-5A). Perimeter fencing of approximately 3,200 feet will be installed around the Pier 7 cargo yard (S-7), depending on the needed extent of the yard into the Multi-Purpose flex area. This will be in addition to the 13,000 feet of fencing already installed from Pier 1, around the large Cargo Yard and around the Hawaiian Cement property. Tenants will be responsible for the installation of their own fencing. The security fences will be eight-foot high, two-inch mesh chain link construction with a barbed finish. Security will be maintained through controlled ingress and egress at the Fuel Terminal, and for the Cargo Yard across from Pier 5-A at S-5A and across from Pier 7 at S-7 adjacent to Hawaiian Cement.

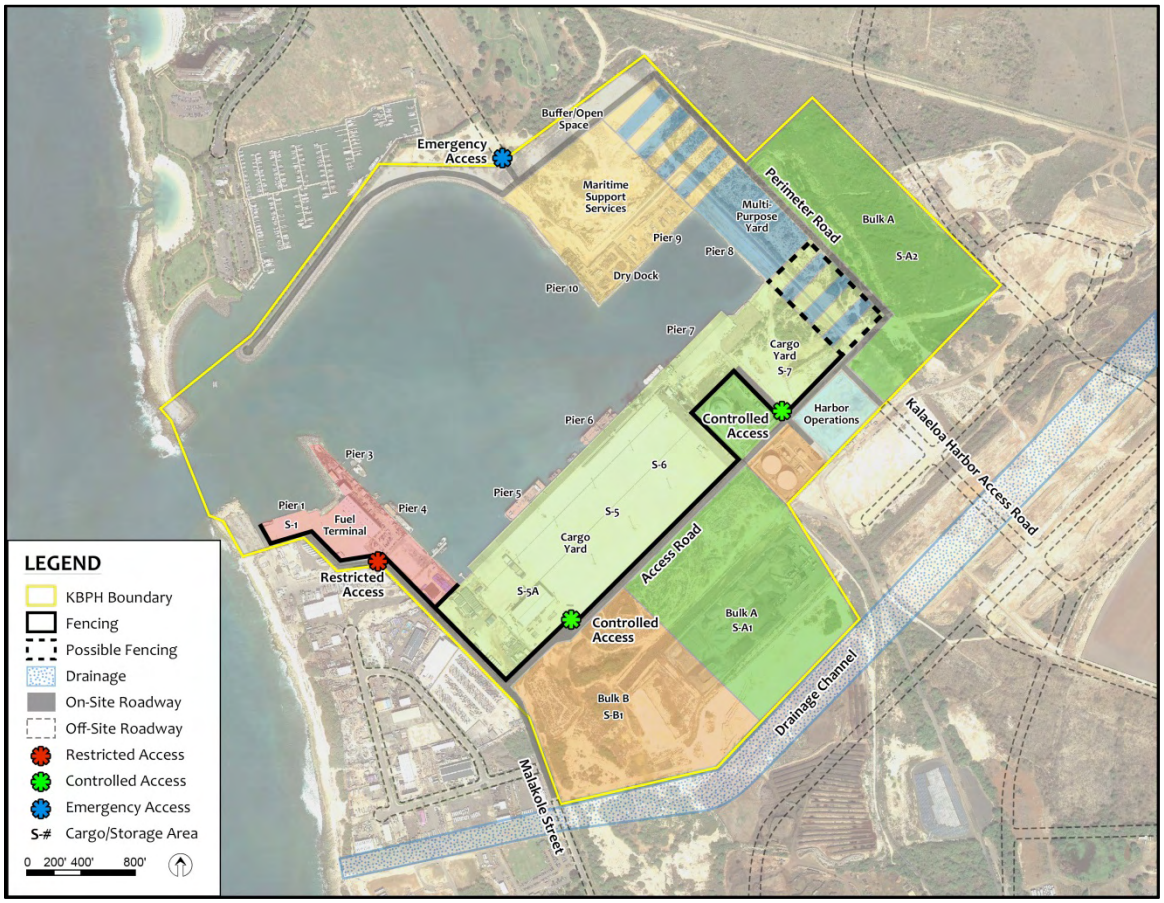


Figure 6.16 – KBPH Fencing and Security Plan

Potable/Non-potable Water

Potable water lines will be developed incrementally throughout KBPH to all developed piers, buildings, and Personnel Shelters. The potable water system will loop along the relocated Perimeter Road, serving dockside needs at Piers 7 to 10 as well as the Personnel Shelters, Harbor Operations site, and Maritime Support Services *(Figure 6.17).* Looped systems have pipes that are interconnected throughout so that water can move through the entire system back and forth, depending on the points of largest demand. An additional main will need to be extended from the current system to service the Bulk A and B areas. The potable water distribution mains are typically installed first, with service laterals and submeters to individual tenants as the harbor is developed. The potable water system at the fuel pier area will be improved to include a looped system.

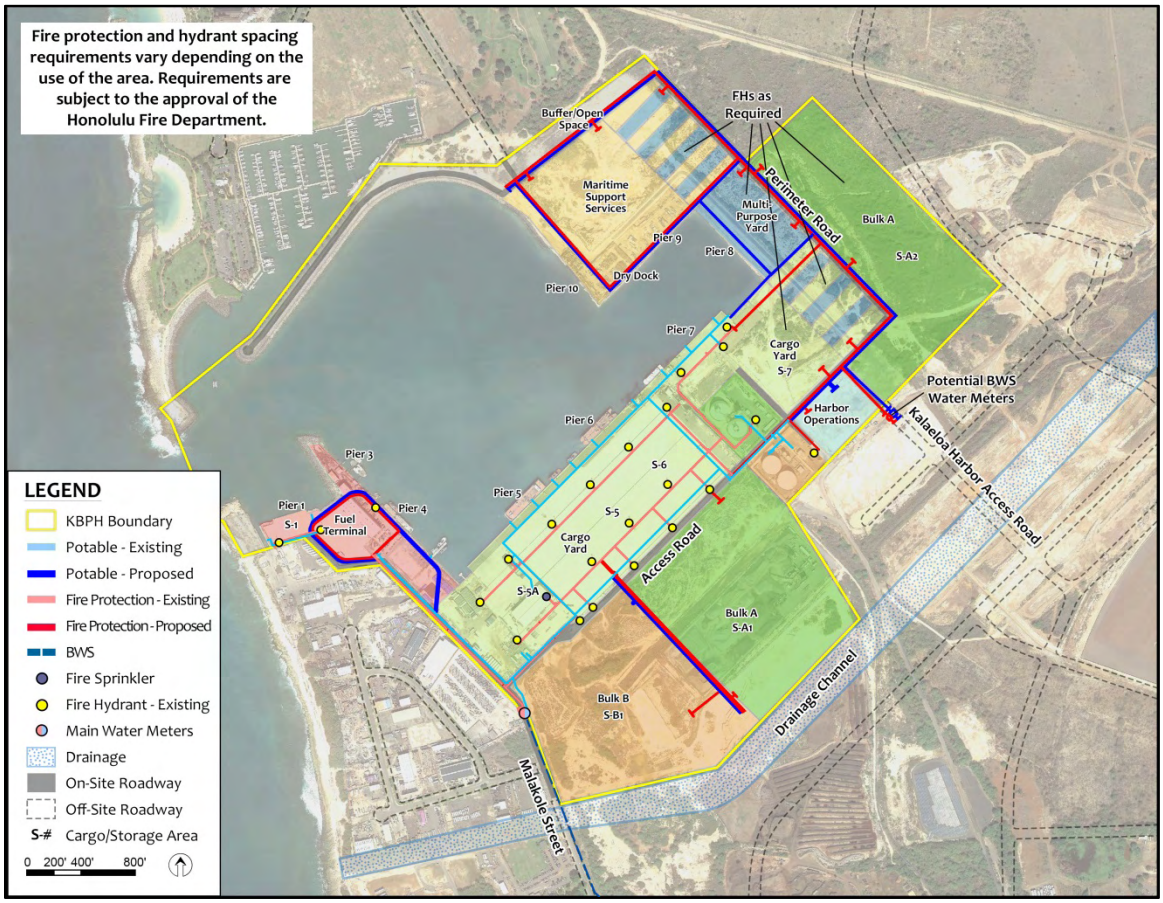


Figure 6.17 – KBPH Potable Water Plan

As the water demands of all future tenants and other users are currently unknown, the users of the potable water system should be further analyzed in the design stage and the system appropriately upsized to accommodate potential future demand. If water demand increases substantially at the harbor over time, additional capacity could be obtained by upsizing the two-inch Honolulu Board of Water Supply (BWS) water meter or by adding a second connection to the public water system once the Kapolei Harborside project is developed. Kapolei Harborside is a planned industrial and commercial development approximately 345 acres in size located on the east side of the harbor. The development

will include a public roadway and utility improvements up to the harbor. This secondary connection would be located along the Kalaeloa Harbor Access Road up to the Harbor Operations site.

Fire Protection

The proposed fire protection water infrastructure improvements will include fire protection water main extensions, fire hydrants and fire sprinkler services to buildings, Personnel Shelters, and the new Harbors Office *(Figure 6.17).* As the fire protection demands of tenants and other users are unknown, the fire protection water system should be appropriately upsized for anticipated future demand. The water distribution mains are typically installed first, with a minimum number of hydrants to meet spacing requirements. Hydrant spacing requirements vary on a case-by-case situation, depending on area use, and are subject to the approval of the Honolulu Fire Department (HFD). Additional hydrants and fire sprinkler services to individual tenants can be installed as the harbor is developed.

At a minimum, design and sizing of the fire protection water system should follow the BWS standards and the Uniform Fire Code (National Fire Code) standards. During the design stage, HFD reviews plans to ensure they meet these standards. In order to accommodate users with specific requirements or large demands, the system can be appropriately upsized for these tenants. Specific land uses such as the Fuel Terminal will have very specific requirements and additional standards, and shall be designed on a case-by-case basis.

Stormwater

Any new development or redevelopment project, whether it is a DOT-H or a tenant's project, shall follow the requirements set forth by the DOT-H stormwater management program. The requirements reference the DOT-H *2015 Stormwater Management Plan* (SWMP) for *Honolulu Harbor* and *Kalaeloa Barbers Point Harbor* (URL: http://hidot.hawaii.gov/harbors/library/storm-water-management/), which requires that any project (new or redeveloped) that results in a land disturbance of one acre or more, is subject to post-construction best management practices (BMPs). The SWMP also has a Construction Site Runoff Control manual that all projects are required to follow during design and construction. The SWMP has adopted the City and County of Honolulu *Rules Relating to Storm Drainage Standards* (as amended), meaning all BMPs shall be selected and designed according to the City's standards. The SWMP is required because the harbor is under Notice of General Permit Coverage (NGPC) for its small municipal separate storm sewer system (MS4), a US Environmental Protection Agency (EPA) mandate.

Proposed drainage infrastructure will include the installation of post-construction BMPs throughout the proposed project areas as required by the SWMP. Proposed project areas will be graded to direct runoff towards BMPs before sheet flowing either off the property, into the neighboring Harborside drainage channel (when installed), or into the harbor MS4 trench drains and outlets *(Figure 6.18).*

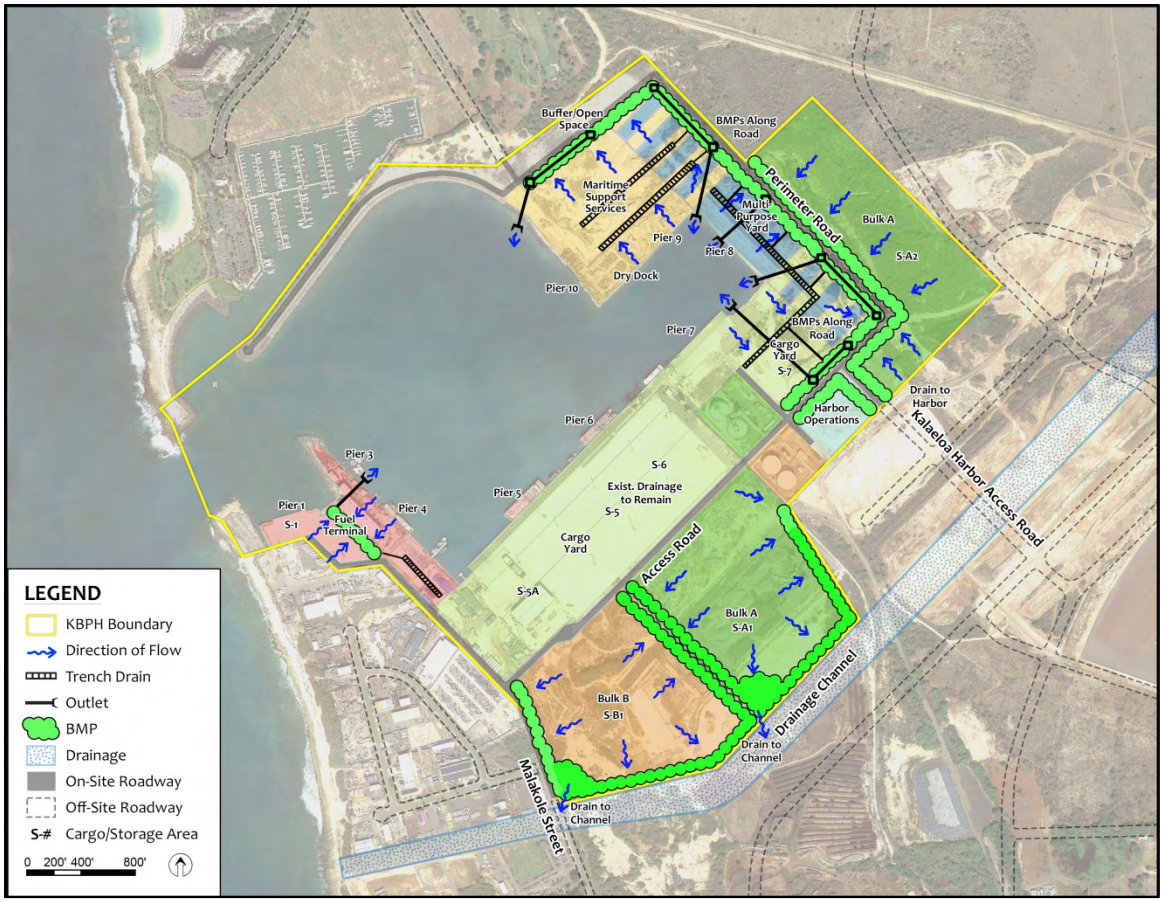


Figure 6.18 – KBPH Drainage Plan

As stated in *Post-Construction Stormwater Management in New Development and Redevelopment* [for] *Honolulu and Kalaeloa Barbers Point Harbors* (May 2014), to comply with this manual and be consistent with the City's standards, the following criteria shall be met for all regulated projects:

1. Incorporate appropriate low impact development (LID) site design strategies. This includes 1) *retaining* on-site the water quality volume (WQv - the first inch of runoff, which contains the greatest concentration of pollutants) with appropriate LID retention treatment control BMPs, or 2) *biofilter* the WQv with appropriate LID biofiltration treatment control BMPs, or 3) a combination of the two, unless determined to be infeasible due to infiltration issues (such as a high water table).

2. Incorporate appropriate source control BMPs.

3. If it is determined to be infeasible to retain and/or biofilter the WQv, then this discharge needs to be treated with appropriate treatment control BMPs, using the City and County of Honolulu guidance in §1-5.2 Part II B of the *Rules Relating to Storm Drainage Standards*. If this is not possible, a waiver will be granted by the DOT Environmental Section based on the infeasibility of all treatment control BMPs.

Possible post-construction stormwater BMPs to be installed for the DOT-H and tenant areas include:

- Vegetated buffer strip
- Vegetated swales
- Dry swale
- Dry wells
- Permeable pavement
- Infiltration trench
- Infiltration basin
- Detention basin
- Bioretention basin
- Bioretention filter
- Sand filter
- Subsurface infiltration
- Manufactured treatment device

Wash water from the vehicle wash and clean area would require more stringent treatment standards than the stormwater BMPs listed above. Requirements for wash facilities are outlined in the SWMP. A permit from DOT-H is required for such facilities. Tenants involved with industrial activities exposed to the weather such as material handling, storage, ship building and repair will need to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage.

Wastewater Treatment

As there are no available municipal sewer systems currently serving KBPH, Department of Health, Wastewater Branch (DOH-WWB) would require the installation of onsite wastewater treatment systems (OWTS) as the wastewater treatment and disposal option. An OWTS is a system relying on natural processes and/or mechanical components that are used to collect, treat, and disperse/discharge wastewater from single dwellings or buildings. An OWTS is recognized by DOH-WWB as an individual wastewater system (IWS) when flows are less than 1,000 gallons per day. A waste water treatment plant (WWTP) is used for larger flows. An IWS would likely be sufficient for Personnel Shelters and the Harbor Office, but would not be sufficient for a large office such as Marisco's facility that may have over 100 personnel *(Figure 6.19).* In general, an IWS can treat an office of up to 50 personnel. In the case of the Marisco facility, a WWTP or multiple IWSs will need to be installed.

The Ko 'Olina sewer system is the closest municipal system to KBPH. However, for KBPH to connect to this system, multiple private properties would have to be crossed. It is also likely that the system has not been sized to accommodate additional wastewater flows from KBPH.

Another municipal sewer system near James Campbell Industrial Park is located approximately a half mile away from KBPH. This system may be expanded with development of the neighboring proposed Kapolei Harborside project. Sewer construction will be phased in conjunction with road development. Municipal sewer service will likely be installed along the Kalaeloa Harbor Access Road and up to the future Harbor Operations site. Once this sewer system has been installed, DOH-WWB could require new buildings within KBPH to connect to these public sewer mains. DOT-H should continue to work with neighboring landowner KPL regarding forecasted harbor wastewater flows and timing of the Kapolei Harborside sewer infrastructure construction. Collaborative planning will ensure that harbor wastewater infrastructure needs are achieved.

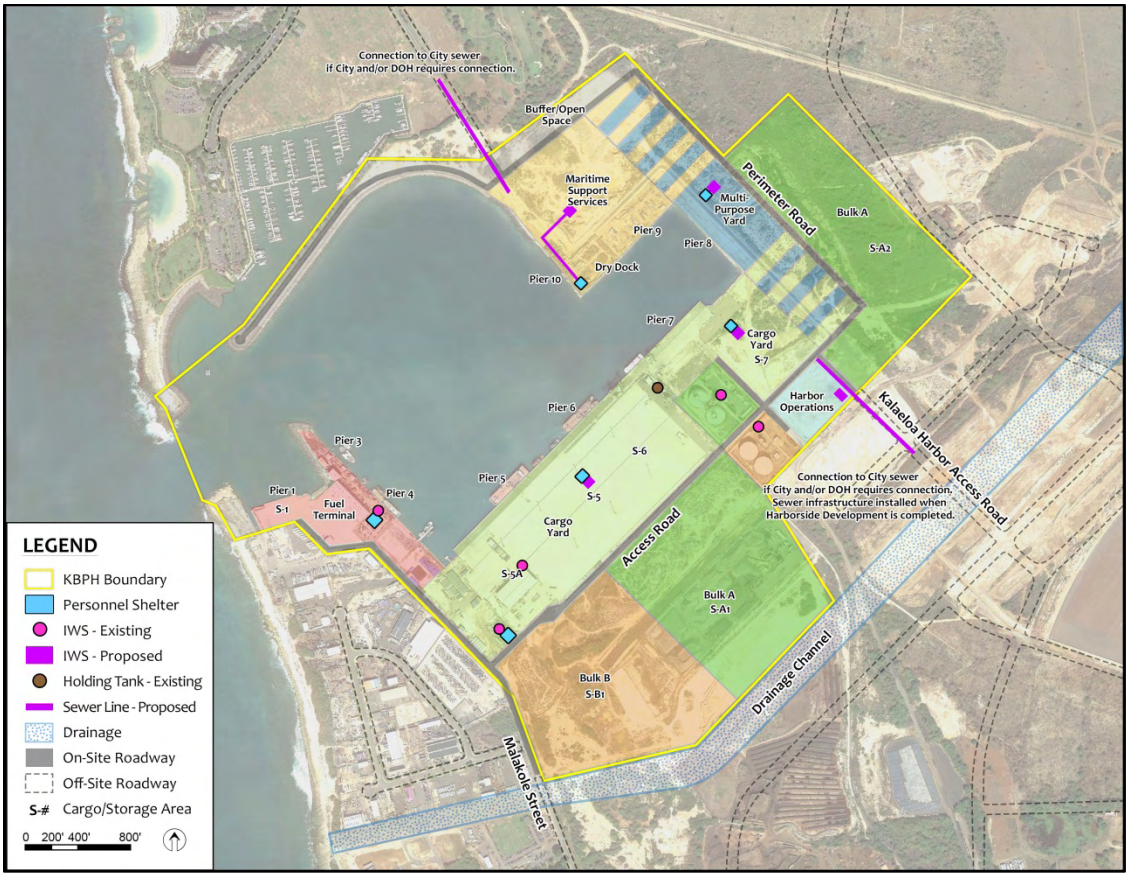


Figure 6.19 – KBPH Wastewater Plan

Until such time that a municipal sewer system is extended to KBPH with sufficient capacity, OWTS will be the only available wastewater treatment and disposal option. The OWTS should be placed inland so that seepage does not occur into the harbor and designed according to the porous nature of the coral outcrop at KBPH. Currently, each existing tenant is responsible to design, permit, construct and operate their own IWS. Any relocated tenants and future tenants would be required to do the same. Industrial waste (separate from wastewater) accumulated from ship repair work would also need to receive approval from DOH-WWB as to disposal procedures.

Landscaping

Landscaping of selected harbor areas will be accomplished as the facilities are developed. Each entrance will have a landscaped corridor which will be planted with trees, hedge shrubs, and ground cover. Landscaping should incorporate LID concepts that harmonize with post-construction storm water management as outlined in the SWMP. Landscaping at the main harbor entrance will primarily consist of native trees planted in random groves with groundcover to provide shade areas. Plant material will be selected on the basis of salt and drought tolerance, low maintenance, general hardiness and ability to succeed under the growing conditions present at Kalaeloa. Native plants are preferred, and those specific to the KBPH area and available by various growers on the island are portrayed in *Figure 6.20*. These recommendations are made by Hui Kū Maoli Ola, a Hawaiian native plant nursery familiar with Kalaeloa coastal restoration.

TREES

True Kamani
(Calophyllum inophyllum)

Kou
(Cordia subcordata)

Hau
(Hibiscus tiliaceus)

Naio
(Myoporum stellatum)

Lonomea
(Sapindus oahuensis)

SHRUBS

Naupaka
(Scaevola frutescens)

Pohinahina
(Vitex rotundifolia)

'Ilima
(Sida fallax)

Red 'Ilima
(Abutilon menziesii)

'Ewa 'Akoko
(Euphorbia skottsbergii)

Hibiscus
(Hibiscus arnottianus)

'Ewa Hinahina
(Achyranthes splendens)

GROUND COVER

Beach Morning Glory
(Ipomoea pes-caprae)

'Akulikuli
(Sesuvium portulacastrum)

Mau'u'aki'aki
(Fimbristylis cymosa)

Figure 6.20 – Recommended Native Plants for Kalaeloa Barbers Point Harbor

6.1.6 Navigational Aids and 24-Hour Access

Stakeholders have requested 24-hour access to increase efficiencies within the harbor. Tugs and barges can currently access KBPH 24 hours a day, but vessels 300 feet LOA and longer are currently restricted to daylight transit. The *2040 Master Plan* recommends that improvements to navigational elements for daylight transit are needed to increase safety before improvements are made to allow for large vessel 24-hour access. The cross currents prior to the harbor channel entrance cause vessels to be pushed off from their intended track, requiring them to 'crab' in order to keep the intended course. Reliance is heavy on lighted day markers along the entrance channel and range lights. There have been at least three groundings at KBPH over the past 25 years versus no significant grounding in other Hawai'i ports and channels during the same time. This is in part due to the incorrect positioning of the current lighted day markers. In addition, the positioning of the range lights is too close together, making it difficult to track vessel alignment on approach. Improvements to navigational aids will be coordinated with the US Coast Guard (USCG).

Navigational Aid Improvements for Daylight Transit

Information for recommended improvements was gathered from a study entitled *Barbers Point Harbor, Nighttime Simulation* (US Army Corps of Engineers [USACE], 2007) and communications with the Hawai'i Pilots Association and the USCG. The USACE study found navigational risks at KBPH which include wind and wave conditions as well as cross currents that can make the entrance difficult; reading the currents is next to impossible as currents in the area do not necessarily follow the wind and wave patterns; and the short entrance channel makes using the range lights difficult. The Hawai'i Pilots Association expressed concern due to the currents, narrow channel entrance, and unreliability of channel markers. Priority improvements for mitigating the existing daylight navigational risks at KBPH include:

1. Relocation of buoys and lighted day markers to correctly mark the entrance channel.
2. Installation of a Vessel Traffic Service to monitor ocean traffic movements.
3. Availability of real-time oceanographic data.
4. Increasing the sensitivity of the entrance range lights.
5. Widening and deepening of the entrance channel.

Relocation of Buoys and Lighted Day Markers

During this investigative planning process and discussions with the Hawai'i Pilots Association and other harbor users, it was identified and concerns were communicated that the current positioning of buoy numbers 2 and 3 may be unreliable navigational aid markers for the entrance channel. It is recommended that their repositioning be taken under consideration, further evaluated and reviewed, and any applicable and prudent action be taken to address this navigational concern.

Lighted day marker numbers 4 and 5 are affixed to the ocean bottom to mark the entrance channel. They are incorrectly positioned between 70 and 90 feet outside of the channel. As a result, from above the surface, the channel appears 30 percent wider. In order to protect ships from groundings, lighted day marker positioning should also be confirmed, and if necessary, repositioned to the appropriate locations.

Installation of a Vessel Traffic Service (VTS)
The USCG *Ports and Waterways Assessment Workshop Report* (PAWSA, 2009) recommended the establishment of a VTS to cover ocean traffic movements around the Hawaiian Islands with a primary focus on vessel traffic movements at Honolulu and Kalaeloa Barbers Point Harbors. The purpose of a VTS is to provide active monitoring and navigational advice for vessels in particularly confined and busy waterways. The VTS systems encompass a wide range of techniques and capabilities aimed at preventing vessel collisions, rammings, and groundings in the harbor, harbor approach and inland waterway phase of navigation. They are also designed to expedite ship movements, increase transportation system efficiency, and improve all-weather operating capability.

A VHF-FM communications network forms the basis of most major services. Transiting vessels make position reports to a vessel traffic center by radiotelephone and are in turn provided with accurate, complete, and timely navigational safety information. The addition of a network of radars, automatic identification system, and closed circuit television cameras for surveillance and computer-assisted tracking, similar to that used in air traffic control, allows the VTS to play a more significant role in marine traffic management. This decreases vessel congestion, critical encounter situations, and the probability of a marine casualty resulting in environmental damage.

The establishment of a VTS covering KBPH can further be justified as the harbor does not have a residing Marine Traffic Controller. All of the harbor's inbound and outbound vessel movements are coordinated via VHF radio from the Aloha Tower Marine Traffic Controller who is situated in Honolulu Harbor, 26 nautical miles away from KBPH. The Marine Traffic Controller is solely dependent on limited visual monitoring of the harbor, with a fixed camera monitor and no real-time data (one to two minute delay) of KBPH's approach and channel conditions. A VTS system covering KBPH would enhance the current system and help to generate and provide harbor users, pilots, vessel masters and the Marine Traffic Controller with a comprehensive overview of the harbor's approach and entrance channel conditions. Influencing factors including meteorological and hydrographic data in real-time could be disseminated to users in ways that add value by improving safety and efficiency.

Real-Time Oceanographic Data
The installation of two buoys with the capability of transmitting ocean current data would provide information to pilots before their approach to KBPH *(Figure 6.21).* These buoys would provide valuable information for daytime transits and a major improvement for the safety of nighttime runs. These data buoys should be sub-surface to avoid picking up the surface wind-driven current. These types of buoys are normally minus 15-foot to 25-foot depth. The ideal placement for the current sensors would be in two locations:

1. Just outside of the channel entrance, approximately 0.2 nautical miles offshore of buoys 2 and 3, and
2. In the channel approximately 0.1 nautical mile northeast of lighted day marker 4.

The installation of the ocean current gauges could be implemented through the National Oceanographic and Atmospheric Administration's (NOAA) Physical Oceanographic Real-Time System (PORTS) program. Installation of PORTS would support safe navigation by providing harbor pilots' ship masters with accurate real-time information that would help to avoid groundings and accidents. This program is estimated at approximately $80,000 for the initial equipment, with ongoing maintenance costs of approximately $30,000 to $40,000 per year. This is a program that would need to be supported by DOT-H.

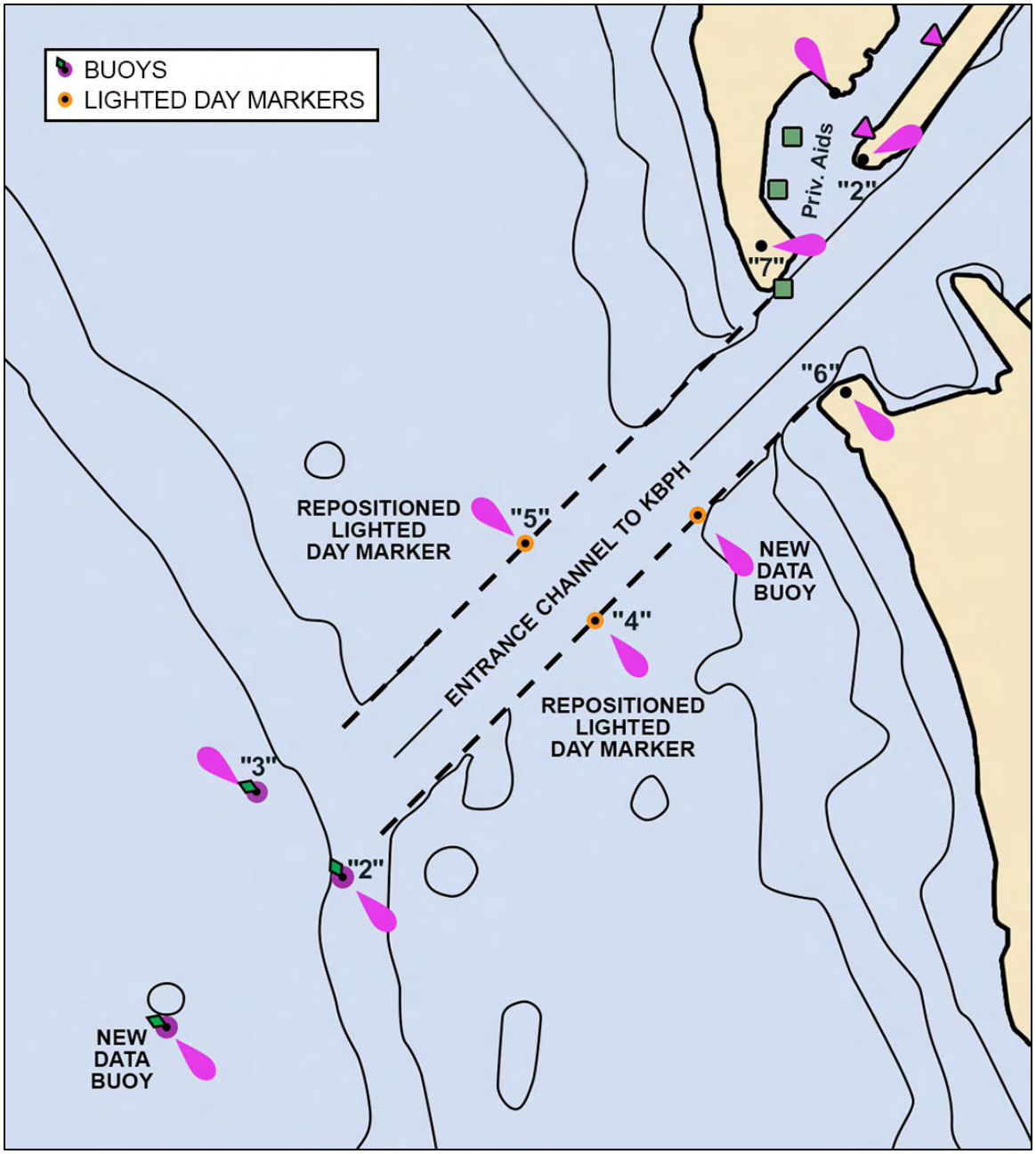


Figure 6.21 – Proposed Ocean Current Data Buoy Locations
(Adapted from: Barbers Point Harbor, Nighttime Simulation, 2007)

Increased Range Sensitivity

In addition to the data buoys, another improvement for inbound transits would be adjustments to the sensitivity of the range lights. KBPH's entrance range is less sensitive than the ranges for Honolulu, Kahului, Hilo, and Nawiliwili, all of which have wider approaches and more predictable ocean currents near the harbor entrances. Due to circumstances at the time of their construction, KBPH range lights were built fairly close together *(Figure 6.22).* This makes it difficult to see relatively small errors in alignment. The lack of sensitivity of the range lights could be augmented by increasing the distance between the forward and rear markers. In addition, replacement of the range boards with bigger and brighter boards would increase their visibility. USCG and DOT-H are currently considering moving the forward marker onto DOT-H property, closer to the edge of the Pier 10 revetment.

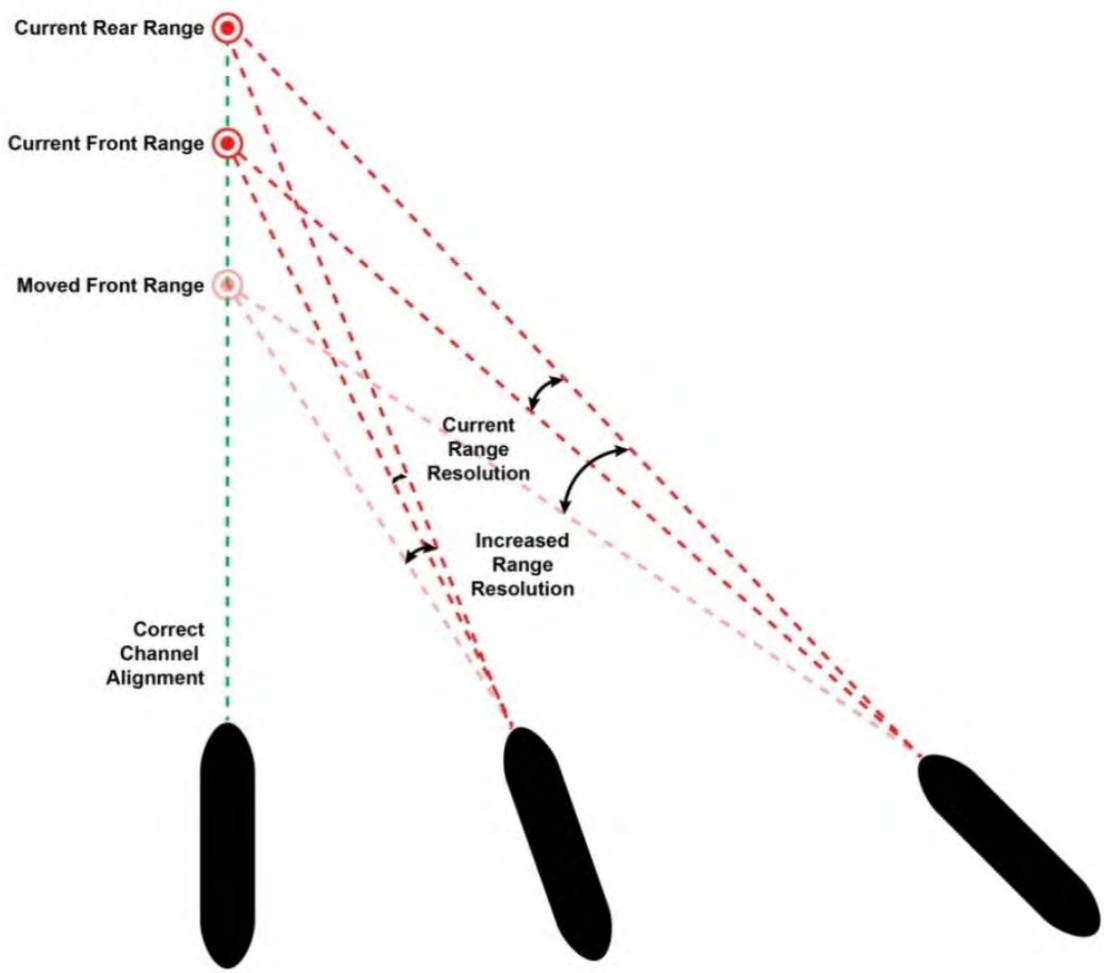


Figure 6.22 – Range Viewpoint Using Existing and Repositioned Range Lights

Entrance Channel Widening and Deepening
To increase the margin of safety for vessels transiting in and out of KBPH, the *2040 Master Plan* supports flaring and dredging of the harbor's entrance channel. A 2008 USACE *Barbers Point Harbor Jetty Modification Study* also recommended a 375-foot jetty and shallower depth transition inside the harbor. However, after consultation with harbor pilots, the most recent decision by USACE was to not build the jetty and instead to flare the entrance channel. Flaring (to increase margin of safety) was seen as more beneficial than the jetty (to mitigate cross currents), as existing tug capabilities reduce safety concerns associated with cross currents in the entrance channel and vessel stopping distances.

A 2014 report entitled *Approach Channels: Preliminary Guidelines* by the joint working group of Permanent International Association of Navigation Congress (PIANC) and International Association of Ports and Harbors (IAPH), in cooperation with the International Maritime Pilots Association (IMPA), and the International Association of Lighthouse Authorities (IALA) calculates the safety of a Panamax tank ship entering KBPH and other Hawai'i harbors. The report evaluated the safety margin for the KBPH entrance channel at negative 21 percent, which is less than satisfactory. This PIANC document concluded that the KBPH entrance channel should be at least 546 feet wide. These projects will be coordinated with USACE.

Plans for dredging the turning basin to accommodate deeper draft vessels will also be coordinated with USACE. KBPH was originally designed to accommodate vessels with a length of 720 feet, beam of 95 feet, with a loaded draft of 34 feet. As a result of changing vessel design and economic conditions, this necessitated the employment of larger vessel calling on KBPH. Harbor pilots are currently bringing in vessels up to 750 feet LOA, with a beam of 106 feet (Panamax), and maximum draft of 36 feet. A deeper draft would allow for full utilization of larger vessels that currently arrive partially loaded due to the limited depth. USACE is evaluating depths from the current minus 38 feet MLLW up to minus 45 feet MLLW to allow fully laden vessels into the harbor.

About 50 percent of the project benefits are related to coal/biomass imports. Construction industry imports of aggregate, sand and cement have become increasingly important at KBPH over recent years, and will also benefit substantially from a deepening of the harbor. In addition, scrap metal is also exported through KBPH, but is expected to benefit only occasionally from a deepening.

Coal is presently being imported on foreign flagged Panamax bulk carriers with an average 72,000 dead weight ton (DWT) and fully laden draft of 44 feet. Water depth is not an issue at the loading ports, just at the discharge port (KBPH). These Panamax-sized vessels are currently making monthly calls at KBPH, transporting approximately 60,000 short tons of coal at an average loaded draft of 36½ feet per call. A minimum vessel under keel clearance of 1.5 feet has been imposed at KBPH by DOT-H, and requires the presence of a one-foot rising tide in order for the Panamax vessel to enter the harbor with a 36½-foot draft.

With a deepening of the harbor, each foot of additional draft will result in an additional foot of cargo loaded on each vessel. This will reduce total transportation costs by reducing, over time, the number of vessels required to meet annual demand. For these types of bulk carriers, each additional foot of draft increases vessel carriage capacity by approximately 2,200 short tons (s/tons). Based on the a demand of 720,000 s/tons per year, this would equate to approximately 144,000 s/tons annually of dead freight, or the need to employ three additional voyage charters per year to meet the same supply demand.

With Hawai'i's ongoing construction boom, the sources of the materials that make up concrete, i.e., sand, aggregate and cement, have undergone rapid changes recently. Concrete is a primary necessity of economic development and the construction industry, and demand is anticipated to continue in the future. O'ahu used to get its natural sand from Neighbor Islands (e.g. Maui), but the frequencies and quantities of these interisland shipments recently have been substantially reduced, as a result of the island of Maui retaining their sand to sustain its own construction demand requirements. New sources of sand and aggregate have been established in British Columbia, Canada. Since 2006, large amounts of aggregate and sand have been imported via KBPH coming from several Canadian ports, such as Port McNeill, Texada Island, and Sechelt.

Depth at these origin ports is not an issue since they are equipped with quadrant ship loaders and can top off the largest of Panamax vessels. With the prevailing harbor depth constraints, these dry-bulk vessels are limited to approximately 54,000 s/ton loads. Each additional foot of harbor depth will allow for an additional 2,200 s/tons of cargo. Adequate storage capacity exists at Barbers Point Harbor to accommodate regularly scheduled Panamax deliveries of sand and aggregate. In addition to requiring fewer ships with larger cargo payloads which reduces ocean transportation cost per commodity ton shipped, it also lowers port expenses and the potential for demurrage assessments. A deepening to minus 45 feet would reduce the number of vessel calls and associated total transportation costs by approximately 23 percent.

In addition to aggregate and sand, cement is required to make concrete, an essential material for Hawai'i's construction industry. The Portland cement is manufactured in Asia and shipped from ports like Singapore and Jakarta where they can fully load 70,000 DWT Panamax bulkers. These bulk carriers are similar to those used to transport sand and aggregate. Bulk cement is also transshipped and transported from KBPH on specialized interisland bulk barges to support construction projects on each of the Neighbor Islands. The cement industry either employs Handymax bulk vessels with smaller cargo carrying capability or they are light-loading the Panamax vessels. Shoreside receiving and storage capacity for handling these 70,000 DWT bulk carriers is not an issue, as KBPH is equipped to handle 70,000 metric tons plus of product in addition to 15,000 metric tons at nearby James Campbell Industrial Park. Each additional foot of harbor depth will allow for an additional 2,200 s/tons of cargo. A deepening to 45 feet would reduce the number of vessel calls by an estimated two additional bulk carriers a year.

Navigational Aid Improvements for 24-Hour Access

The *2040 Master Plan* also recommends improving KBPH navigational elements to permit nighttime transit of larger vessels. The extension of Pier 7 and construction of the Fuel Terminal and Piers 8 and 10 will greatly improve berth utilization. However, 24-hour access would additionally reduce costly delays and increase KBPH's operational berthing and scheduling capabilities. Even with the channel widening and deepening, the loss of visual cues during nighttime transits would have to be minimized to allow safe passage. Once the existing daytime navigational risks are reduced, the following improvements are recommended to aid in 24-hour access:

1. Addition of gated buoys between numbers 4, 5, 6 and 7
2. Adding quartering range lights
3. Review of harbor perimeter lighting system

Additional Gated Buoys

In the 2007 USACE study, the addition of a new pair of lighted buoys in the 'gated' position was recommended between the two lighted day markers 4 and 5 and the shoreline *(Figure 6.23)*. Gated pairs of buoys (with one buoy across from the other) are preferred for marking straight channel legs, with spacing adequate for the probable visibility conditions. In simulations, these additional buoys improved the ability of the pilot to determine where they need to be as they pick up speed outbound, before they are affected by crosscurrents and waves. There is no feasible way to place ranges for the outbound transit, and the inbound ranges are too close to be of much value. However, buoys can, in a limited way, be used as ranges as well as marking the channel limits.

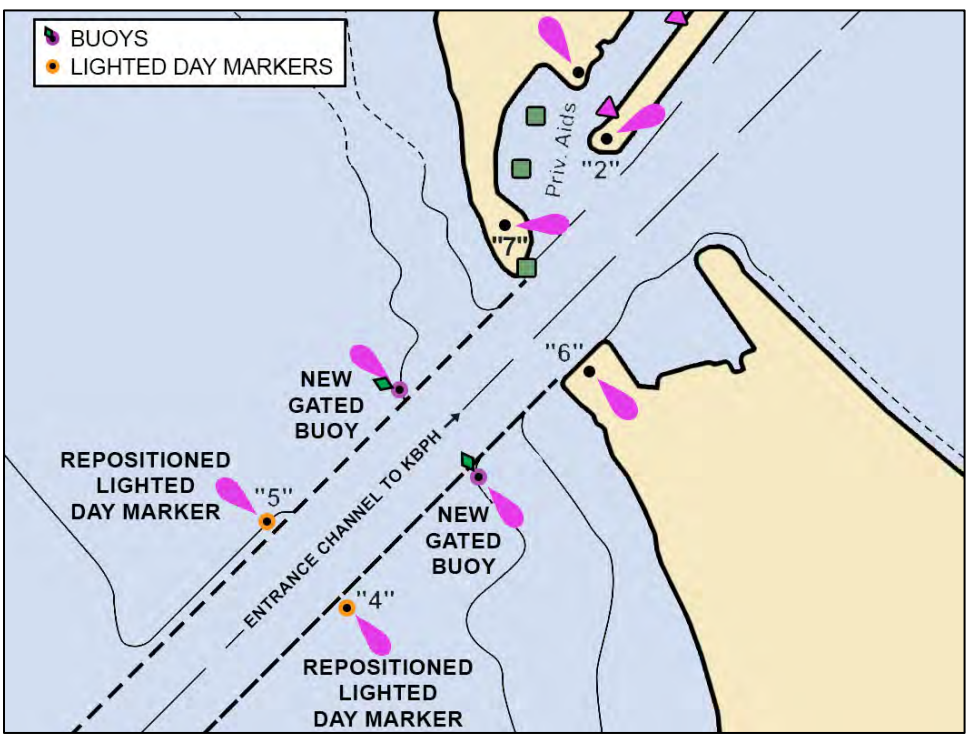


Figure 6.23 – Proposed Gated Buoy Locations
(Adapted from: Barbers Point Harbor, Nighttime Simulation, 2007)

Quartering Range Lights

The USACE study tested harbor pilots in various nighttime simulations. The study found that the pilot's confidence for navigating the channel at night increased with quartering range lights *(Figure 6.24).* Being on the quarter means to align the vessel with the range lights along the line of the keel (the central structural basis of the hull) and the beam (the width of the vessel at its widest point). The addition of quartering range lights would enable the pilots to determine their location in the channel to a greater degree of accuracy than the existing single set of range lights, as a slight deviation from the center of the channel is more pronounced when comparing the distances between the two outside range lights.

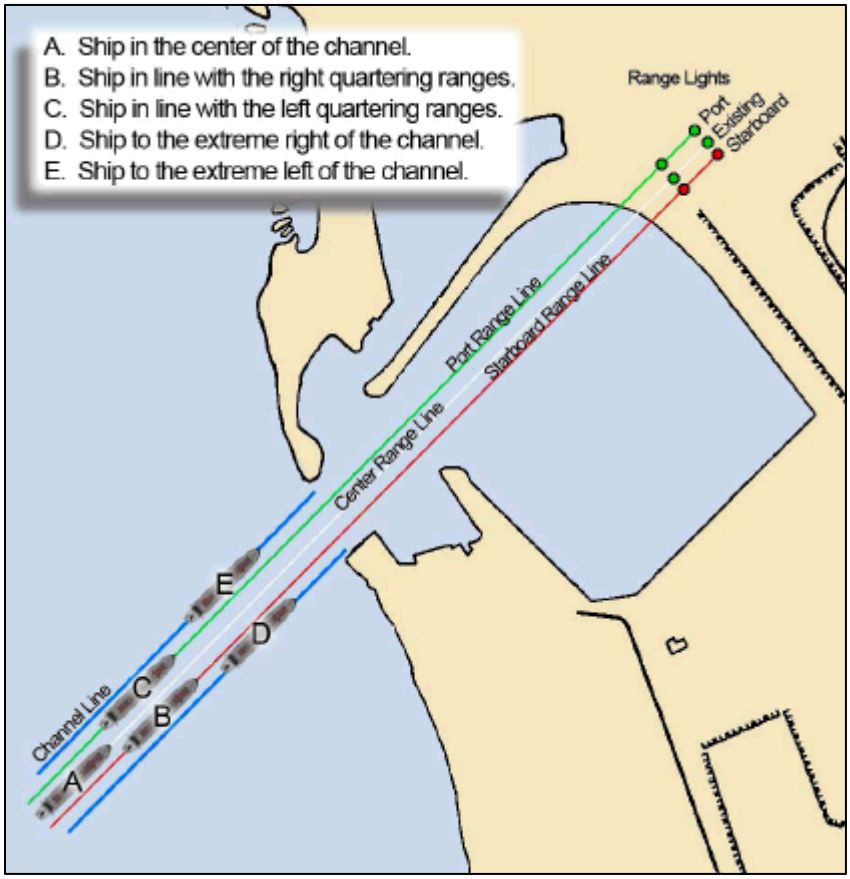


Figure 6.24 – Linear Ship Position in Channel for Range Viewpoint
(Source: Barbers Point Harbor, Nighttime Simulation, 2007)

Perimeter Lighting System

The current perimeter harbor lighting is located on the western side of KBPH along the Ko 'Olina mole. The harbor lighting system should be reviewed to determine if the height of the poles are sufficient and lights properly directed to light up the harbor basin, as well as shielded to eliminate or reduce visual blinding. Current lighting is commercial grade, but not effective for marine operations. Lighting similar to that used in the Panama Canal to facilitate 24-hour access would be ideal.

Summary
Improving the feasibility of nighttime transits of large vessels into and out of KBPH has to begin with improving the existing system of navigational aids. Subsequently, conditional acceptance and limitations will need to be reviewed and established. For example, pilots may need to complete vessel transiting simulation testing under nighttime operations. They could then start with navigating smaller vessels (less than 500 feet LOA) into and out of the harbor, and expand the range of feasible ships based on an established comfort level for the safe transiting margins, coupled with corresponding ship handling experience and knowledge.

6.2 Development Constraints

6.2.1 Land Management

Lease Process of State Lands
There are two forms of leases for State lands. They include a revocable permit, which is month-to-month, and the standard lease, which has a fixed duration. Any potential applicant interested in leasing lands at KBPH will have to complete and submit to DOT-H either: (1) an *Application for a Revocable Permit* or (2) an *Application for Harbor Lease and Qualification Questionnaire*. The lease application requires a $1,000.00 non-refundable deposit. The lease application initiates an internal evaluation process which determines the financial ability, experience and competence of the applicant to carry out all of the covenants, terms and conditions of the potential lease agreement. In addition, the proposed use will be evaluated for compatibility with the *2040 Master Plan*.

The applicant will also need to complete a Hawai'i Revised Statutes (HRS) Chapter 343 document for the proposed use of State lands. The applicant is expected to identify and contact the appropriate approving agency, i.e., the agency with the most jurisdiction over the proposed action. The approving agency will have final acceptance authority over the Chapter 343 document. Concurrent to this process, the applicant will be required to consult with the appropriate governmental agencies to verify that their proposed use of State lands complies with all applicable zoning and permitting laws, rules, regulations and ordinances. This includes the City and County of Honolulu's Special Management Area (SMA) permit, if applicable.

DOT-H, as the agency with management and control over State lands at KBPH, will then submit a request before the State Land Board for authorization to issue a lease.

Once approved, the applicant will need to order a survey of the site to establish the property boundaries. Once the boundaries are established, an independent land appraisal of the subject property is ordered by DOT-H to determine the rental rate. The applicant is responsible for the survey and appraisal costs. The lease agreement is then prepared by DOT-H and reviewed by the office of the Hawai'i Attorney General. Once all of the above is completed, the lease is executed.

Property Recordation Process
There are two systems of recording property in the State of Hawai'i, the *Land Court System* and the *Regular System*.

The *Land Court* was established in 1903 and functions as a registration system for land ownership. Certificate of titles are issued to owners of land registered in Land Court and documents are identified currently by a seven digit number. The number to the Certificate of Title and document run in sequence from the first issuance in 1903.

Those that place their property in Land Court have had to go through a lengthy process of a judicial review of the survey of the parcel, title abstract and determination of ownership. With the ability to obtain title insurance on land ownership, the need for judicial determination of ownership has decreased tremendously. Activities of Land Court are governed by HRS Chapter 501.

The *Regular System* only serves to give 'notice' that an encumbrance is on title. Since 1990, documents recorded are identified by the year followed by the sequential number of recording, e.g., 90-0001234. Administration of this activity is governed by HRS Chapter 502.

Land at KBPH is recorded in the *Land Court System* of conveyance. Unlike *Regular System*, property ownership in *Land Court* is guaranteed by the State of Hawai'i. However, the State of Hawai'i does not support recognition of property to a lessee even in *Land Court*. Generally, a transfer of title needs to occur in order for a property to be legally recognizable. However in this case, the State is only leasing the land and is not transferring ownership.

Recognizable Property
KBPH is comprised of two large parcels, and is not subdivided. This causes difficulties for potential applicants to meet county requirements, secure permits and finance improvements for their land leases; all of which require a legally recognizable property.

Due to the State property structure, this legally recognizable property will have to be created. There are two options to address this, with pros and cons for each:

<u>Subdivision</u>
- Potential applicants would need to subdivide the parcel to fit their needs
- Applicants would have to work with the City and County of Honolulu and meet all standards (e.g. roadways, setbacks and utilities, etc.), which may be an issue in some situations
- This can be a lengthy and expensive process
- ALL lenders recognize this

Metes and Bounds

- Potential applicants would need to survey the parcel and create boundaries using metes and bounds to fit their needs
- This can be done very quickly
- MOST lenders recognize this
- The City and County of Honolulu recognizes this in their permitting process
- However, Department of Land and Natural Resources (DLNR) Land Board may not recognize metes and bounds in some cases, and may require a subdivision

To reduce subdivision processing time, DOT-H could initiate the subdivision process for the future applicants by establishing a 'preliminary subdivision'. This option is not available to private parties, but may be done as a courtesy to the State under the right circumstances. In this case, DOT-H would delineate the roadways and parcels into general, large pieces. The applicants would then further delineate the parcel once they have a *Preliminary Engineering Report* (PER) completed and know their property boundaries. This could save some time, but ultimately, if a metes and bounds survey is not recognized by DLNR, all applicants will need to pursue the subdivision process in order to obtain financing. Overlaying a Joint Development Agreement on the subdivision may also be an option.

6.2.2 Height Restriction

County zoning limits building height to 60 feet above the surface of the ground over the entire property. A variance is required for heights above 60 feet. Formal notice to the US Department of Transportation, Federal Aviation Administration (FAA) is required for any construction or alteration of greater height than that extending outward and upward at the slope of 100 to 1, for a horizontal distance of 20,000 feet, from the surface of the nearest point of the nearest runway of Kalaeloa Airport *(Federal Aviation Regulation (FAR) Part 77, Notice of Proposed Construction or Alteration).* As KBPH is approximately 10,000 feet from Kalaeloa Airport, the construction of facilities 200 feet or higher requires formal notice to FAA.

6.2.3 Bulk A (S-A1) and Bulk B (S-B1) Drainage Issues

Drainage issues at the Bulk A (SA-1) and Bulk B (S-B1) sites will need to be remediated. There are several drainage features in the Bulk A area near the Grace Pacific facility that may become development constraints for future tenants. These features channel runoff between coral stockpiles and the designated Bulk B storage area in the southwest portion of DOT-H property, creating large ponds that eventually infiltrate into the ground and evaporate *(Figure 6.25).* During large storm events, runoff may flow onto Malakole Street and continue south towards a drainage channel located south of and adjacent to the Kenai Industrial Park.

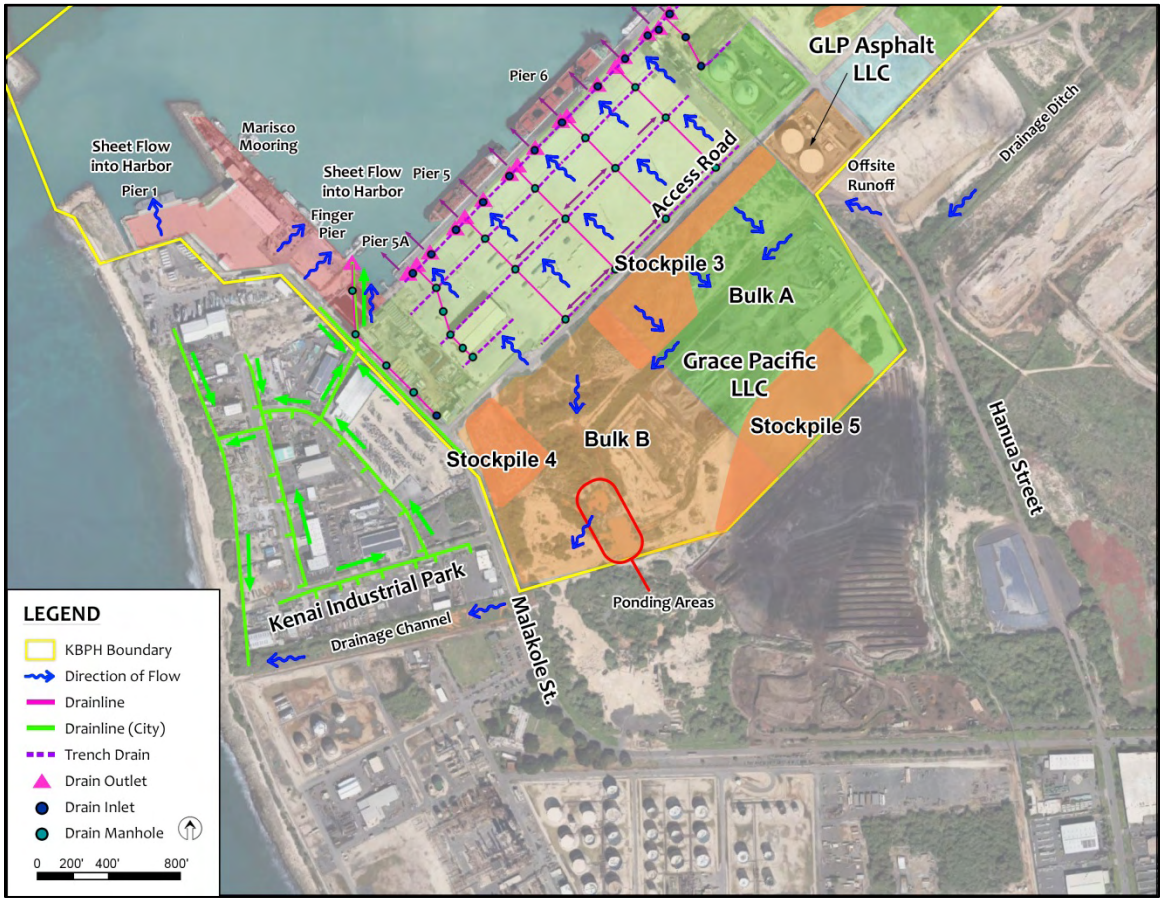


Figure 6.25 – Ponding in the Bulk B Storage Area, Southwest of Grace Pacific

A drainage report assessing required improvements will need to be prepared prior to the construction of improvements. An approved National Pollutant Discharge Elimination System (NPDES) permit would also be required before the start of construction activities. Until the Harborside drainage channel is completed by Kapolei Properties, LLC, there will continue to be drainage issues in both the Bulk A and Bulk B areas.

6.2.4 Critical Habitat Area

North of KBPH is a designated Critical Habitat area *(Figure 6.26)* for a plant variety listed as Endangered in 1982, *Euphorbia skottsbergii* var. *kalaeloana*. Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that actions they authorize, fund, or carry out do not jeopardize the existence of any species listed under the ESA, or destroy or adversely modify designated critical habitat of any listed species. Therefore, Section 7 requires consultation between the federal 'action agency' (the agency authorizing, funding, or carrying out the action) and the appropriate expert agency, either the National Marine Fisheries Service (NMFS) for marine species or the US Fish and Wildlife Service (USFWS) for terrestrial and freshwater species. As many of the improvements recommended in this *2040 Master Plan* will be permitted federal actions, they will undergo Section 7 consultation with the appropriate federal agencies and USACE. This will allow the agencies to assess impacts and make recommendations to ensure biological features within the critical habitat remain intact.

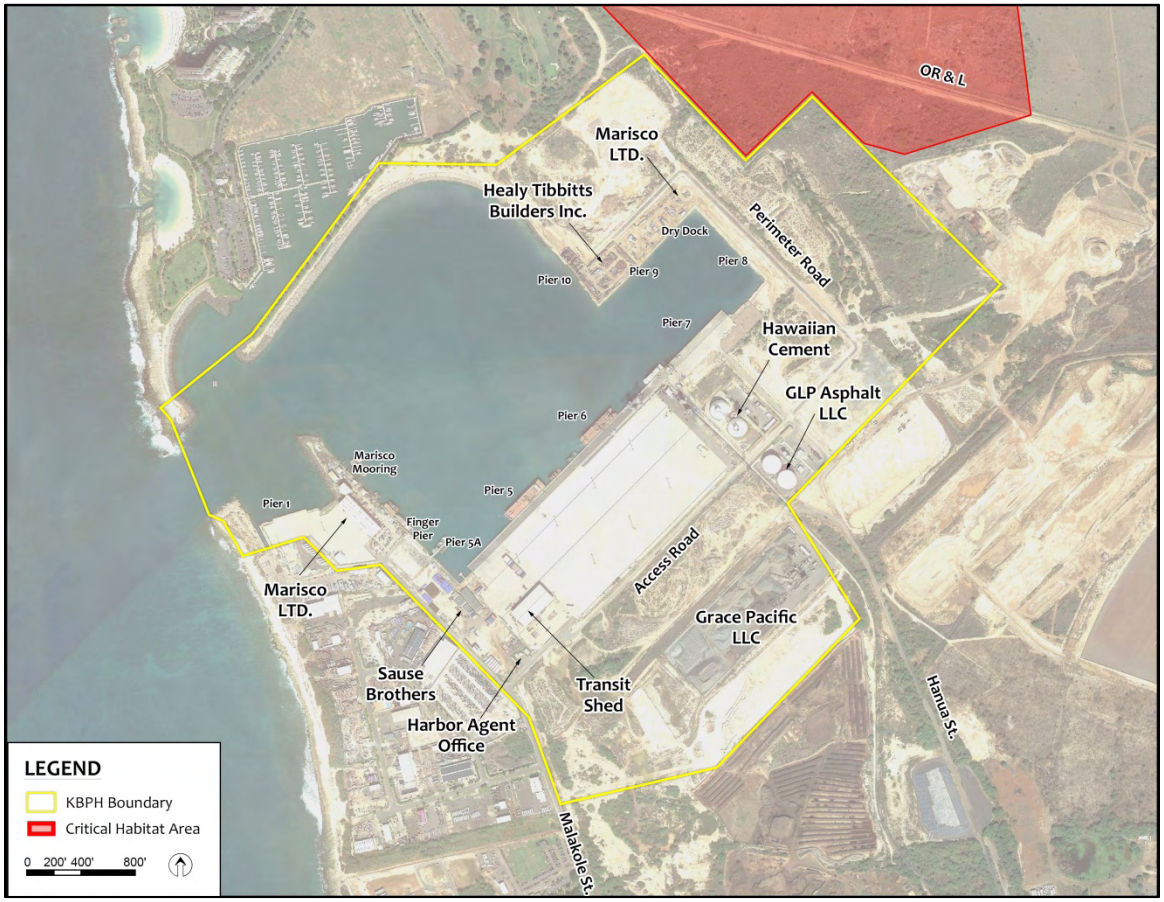


Figure 6.26 - USFWS O'ahu Critical Habitat LDU8, September 18, 2012 - Final Rule

6.2.5 Culturally Sensitive Area

A pedestrian reconnaissance survey performed by Keala Pono Archaeological Consulting, LLC in July 2013 identified 89 individual components of surface architecture in the northern portion of the harbor in the Bulk A Storage Yard (S-A2) *(Figure 6.27).* Feature components consist of 68 mounds, ten walls, six enclosures, three sinkholes, and two uprights. These sites may limit the extent of development in the area mauka of Pier 8 and Perimeter Road until further studies can be completed. The area encompassing these features is approximately 17 acres.

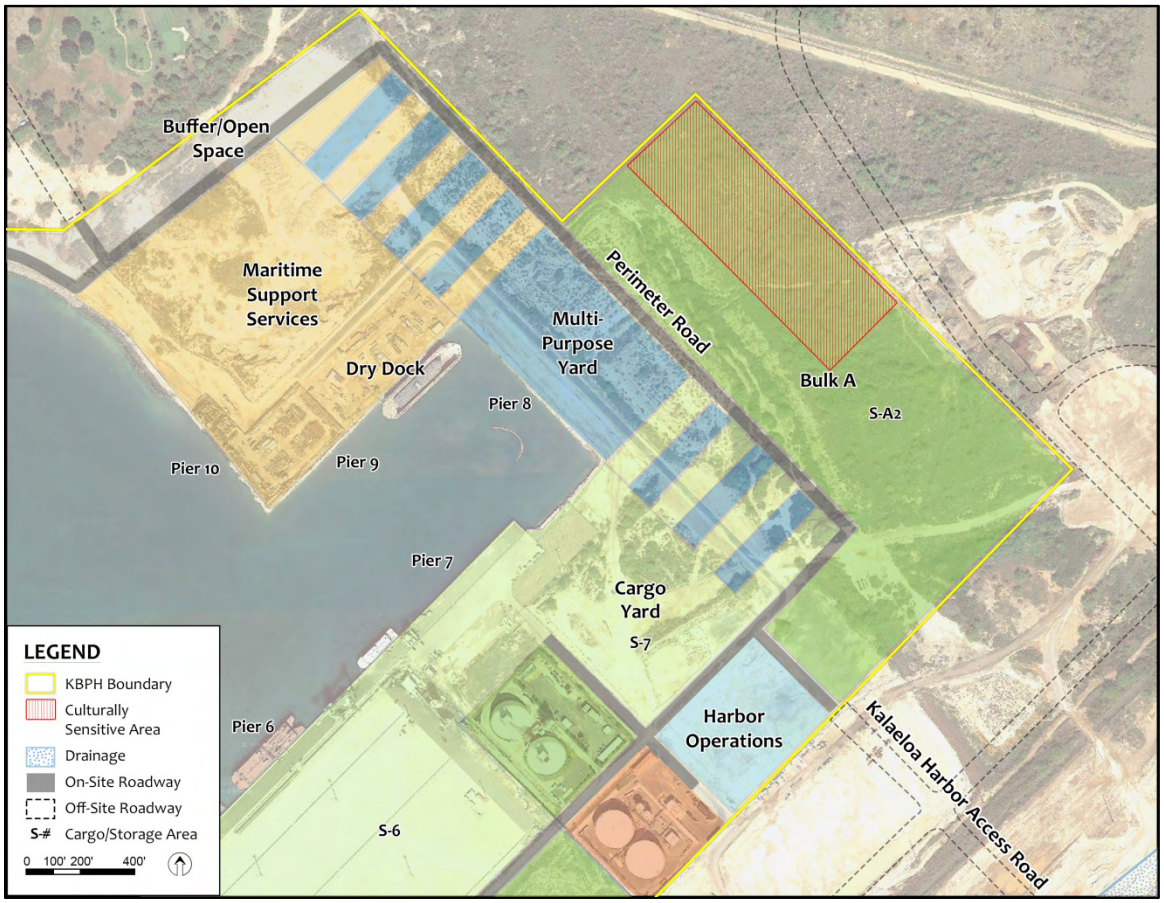


Figure 6.27 – Culturally Sensitive Area

Should a tenant be interested in leasing the potentially culturally sensitive area of Bulk A, an Archaeological Impact Assessment (AIS) would most likely be required that complies with Hawai'i Revised Statutes Chapter 6E, Historic Preservation. Recent interpretation of the law encourages the agency involved to speak directly with the Hawai'i State Historic Preservation District (SHPD) to determine if an AIS is required and what the scope of the investigation needs to be. In this case, the interested tenant would need DOT-H to work with SHPD on their behalf.

6.2.6 Climate Change and Sea Level Rise Effect

Due to the heat-trapping effects of greenhouses gases (GHG), climate scientists project that if GHG emissions continue to accelerate at current output trends, then the average global temperature will likely increase by three to seven degrees Fahrenheit (1.7 to 3.9 degrees Celsius) by the year 2100. These figures were derived from a number of global climate models, which were based on various scenarios of changes in the concentrations of greenhouse gases in the Earth's atmosphere.

Sea level can rise by two different mechanisms with respect to climate change. The first is the expansion of the sea water as the oceans warm due to an increasing global temperature, increasing the total volume of the oceans and producing thermosteric sea level rise. Global average thermal expansion can be calculated directly from simulated changes in ocean temperature. The second mechanism is the melting of ice over land, which then adds water to the ocean.

Currently, governmental policy for civil works is limited and still evolving with respect to specific planning for future sea level rise, with only a handful of local and international bodies with any policies in effect. In Canada, draft British Columbia policy is planning for a rise in global sea level of 20 inches (50 cm) by 2050, and 3.3 feet (1 m) by the end of the century. Locally, the University of Hawai'i's School of Ocean and Earth Sciences and Technology (SOEST) has developed an unofficial policy that proposes three major actions that state and local governments should consider to successfully adapt to sea level rise, including the following: the Governor of Hawai'i or State Legislature should direct state agencies to incorporate a sea level rise benchmark of one foot by 2050 and three feet by 2100 in planning and permitting processes and decision-making, similar to the approach taken by the USACE and to an executive order issued in California.

According to USACE Circular No. 1165-2-212, which currently applies to all USACE Civil Works responsibilities, potential relative sea level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. All planning, engineering, design, operation, and maintenance for sea level change must consider how sensitive and adaptable are: 1) natural and managed ecosystems, and 2) human and engineered systems to climate change and other related global changes. Guidance provided in EC 1165-2-212 gives the planner or engineer specific instructions to account for changes in mean sea level (MSL) for USACE civil works projects in order to satisfy Federal requirements.

The O'ahu Metropolitan Planning Organization published a report in 2011 entitled *Transportation Asset Climate Change Risk Assessment Project,* which performed and evaluated a risk assessment of climate change on important transportation assets. Analysis of KBPH and the surrounding area measured the ground surface elevations ranging between +9 and +12 feet MSL, fronting or in close proximity to the ocean. The sea level rise model for 2050 depicting one foot of sea level rise showed low structural impact and vulnerability to the entire area.

The sea level rise model depicting three feet for the year 2100 showed a moderate impact, showing most of the predicted sea level rise affecting Pier 1 *(Figure 6.28)* more than any other pier. By the year 2100, Pier 1 will be 140 years old, well over the 50 to 80 year life expectancy of a commercial pier. Should Pier 1 be renovated in the future, pier height will need to take into consideration this rise in sea level. Existing access roads to the area appear to remain passable with the predicted three feet of sea level rise.

Figure 6.28 – Expected Sea Level Rise at KBPH and Surrounding Area in 2100
(Source: Transportation Asset Climate Change Risk Assessment Project, 2011)

6.3 Maintenance

Maintenance, including repair, of KBPH requires a coordinated effort between DOT-H and its users. This section is grouped by the type of maintenance required for KBPH: a) long-term maintenance comprised of large-cost projects, b) routine maintenance that is accomplished on a schedule either by DOT-H or contract, or c) maintenance that is the responsibility of the tenant or a utility company.

Long-term Maintenance
Each year, DOT-H has a statewide maintenance budget of approximately $13.5 million to perform repair and maintenance projects on all existing harbor facilities. Due to limited resources, harbor projects are prioritized every year according to need, with health and safety as the highest evaluation criteria.

There are no regularly scheduled inspections of pier structures at KBPH, although the DOT-H Engineering Maintenance Section is able to conduct inspections as necessary. According to *Design of Marine Facilities for Berthing, Mooring, and Repair of Vessels* (ASCE, 2004), most port facilities and most public works facilities have economic design lives on the order of 50 to 80 years. US Navy and many commercial facilities have nominal design lives on the order of 25 years, with practical service lives of up to 50 years or more with periodic maintenance and upgrading.

USACE coordinates with DOT-H to perform maintenance dredging within the Federal Project Area of KBPH. USACE will only dredge prioritized critical areas at KBPH in 2015, as they did not receive full funding from Congress. The remainder will be dredged when additional funding is received. Spoils are ocean disposed if deemed suitable depending on the sediment test results.

Routine Maintenance
Each District Office has a maintenance crew that completes routine maintenance projects each fiscal year. Maintenance issues are addressed when DOT-H local personnel or its users notice damage to a facility, as they are the day-to-day users of the facilities.

Through the SWMP for KBPH and in accordance with its Notice of General Permit Coverage (NGPC, KBPH permit number HI03KB488), DOT-H implements maintenance measures established by the EPA and as required by the Hawai'i Administrative Rules (HAR) 11-55 Appendix K and the NGPCs. These are outlined in *Table 6.3*.

Table 6.3 – Routine Stormwater-Related Maintenance for KBPH

Maintenance Measure	Action	Purpose	Frequency
Public Education and Outreach	Outreach to general public – via various media, events, volunteer activities, stormwater hotline, signs at inlets and open channels	To create and promote awareness and prompt behavioral changes in the community	Frequently – Website, phone hotlines and signs always available; Additional media tied to events
	Outreach to tenants - New Tenant Information Package; Training workshops; Tenant Environmental Manager of the Year award	To make new tenants aware of the stormwater requirements and understand how to identify and report illicit discharges	New Tenant Information Package distributed at the time of new lease or tenant revocable permit signing; Training workshops held annually
	Outreach to vessel operators – Monitoring loading and unloading procedures	To ensure awareness of potential pollutant sources associated with vessel operation in the harbor, including vessel equipment wash water and polluted deck wash-down water, and vessel maintenance.	When docking at KBPH facilities
Pollution Prevention/Good Housekeeping	Emptying/repairing dumpsters; General maintenance and repair of public facilities; Proper use of fertilizers and herbicides; Pier and apron cleanliness; Use of dry cleanup methods for stains, spills and oil spots	To prevent or reduce pollutant runoff	Internal record-keeping system to schedule and document the maintenance activities performed
	Sweeping all common roadways and the apron	To prevent microscopic pollutants from entering the ocean by removing them before they flow into the storm sewer	Twice per month at four hours each

Table 6.3 – Routine Stormwater-Related Maintenance for KBPH (continued)

Maintenance Measure	Action	Outcome	Frequency
Illicit Discharge Detection and Elimination	When illicit discharges are observed, enforcement actions are taken	To eliminate discharges that the established storm drainage system is not designed to accept, process, or discharge	Inspections: High risk tenants - 2x/year; Medium ranking tenants – annually; Low ranking tenants - once every five years.
	Initial and refresher NPDES training	To instruct key personnel at different levels of responsibility on the components and goals of the SWMP	Annually
Construction Site Stormwater Runoff Control	The Harbors Division Engineering Branch (HAR-E) reviews construction plans for potential stormwater quality impacts, and drainage connection and discharge permit applications.	To ensure that plans reflect the actual site conditions.	As needed
	Construction sites are inspected until construction is terminated, the site has been stabilized, and the site's NPDES construction permit has been closed.	To ensure compliance with stormwater-related requirements	Oct. through April: at least bi-weekly Remaining months: at least bi-monthly
	Harbors Division employees who are responsible for construction plan review and site inspections are trained in the requirements of the SWMP and Hawai'i General Permits.	To make certain that the site manager or onsite coordinator is aware of the proper installation and maintenance procedures for construction stormwater BMPs.	Annually

Tenant/Utility Maintenance

Tenants are responsible for maintenance of their leased property, including refuse collection, sewer system, heating, ventilating, and air conditioning (HVAC) system maintenance, gas pipelines (including above ground storage tanks), building maintenance, etc. Liquid-bulk hoses and pipelines are also inspected and maintained by their respective owners.

All utilities, including power, water, and fire suppression are owned and maintained by DOT-H. The Honolulu County Board of Water Supply (BWS) will maintain only up to their main meter on the property.

2040 Master Plan Improvements That Will Require Maintenance

In addition to those items listed in *Table 6.1,* typical maintenance for the *2040 Master Plan* improvements will include landscaping, painting, lighting, and roads. The Fuel Pier and Fuel Terminal fire suppression system will require inspections by the Fuel/Marine Terminal Operator or other responsible party. The NOAA PORTS Program will require ongoing operational maintenance. The vehicle wash facilities in the Harbor Operations area will need scheduled maintenance and inspection. In addition, the Personnel Shelters will require housekeeping.

7.0
Implementation Plan

7.0 IMPLEMENTATION PLAN

This chapter provides the detailed implementation plan for the elements described in Chapter 6. In *Section 7.1* the phasing and cost estimates are described, first for Hawai'i Department of Transportation, Harbors Division (DOT-H) projects, and then for non-DOT-H projects. *Section 7.2* lists the permitting requirements for DOT-H projects.

7.1 Phasing and Cost Estimates of Improvements

Implementation of the *2040 Master Plan* is expected to be completed in phases based on funding availability and prioritization of DOT-H's system-wide Capital Improvement Program (CIP). It will be important not to disrupt cargo operations during improvements. Illustrative phasing is provided in *Table 7.1*, and indicates the period when funding and construction is recommended for each project, irrespective of DOT-H's system-wide CIP prioritized needs and financial constraints. Various parties (DOT-H, other agencies, tenants) will be responsible for implementing individual projects. Therefore, careful advanced planning is essential to successfully implement the *2040 Master Plan*. The overall cost for the DOT-H *2040 Master Plan* improvements is estimated at $256.8 million (in 2014 Dollars).

2015 to 2020 ($30.7 million)

Major Projects
The *2040 Master Plan* recommends implementation of three major projects immediately to facilitate the relocation of Marisco, Ltd. (Marisco) operations from Pier 3 to Pier 9. The first is to complete the coral stockpile removal to prepare the Maritime Support Services area for Marisco's relocation. This was completed in 2014. The Pier 7 Cargo Yard (S-7) and Pier 8 Multi-Purpose Yard will be the next areas to clear in preparation for projects that will occur in those locations. To further prepare the northern area of the harbor for new tenants and piers, the second project will include the installation of main electrical and water infrastructure. The relocation of Perimeter Road at the same time over these utilities will aid in future access for repairs or maintenance. The third project will be the design of the Fuel Pier.

Minor Projects
Minor projects that can be implemented immediately and have a great impact on the safety and operations efficiency of the harbor include the installation of a bollard around the 1,880-foot mark at Pier 6, making minor improvements to the Finger Pier and T-pier (i.e., water spigots, shoreside power and gated access), and the creation of an emergency connection to Ko 'Olina. The emergency connection would require the installation of a gate and grading of a dirt road through neighboring Kapolei Properties, LLC (KPL) and Ko 'Olina Marina for connection to Kekai Place. Stockpile removal will be prioritized by need at the Bulk A (S-A1) and Bulk B (S-B1) storage areas. Drainage issues at the Bulk A (S-A1) and Bulk B (S-B1) storage areas will need to be remediated. Continued stockpile removal will occur as dictated by the market demand and will continue into S-A2 once S-A1 has been fully utilized.

2020 to 2025 ($101 million)

Major Projects
Construction of Phase I of the Fuel Pier will allow most of the liquid-bulk vessels to begin transitioning away from Piers 5 and 6 to the new dedicated facility. This will entail installation of the Fuel Terminal infrastructure, including a fuel control building, paving, fuel pipeline framework with secondary containment, and fuel pipelines. The extension of Pier 7 will relieve berthing congestion associated with Piers 6 and 7. Expansion of the adjoining Cargo Yard (S-7) should occur at the same time. Should the Kalaeloa Harbor Access Road be completed off property, construction will occur on property to extend the Kalaeloa Harbor Access Road to the interior Access Road.

Minor Projects
Navigation to, from, and within Kalaeloa Barbers Point Harbor (KBPH) will become safer with lighting improvements to the perimeter lighting system, in addition to United States Coast Guard (USCG) projects (listed below in non-DOT-H projects). Construction of personnel shelters at Piers 5/6 and 7 will be provided for harbor users.

2025 to 2030 ($97.2 million)

Major Projects
Pier 8 layberth will be constructed to prepare for the demolition of the Finger Pier. This will be necessary to install Phase II of the Fuel Pier at Pier 4B (see *Section 5.2.13 Fuel Piers* for more information). If needed, any remaining coral stockpile at the Multi-Purpose Yard will be removed, and the area will be paved and parking will be striped.

Minor Projects
A new Harbor Office, parking and maintenance area will be constructed and placed near the new main entrance at the Kalaeloa Harbor Access Road. The Personnel Shelter at the old Harbor Office will be renovated, and a new one built at Piers 8/9 to support those workers utilizing the layberth. The public that may be accessing Pier 8 for excursions will also be able to utilize these facilities. Landscaping will occur throughout the harbor.

2030 to 2040 ($27.8 million)

The remaining major projects include constructing a layberth pier and Personnel Shelter at Pier 10, and replacing temporary overhead power lines with underground power lines in the northern harbor area.

Table 7.1 - Phasing Table for Priority Projects and Actions

MAJOR PROJECTS	Proponent	2015	2020	2025	2030
Northern Harbor: Coral Stockpile Removal and Improvements	DOT-Harbors				
Northern Harbor: Utilities Infrastructure and Perimeter Road Relocation	DOT-Harbors				
Pier 3 to Pier 9: Marisco Relocation	Tenant				
Piers 3 & 4: Fuel Pier Construction Phase I	DOT-Harbors				
Fuel Terminal: Fuel Terminal Construction	DOT-Harbors				
Fuel Terminal: Pipeline installation	Tenant				
Pier 7: Pier Extension and Cargo Yard Expansion	DOT-Harbors				
Kalaeloa Harbor Access Road: Construction On and Off Property	DOT-H & HWY				
Off-Site: Kalaeloa Harbor Access Road Weigh Station Construction	DOT-Highways				
Pier 8: Layberth and Multi-purpose Yard	DOT-Harbors				
Pier 4B: Finger Pier Removal and Fuel Pier Construction Phase II	DOT-Harbors				
Pier 10: Layberth and Personnel Shelter Construction	DOT-Harbors				
Northern Harbor: Install Underground Power Lines	DOT-Harbors				

MINOR PROJECTS	Proponent	2015	2020	2025	2030
Pier 6: Bollard Installation	DOT-Harbors				
Finger Pier and T-Pier: Minor Improvements	DOT-Harbors				
Pier 10: Emergency Access Connection to Ko 'Olina	DOT-Harbors				
Bulk Storage Areas S-A1, A2, B: Coral Stockpile Removal and Improvements	DOT-Harbors				
Navigational Aids: Marker Placements, Monitoring, Range Sensitivity	USCG				
Ko 'Olina mole: Perimeter Lighting Improvements	DOT-Harbors				
Piers 5/6 and 7: Personnel Shelter Construction	DOT-Harbors				
Harbor Office Relocation	DOT-Harbors				
Piers 4/5 and 8/9: Personnel Shelter Construction	DOT-Harbors				

EA/EIS / Land Use Permitting
Design/Building Permit/Construct

Non-DOT-H Projects

Marisco will be relocating from the Pier 3 area to the Pier 9 area. Costs for the preparation of the land including grading, drainage, wastewater system installation, and utility extensions from the mains will be absorbed by Marisco. The current office/warehouse building and associated structures at Pier 3 may be dismantled and reconstructed at Pier 9. Paving and fencing will complete the relocation.

The forecasted increase in dry-bulk cargo at KBPH will also increase traffic. It is imperative that the Kalaeloa Harbor Access Road be completed to accommodate this increased flow. KPL, the owner of the property for the proposed road, does not have an estimated schedule for construction of Kalaeloa Harbor Access Road at this time. Current plans are to build the road infrastructure in phases starting at the H-1 Freeway, and then working south and west to the Harbor over a number of years and market cycles.

DOT-H will continue Kalaeloa Harbor Access Road through the harbor to connect with the Perimeter and Access Roads. DOT, Highways Division (DOT-HWY) will install a state-of-the-art truck weigh station just outside the harbor property along Kalaeloa Harbor Access Road.

DOT-H is also working closely with the USCG for repositioning and installation of navigational aids, including repositioning the forward range light, corrected channel markers (if confirmed necessary), installation of data buoys, gated buoys, and quartering range lights.

Flaring of the entrance channel and deepening of the channel and harbor basin will be directed by the US Army Corps of Engineers (USACE), subject to the availability of Federal funds. DOT-H will sponsor the effort with a 20 percent match, estimated at $80 million).

The potential for liquefied natural gas (LNG, or methane) at KBPH could arrive in two forms. LNG is currently being delivered through Honolulu Harbor in International Standards Organization (ISO-Containers), and may also be delivered through KBPH. The LNG industry also may pursue building a bulk LNG terminal at Piers 1 and 3 to supplement an offshore floating storage and regasification unit (FSRU). See *Appendix G* for further discussion.

Summary

The phasing above presents in broad outline a development schedule of the various terminals and facilities that appears to be required at KBPH by 2040. Actual operating experience should be monitored continuously and commerce forecasts reviewed periodically to update estimates of future needs. The *2040 Master Plan* is designed to be a flexible plan which can be adjusted to meet future requirements and funding limitations. The portion of the plan of immediate importance is the near future from 2015 to 2020 when intensive design and construction activities will be required to ensure the Fuel Terminal is in operation by 2020.

The projected development costs for the completion of the individual priority projects in the *2040 Master Plan* are summarized in *Table 7.2*. Development costs are rough order-of-magnitude projections for master planning purposes, and individual projects will undergo more detailed cost estimating during future design processes. These costs are only related to DOT-H costs, and do not reflect non-DOT-H projects.

Table 7.2 - Projected Development Costs of DOT-H Projects (Rough Order of Magnitude Estimates, 2014 Dollars)

PROJECTS		DESCRIPTION	ESTIMATED COST
2015 to 2020 MAJOR PROJECTS			
1	Northern Harbor: Coral Stockpile Removal and Improvements	Remove coral stockpile areas, mass grading and drainage improvements at Storage Yards S-7, Multi-Purpose Yard and Maritime Support Services.	$10,700,000
2	Northern Harbor (Piers 7, 8, 9, 10): Utilities Infrastructure and Perimeter Road Relocation	Install temporary overhead power lines, water lines, fire protection lines and hydrants, telecommunication lines (to piers and personnel shelters), new roadway including AC paving and gutter, roadway drainage and lighting	$13,300,000
2015 to 2020 MINOR PROJECTS			
1	Pier 6: Bollard Installation	Installation of a double-bitt mooring at the 1,880-foot mark	$112,000
2	Finger Pier and T-Pier: Minor Improvements	Minor improvements - gated access to Finger Pier; Water spigots and shoreside power connections to both piers	$30,000
3	Pier 10: Emergency Access Connection to Ko Olina	Gate and road access to Kekai Place	$15,000
4	Bulk Storage Areas S-A1, A2, B1: Coral Stockpile Removal and Improvements	Remove coral stockpile areas, mass grading and drainage improvements, fill existing drainage channel, potable water line	$6,500,000
		Subtotal	***$30,657,000***

Table 7.2 - Projected Development Costs (continued)

PROJECTS		DESCRIPTION	ESTIMATED COST
2020 TO 2025 MAJOR PROJECTS			
1	Piers 3 & 4: Fuel Pier Construction Phase I	Remaining studies, design, permitting, construction	$35,300,000
2	Fuel Terminal: Fuel Terminal Construction	Grading, additional lighting, shore-based electrical power and potable water for vessels, upgraded individual wastewater system (IWS), fire suppression system, paving, fencing, pipeline rack and secondary containment construction, pipelines, fuel control room, parking, security shack, cameras, video, emergency system, first aid station, navigation.	$22,500,000
3	Pier 7: Pier Extension and Cargo Yard Expansion	Engineering evaluation of pier improvements as continuous pier similar to existing design. Install utilities (see Table 7.2 – 2015 to 2020 Major Projects #2: Northern Harbor (Piers 7, 8, 9, 10): Utilities Infrastructure and Perimeter Road Relocation), concrete hardstand, lighting. Pier amenities: spigot, wash/first aid station, fencing, emergency communication	$40,000,000
4	Kalaeloa Harbor Access Road: Construction On Property	DOT-H connection from Perimeter Road/Access Road to Kalaeloa Harbor Access Road	$800,000
2020 TO 2025 MINOR PROJECTS			
1	Ko ‘Olina mole: Perimeter Lighting Improvements	Remove and replace fixtures with marine-standard lights	$36,000
2	Piers 5/6 and 7: Personnel Shelters	Install Septic System, water, power, telecommunications, new facilities	$2,600,000
		Subtotal	***$101,236,000***

Table 7.2 - Projected Development Costs (continued)

PROJECTS		DESCRIPTION	ESTIMATED COST
2025 TO 2030 MAJOR PROJECTS			
1	Pier 8: Layberth and Multi-purpose Yard	Engineering evaluation of pier improvements, Install utilities (see Table 7.2 – 2015 to 2020 Major Projects #2: Northern Harbor (Piers 7, 8 , 9, 10): Utilities Infrastructure and Perimeter Road Relocation), concrete hardstand, pier amenities: spigot, wash/first aid station, lighting, fencing, parking lot/multi-purpose yard, emergency communication	$74,000,000
2	Pier 4B: Finger Pier Removal and Fuel Pier Construction Phase II	Finger Pier Removal, Extension of Pier 4B	$8,400,000
2025 TO 2030 MINOR PROJECTS			
1	Harbor Office Relocation	Install Septic System, new Harbor Office, parking, maintenance wash-down facility and storage	$12,900,000
2	Piers 4/5 and 8/9: Personnel Shelter Construction	Piers 4/5: Renovate existing; Piers 8/9: Install Septic System, water, power, telecommunications, new facilities	$1,700,000
3	Landscaping	Various locations within the harbor	$150,000
		Subtotal	***$97,150,000***
2030 TO 2040 MAJOR PROJECTS			
1	Pier 10: Layberth and Personnel Shelter	Engineering evaluation of pier improvements, possibly mooring dolphins for ship layberth. Install Septic System, water, power, telecommunications, new facilities	$24,000,000
2	Storage Yards S-7, Multi-Purpose Yard and Maritime Support Services: Install underground power	Replace temporary overhead power lines with stub outs to tenants	$3,800,000
		Subtotal	***$27,800,000***
MAJOR PROJECT COLLABORATION WITH USACE			
1	Dredging/Flaring Harbor Entrance and Dredging KBPH Basin	Dredging the harbor up to 45 feet deep (DOT-H: 20%)	$80,000,000
		Subtotal	***$80,000,000***
		TOTAL COST PROJECTION	**$336,843,000**

7.2 Permitting And Approvals

With the completion of the *2040 Master Plan*, DOT-H can proceed with design, permitting and implementation of the priority projects for the modernization of KBPH. The *Kalaeloa Barbers Point Harbor Fuel Pier and Harbor Improvements Environmental Impact Statement* will be completed in 2015, laying the groundwork for permitting DOT-H projects through the year 2025.

Construction and maintenance activities over, under or within navigable waters, whether affecting the setback or not, require authorization from USACE Regulatory Program and the State of Hawai'i Office of Planning, Coastal Zone Management for federal consistency. The extension of Pier 7 and construction at Piers 3, 4, 8, 9, and 10 may require a US Department of the Army (DA) permit, in accordance with Section 10 – Rivers and Harbors Act; Section 404 – Discharge of Dredged Materials; and Sections 102, 103, and 108 – Marine Protection, Research and Sanctuaries Act, related to disposal of dredge materials. This will also require a Hawai'i State Department of Health (DOH), Clean Water Branch Section 401 – Water Quality Certification. Additional drain outlets that discharge into the Harbor would trigger a Clean Water Act Section 404 permit.

Applicants interested in leasing space or building their own pier improvements (such as at the Pier 9 area) will be responsible for their own Chapter 343 environmental compliance documents and may be subject to a DA permit if work is over, under or within the water. They may also need a Special Management Area permit, based on their location within KBPH. For those tenants interested in leasing the portion of Bulk A Storage Yard (S-A2) that is within the culturally sensitive area, an Archaeological Inventory Survey (AIS) would most likely be required that complies with Hawai'i Revised Statutes Chapter 6E, Historic Preservation. The interested tenant would need DOT-H to work with Hawai'i State Historic Preservation Division on their behalf.

Other permits will be required at the time of construction, including the Community Noise Permit for Construction Activities through DOH and Section 402 – National Pollutant Discharge Elimination System (NPDES). Each tenant is responsible for obtaining their NPDES permit to discharge into the KBPH municipal separate stormwater system (MS4), the Harborside drainage channel, or directly into state waters for all activities producing non-stormwater discharge. On-site wastewater treatment systems (OWTS) should be approved and permitted for use by DOH Wastewater Branch and follow the requirements set forth in the Hawai'i Administrative Rules, Title 11-Department of Health, Chapter 62-Wastewater Systems (HAR 11-62).

County zoning limits building height to 60 feet above the surface of the ground over the entire property. If a tenant plans to build higher than 60 feet, a variance is required. Any structure 200 feet or higher requires formal notice to the US Department of Transportation, Federal Aviation Administration (FAA) *(Federal Aviation Regulation (FAR) Part 77, Notice of Proposed Construction or Alteration).*

Liquid-bulk users interested in installing pipelines within DOT property would require an easement through DOT-H. Those seeking to install a pipeline within this energy corridor are required to follow the process below:

1. Provide documentation indicating State Energy Corridor (SEC) tenants' concurrence with the project. The SEC tenants are (1) Hawai'iGAS, (2) Par Petroleum, and (3) Hawaiian Electric Company (HECO) (Chevron may represent HECO as their agent if indicated by HECO);
2. Provide one (1) set of project plans with callouts to the SEC, include the purpose(s) of encroachment into the SEC; and,
3. Provide a preliminary project schedule.

Upon meeting the above requirements, DOT-H will issue an approval letter for allowing work within the SEC. DOT-H approval for the project shall not be construed to warrant or represent in any manner that the project was approved by or complies with any other governmental agency that has jurisdiction over the project. Upon DOT-H approval, responsibilities also include fulfillment of the following obligations:

1. The Hawai'i One Call Center must be contacted prior to excavation. They may be reached at 1-866-423-7287 or http://callbeforeyoudig.org;
2. Ensure that all applicable governmental agency rules and regulatory concerns, including but not limited to the EPA/DOH, are satisfied;
3. Ensure that all requirements by Hawai'iGAS, Par Petroleum, and HECO (or its agent, Chevron) will be followed and included in the final drawing package;
4. Ensure that the final drawing package indicates all specific, appropriately scaled encroachments into the State Energy Corridor prior to construction;
5. Provide a project schedule prior to construction;
6. Provide one (1) set of as-built drawings upon completion of the project.

7.3 Economic Benefits

The assumed development period is 25 years, from about 2015 to 2040. However, development could require more or less time, depending on funding, permitting, construction delays, etc.

Expenditures and Sales

Over the 25 year development period, total construction expenditures for the improvement projects are estimated to be about $334.7 million in 2015 dollars. This translates into average construction expenditures of about $13.4 million per year in 2015 dollars. In practice, construction expenditures will vary from year to year.

In addition to construction expenditures, development activities will generate indirect sales associated with supplying goods and services to construction companies and to the families of construction workers. In turn, the companies that supply goods and services, and the families of their employees, will purchase goods and services from other companies, and so on. These indirect sales will include sales by companies supplying: construction equipment; equipment services; building materials (cement, steel, lumber,

surface materials, plumbing, electrical equipment, hardware supplies, lighting, etc.); warehousing services; shipping and trucking services; etc. Indirect sales include those by grocery stores, drug stores, restaurants, service stations, medical providers, accountants, insurance agents, etc. Based on state economic multipliers, these indirect sales are expected to average about $15.7 million per year, of which about $6.8 million per year will be consumption expenditures by the families of workers. Total construction expenditures plus indirect sales are projected to average about $29.1 million per year.

Employment

During the 25 year development period, construction employment is expected to average about 101 jobs per year. These jobs will include supervisors, heavy-equipment operators, cement workers, metal workers, carpenters, plumbers, electricians, roofers, glass and window installers, painters, equipment installers, etc. Other jobs related to construction will include planners, architects, civil engineers, draftsmen, government inspectors, etc. These jobs will range over a variety of skill levels, including entry-level, semiskilled, skilled, management, and professional positions.

As with indirect sales, development activities will generate indirect jobs associated with supplying goods and services to construction companies and to the families of construction workers. In turn, the companies supplying goods and services, and the families of their employees, will purchase goods and services from other companies, and so on. Indirect jobs will include those at companies supplying: construction equipment; equipment repair services; building materials (cement, steel, lumber, roofing materials, plumbing, lights and electrical devices, hardware, flooring, etc.); warehousing services; shipping and trucking services; etc. Other indirect jobs will include those involved with supplying goods and services to employees and their families: grocery workers, store clerks, restaurant workers, service-station workers, barbers, bankers, pharmacists, veterinarians, computer technicians, medical workers, accountants, attorneys, etc. The jobs will range over a variety of skill levels, including entry-level, semi-skilled, skilled, and management positions. Based on state employment multipliers, indirect employment related to the improvement projects development is expected to average about 90 jobs.

Total direct-plus-indirect employment associated with the improvement projects development will average about 191 jobs per year to 2040.

Payroll

Development activities are expected to generate a total payroll of about $13.5 million per year, of which about $9.4 million will be for construction workers and about $4.2 million for indirect employment. These estimates are based on the average number of direct and indirect jobs multiplied by average wages as reported by the Hawai'i Department of Labor and Industrial Relations. Wages will range from about $30,000 annually to over $150,000, and are expected to average about $92,000 per year for construction jobs, and about $46,000 for indirect jobs. During the 25 year development period, direct and indirect jobs provided by improvement projects construction will support about 325 residents housed in about 108 homes.

Excise Tax Revenues

During the 25-year development period, the State of Hawai'i is expected to collect an average of about $952,000 per year in excise taxes, based on construction expenditures and consumption taxed at 4.5 percent and other indirect sales taxed at 0.5 percent. Of this amount, about $861,000 per year will be allocated to the State and about $91,000 allocated to the City and County of Honolulu.

8.0
References

8.0 REFERENCES

Agerschour, Hans, et. al. 2004. *Planning and Design of Ports and Marine Terminals, 2nd Edition.*

Annex V: International Tramp (Unscheduled) Shipping to Hawai'i. *List of Tramp Ship Types and Cargoes Calling in Hawai'i.*

Austin, Tsutsumi & Associates, Inc. (ATA). 2014. *DRAFT Traffic Assessment, Kalaeloa Barbers Point Commercial Harbor, Kalaeloa, O'ahu, Hawai'i.* Prepared for Group 70 International, Inc. October.

Belt Collins Hawai'i Ltd. 2008. *Drainage Report for Kalaeloa Baseyard, Barbers Point, O'ahu, Hawai'i.* Prepared for Grace Pacific Corporation. June.

Belt Collins Hawai'i Ltd., 2012. *Kapalama Container Terminal EIS Public Meeting Presentation.* [URL: http://www.kapalamaeis.com/wp-content/uploads/2012/12/App-A-Public-Involvement.pdf] Accessed: December 1, 2014.

Briggs, M.J., et. al, 1994. *Physical and Numerical Model Studies of Barbers Point Harbor, O'ahu, Hawai'i.* U.S. Army Corps of Engineers Waterways Experiment Station, Technical Report CERC-94-14. Prepared for U.S. Army Engineer Division, Pacific Ocean.

City and County of Honolulu Department of Planning and Permitting, 2000. *Rules Relating to Storm Drainage Standards.*

Connecticut Department of Transportation, 2008. *A Study of Weigh Station Technologies and Practices.* The Connecticut Academy of Science and Engineering.

Federal Energy Regulatory Commission, n.d. *A Guide to LNG What All Citizens Should Know.* [URL: http://www.cheniere.com/resources/citz-guide-lng.pdf] Accessed: November 10, 2014.

Foss, Michelle Michot, Ph.D., 2006. *LNG Safety and Security.* Center for Energy Economics, The University of Texas at Austin.

GLP Asphalt, LLC, 2007. *Final Environmental Assessment GLP Asphalt LLC Kalaeloa Asphalt Terminal Kalaeloa Barbers Point Harbor Kapolei, Hawai'i.* Prepared by Environmental Science International.

Gonser, James, January 28, 2001. *Kalaeloa Harbor Expansion Planned.* HonoluluAdvertiser.com. [URL: http://the.honoluluadvertiser.com/2001/Jan/28/128 localnews27.html] Accessed: November 10, 2014.

Hawaiian Cement, 1999. *Hawaiian Cement Terminal at Kalaeloa/Barbers Point Harbor O'ahu, Hawai'i Final Environmental Assessment/Finding of No Significant Impact.* Prepared by Parsons Brinckerhoff Quade & Douglas, Inc.

Hoover, Will. March 20, 2005. *Boaters Knock New Ramp*. Honoluluadvertiser.com. [URL: http://the.honoluluadvertiser.com/article/2005/Mar/20/ln/ln26p.html] Accessed: December 1, 2014.

Joint Permanent International Association of Navigation Congresses and International Association of Ports and Harbors Working Group II-30. 2013. *Approach Channels: Preliminary Guidelines.* In cooperation with International Maritime Pilots Association and International Association of Lighthouse Authorities.

Kapolei Property Development LLC, 2011. *Kapolei Harborside Roadway Master Plan.* Prepared by R.M. Towill Corporation.

Kelly, Stephen H., 2014. James Campbell Company LLC. Personal communications.

Lee, D and Olive, C, 1994. *Size and Growth Potential of Hawai'i's Maritime Industry.* Department of Agricultural and Resource Economics and Sea Grant College Program.

Marisco, Ltd., 1990. *Chapter 343, HRS Negative Declaration for Ship Repair Facility Building Barbers Point Harbor.* Prepared by Environmental Communications, Inc.

O'ahu Metropolitan Planning Organization, 2011. *Transportation Asset Climate Change Risk Assessment.* Prepared by SSFM International.

Parsons Brinckerhoff Quade & Douglas, Inc., 1998. *Basin Expansion at Barbers Point Harbor Drainage Master Plan*. Prepared for State of Hawai'i Department of Transportation Harbors Division. August.

Pukui, Mary Kawena, S.H. Elbert, E.T. Mookini, 1974. *Place Names of Hawai'i*. University of Hawai'i Press, Honolulu.

Sea Engineering, Inc., 2013. *Kalaeloa Barbers Point Harbor Oceanographic Conditions Assessment. Kapolei, O'ahu, Hawai'i*. Prepared for Group 70 International, Inc.

State of Hawai'i Department of Transportation Harbors Division, 1991. *2010 Master Plan for Barbers Point Harbor*.

State of Hawai'i Department of Transportation, Harbors Division, 1997. *O'ahu Commercial Harbors 2020 Master Plan*.

State of Hawai'i Department of Transportation Harbors Division, 2008. Port Hawai'i Handbook. [URL: http://hidot.hawaii.gov/harbors/library/port-hawaii-handbook/] Accessed: March 2014.

State of Hawai'i Department of Transportation Harbors Division, 2014. *Final Post-Construction Stormwater Management in New Development and Redevelopment Honolulu and Kalaeloa Barbers Point Harbors.* Small Municipal Separate Storm Sewer Systems File Nos. HI 03KB482 and HI 03KB488.

State of Hawai'i Department of Transportation, Harbors Division, 2015. *2015 Stormwater Management Plan, Honolulu Harbor and Kalaeloa Barbers Point Harbor*. Prepared by Weston Solutions, Inc.

State of Hawai'i Department of Transportation, Harbors Division, 2015. *Dredge Spoil Stockpile Management Plan, Kalaeloa Barbers Point Harbor, O'ahu, Hawai'i.*

TranSystems Corporation, 2007. *Maritime and Intermodal Planning Guidebook.*

Trustees of the Estate of James Campbell, 1958. *A Preliminary Draft Study for the Development of the Barber's Point Industrial District, Honouliuli, O'ahu, Territory of Hawai'i.* Prepared by Harland, Bartholomew & Associates.

US Army Corps of Engineers Honolulu District, 1994. *The Physical and Numerical Model Studies of Barbers Point Harbor, O'ahu, Hawai'i.*

US Army Corps of Engineers Honolulu District, 2008. *Preliminary Draft: Kalaeloa Barbers Point Harbor Modification Study, Island of O'ahu, Hawai'i. Feasibility Report and Supplemental Environmental Impact Statement.*

US Coast Guard Office of Waterways Management, 2009. *Port and Waterways Safety Assessment – Workshop Report, Honolulu and Barbers Point-Kalaeloa Harbors, O'ahu, Hawai'i, 24-25 August 2009.*

US Code of Federal Regulations (CFR) 49, Part 193. [URL: http://cfr.law.cornell.edu/cfr/cfr.pho?title+49&type=part&value+193] Accessed December 1, 2014.

US Department of Defense, 2012. *Unified Facilities Criteria (UFC) Design: Piers and Wharves.* UFC 4-152-01.

Watanabe, June, April 21, 2014. *2015 Could See Construction of the Boat Ramp at Ko Olina*. [URL: http://www.staradvertiser.com/newspremium/kokualinepremium/2015_could_see_construction_of_the_boat_ramp_at_Ko_Olina.html?id=255978571] Accessed: December 1, 2014.

US Geological Survey, 2002. *Atlas of Natural Hazards in the Hawaiian Coastal Zone*. By: Charles H. Fletcher III, E.E. Grossman, B.M. Richmond, and A.E. Gibbs. Prepared in cooperation with University of Hawai'i, State of Hawai'i Office of Planning, and National Oceanic and Atmospheric Administration.

US Geological Survey, Hawaiian Volcano Observatory, 2001. *Earthquakes.* [URL: http://hvo.wr.usgs.gov/earthquakes/] Accessed: March 2014

APPENDICES

APPENDIX A
STAKEHOLDER MEETING SUMMARIES

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA HARBOR 2040 MASTER PLAN

Notes from Planning Workshop #1
July 18, 2013

The meeting was opened up by Carter Luke and Randy Grune of Department of Transportation, Harbors Division (DOT-H), and Jeff Overton of Group 70. Jeff presented the powerpoint presentation on existing conditions and known issues. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity towards the end of the presentation to comment and ask questions.

Below are the various topics covered and comments made by attendees. DOT-H and Group 70 comments and/or responses where included are *italicized.*

Goals

Be Realistic and Achievable

- *DOT-H would like to stress that this is a user group-directed process and plan, not a State-directed plan. This is an opportunity for the stakeholders to present their thoughts and tell us what would be the most preferable for their operations. From this information, we can then make assessments to obtain a realistic plan.*

Be Flexible to Meet Future Needs

- Need to be flexible in the fuel trending demand forecast, which will affect the volume of products coming into the harbor facility.
- Consider both dry and liquid bulk uses (no restrictions) for the land area, and consider safety areas in the plan, so that lessees will already have this information. Without this flexibility, it may limit lands that could otherwise be leased (i.e., dry bulk areas only for dry bulk).
- We are planning for a maximum ship size 751' and will include the necessary safeguards with manageable risk.

Be Compatible with Surrounding Uses

- Understanding how the zoning works is important, and then need to talk with neighbors early in the process in order to take their concerns into consideration. Wouldn't be surprised if neighbors would object to light and dust.

  The harbor is zoned I-3, and the state will not be required to get county zoning (although this does not apply to tenants). DOT-H will be conducting individual meetings with adjacent landowners and key stakeholders early in the process to understand and address their concerns.

Consider Environmental Issues

- Will there be a problem with live coral in the harbor? This could be considered a constraint.

  We have done an initial marine survey at the harbor. There is a common variety of coral, but we believe there is a workable solution through design. There has been a problem with coral in the past with deepening of the basin and channel.

Consider Safety and Security

- Need to have water access and facilities to support the response community, as all users are required to have rapid response ability.
- Risk management tools
  - International users present risks when they don't strictly comply with international standards and best practices (i.e. International Maritime Organization (IMO), International Safety Management code (ISM), International Standard Organization (ISO)). This impacts each of us and creates complex issues.
  - Safety zones have issues that need to be included in the report. Each user has their own safety and evacuation plan, but there needs to be an alarm that all will recognize and people can get out. There is not currently a PA or alarm system for the overall harbor, although there are individual PA systems at specific user locations that can be heard elsewhere.

Outline a Phased Sequence of Improvements

- *Improvements, land leases and integration will be phased beginning with most immediate needs and every 5 years thereafter.*

Joint Stakeholder Projects

- The harbor users may want to consider teaming up on improvements. It is also important to establish industry protocols not just for individuals, but for clusters of stakeholders that have a common interest.

  We may need to look at a consortium for the pipelines at the fuel pier.

Opportunities

Increase Berthing Capacity to Meet Future Growth

- In the tug and barge industry, delays occur while waiting for scheduling to free things up. Problem is point of accessibility.

  The Fuel Pier will free up piers 5 and 6, reducing berthing conflicts.

- If Pier 1 was dredged deeper, it could be utilized more and might alleviate a barge or two. The storage area next to that is not used very often and could be used for covered storage.

Enable 24-hour Transit

- Will the report also look at nighttime transit?

  Previous lighting studies for nighttime transit will be reviewed and updated in this plan. Note: nighttime cargo operations are a current practice.

Improve Utilities Infrastructure

- DOT-H cannot control the economy, but we can be prepared with enough infrastructure to handle forecasted capacity. This includes additional berthing, roads, navigational enhancements for night transit, adequate laydown area, possible crane, accommodations throughout, etc.

- In the maritime industries, need to look at the height as well. Bigger ships will be taller - need to look at FAA obstruction for storage tanks, cranes (i.e. rubber tire gantry), RO/RO facility, etc.

- There will be no space in 2040 for containerized cargo at Honolulu Harbor, as it is already over capacity. Matson and others may say they need container area.

If a user tells us that they need it, then we can make accommodations for it. Note: There are plans to add 2 berths and 70 acres of yard for containerized cargo at Honolulu Harbor.

New Harbor Access Road from Hanua Street

- Current infrastructure is inadequate for increased and different types of cargo. The windmill operation was a snapshot of the entire cargo storage yard and adjacent staging areas at maximum capacity. All of these industries can't be reliant on one artery that gets clogged at 3pm. Whatever is improved in the harbor will also have an effect on the infrastructure. Need to look at: 1) Key Access route, 2) Traffic and 3) Heavy lift area limits.

USACE: Deepen Basin and Widen Channel

- Before expanding the harbor, make sure the draft is deep enough for future ships. Ships / barges will be larger, requiring larger tugs. Liquefied Natural Gas (LNG) could be a future user, which is not a small ship.

  We will need to make sure the facility can handle the throughput. Need to put pressure on USACE to deepen the channel, but the cost/benefit ratio needs to make sense. If ship is not fully laden, it is inefficient. This plan will feed into USACE deepening study.

- If the channel is deepened to accommodate larger and fully-laden vessels, it also needs to be widened due to cross currents. Currently, pilots are limited by the width, and there is no choice once in the channel. Can't go in safely even at 5 to 7 knots.

  Yes, the current can change in a matter of hours. There are studies in progress by USACE for widening and/or flaring the channel.

- How will we accommodate for the surge? If the channel is widened then it will bring in the surge. This will end up at the "toilet bowl" (upper inner basin) at Pier 7, and start snapping lines.

  We believe this is mainly offshore, but will need to be studied.

- A flow/current meter in the channel is needed to assist pilots in the entry way.

Resilience and Recovery.

- What if Honolulu Harbor were in a disaster and some temporary operations needed to move to Kalaeloa?

  We will need to review how Honolulu Harbor and KBPH can complement each other based on resilience, security, capability, and efficiency.

- Hawaii doesn't have a large warehouse capacity. This affects resiliency by not having supplies to last more than 30 days.

  We don't want to limit open yard storage as there are really no other harbors with as much open yard capacity in the state. For example, during previous hurricane disasters the open yard was needed for emergency relief equipment, supplies, and infrastructure repairs (i.e. utility poles). In some cases, vessels were turned away because space ran out at neighbor island harbors.

Constraints

Lighting and Noise from 24-hour Transit Operations

- Lighting may cause conflicts with Kapolei West in the mauka area. Need to look at possible mitigation measures.

Neighboring Land Uses (Resort, Residential)

- What can be located in the mauka portion of the harbor? How close can we get to the residential area without conflicting with our neighbor, such as a type of storage? Are we limited to dry? Or we were here first so too bad?

  There is generally a buffer with our northern neighbors due to the OR&L right-of-way, a proposed golf course and cultural park. However, there may be some setbacks for fuel area storage, and other impacts related to harbor use which will need to be studied.

Lengthy Process to Plan, Permit, and Construct

- *The Master Plan process will feed into the USACE process, but it will still take 8 years to complete. The permits and appropriations of funds are on demand, and USACE does not pay 100%. However, private operations will move more quickly.*

Funding for Projects

- Politicians/decision makers need to be educated. All they see is pipelines and are blind to how much cargo is going through the conveyor belts. They don't realize that this is the second busiest port in the system.

  We should have a good draft plan by the 2014 session to direct the legislature on the amount of money needed at the harbor.

- The need to play with everyone and feed the needs of the harbor is understood. But there are concerns about the costs of the fuel pier, as there have already been sizeable investments into fuel piers 5&6. What will the cost be to fuel users?

  Any fuel lines and additional equipment will need to be provided by the users. Depending on the option chosen, cost estimates will be provided in the development plan. DOT-H will be responsible for the cost of building the pier itself.

Master Plan Relative to Neighbor Islands

- Planning for the harbor needs to be separated into two primary parts – Oahu imports/exports, and Neighbor Island exports. Will have changes at Oahu that will not happen at neighbor islands. Need to consider how the other harbors are not changing, and how this will have an effect on ship size and scheduling, possibly causing more complexity and delays. Need a layberth to help make up for this.

  A layberth is being considered for tugs and barges that are not currently loading to alleviate congestion. Coordination with neighboring island ports will be considered as part of the Master Plan.

- Will the master plan be integrated into other harbor projects statewide? Are there other projects at Honolulu harbor that are on the table that should be accelerated, so that we can understand what needs to take place at KBPH?

  Any throughput analysis will be looked at, that is why the information from the questionnaire is so important. This directly translates to what will be needed on the neighbor islands. DOT-H has fuels leasing requests, which translates into Neighbor Island storage. Barge traffic on the Neighbor Islands may then increase by 30-40%, and will be different products. There may not be complete integration into their plans, but will feed them information.

Those Present:

AES – J. Holden
Aloha Consulting – M. Zopresti
Amergent Techs – W. Anonsen, R. Beauchamp, F. Whipple
Ameron Hawaii – E. Yoshizawa
BAE Systems (HSY) – J. Cummings
Chevron – H. Maxie
DOT Harbors – D. Ancheta, S. Dale, R. Grune, C. Luke, A. Murakami, D. Watase, D. Yogi
Group 70 – B. Natale, J. Overton
Hawaii Gas – T. Young, R. DeGarmo, J. Vient
Hawaii Pilots Association – T. Heberle
Hawaiian Cement – R. Bautista
Healy Tibbitts Builders, Inc. – C. Hutchinson
HECO – J. Arakaki
Kirby Offshore – D. Naunguyan, R. Brown
Marine Cargo Surveys of Hawaii – R. Lund
Marisco – F. Anawati
Maritime Licensing Center – C. Devoe
Matson – K. Park
McCabe – J. Zane
National Cargo Bureau – N. Fotu
Oahu Gas Service – B. Kawano
PENCO/AMC – D. Carter
Sause Bros., Inc. – K. Pomaikai
Tesoro Hawaii – L. Tanaka
Transmarine – K. Kinerney
USCG – R. Deakin, D. Tonen, C. Petersen
Waldron Norton Lilly International – M. McCormik

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA HARBOR FUEL PIER DEVELOPMENT PLAN

Notes from Planning Workshop #1
July 18, 2013

The meeting was opened up by Carter Luke and Randy Grune of Department of Transportation, Harbors Division (DOT-H), and Jeff Overton of Group 70. Jeff presented the powerpoint presentation on existing conditions and known issues. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity towards the end of the presentation to comment and ask questions.

Below are the various topics covered and comments made by attendees. DOT-H and Group 70 comments and/or responses where included are *italicized.*

Goals

Address Berth Conflicts

- Why build pipelines at Pier 3 and 4 when there are already fuel-related uses at Piers 5-7?

  The fuel pier will be able to double berthing capacity for the harbor, and relieve congestion at Piers 5 & 6 due to competition for berthing with dry bulk uses (the fuel pier does not require similar yard space needed for dry bulk). This area is further away from residents and closer to current fuel lines.

- Does construction of this dedicated fuel pier mean that Piers 5 and 6 will be abandoned?

  No. Even though Piers 3 and 4 would be a preferred berth, Piers 5 and 6 would still be available. Priorities of fuel vs. cargo are based on the current infrastructure, and we are open to suggestions.

- It will be very expensive to build this pipeline. Is this cheaper than to make bulk landings at piers 3 & 4 to free up berthing space?

  There is not sufficient landside area at 3&4 for laying down cargo, although there is some space at neighboring Pier 1. To expand cargo space past pier 3 & 4, nearby industrial park lots would have to be condemned.

- Will harbor traffic increase to Kalaeloa from Honolulu Harbor?

  We don't expect it to, as Honolulu is primarily a container terminal, and DOT-H is building another 80 acres in Honolulu to accommodate growth in container traffic. There may be an increase of bulk cargo at Kalaeloa, however.

Be Flexible for All Fuel Types

- Pier 1 is currently used for propane but has periodic surge conditions that affect operations seasonally for approximately three months out of the year. Is propane access to Piers 3 and 4 an option? Piers 5 & 6 were being evaluated for alternative locations.

  The development plan will take into consideration various fuel type options, including propane, LNG and potential land-based safety zones.

- Will this pier be able to handle the full suite of fuels?

  This is currently under investigation. We are planning for the next 25 years, but it is difficult to predict what will happen with the current volatility of the world market. The basic infrastructure will be flexible to handle many fuel types, but some types will require on-site storage or safety zones which would have to be developed and/or permitted by the users as they respond to market demand.

Address New Pipelines

- Is the intent to tie into the existing pipelines? If so, then the pipeline capacity has not doubled, only the moorings. May be able to load two additional vessels, but not necessarily the same fuels.

  Users would need to install appropriate piping for their specific needs. A consortium for pipelines is being considered. Depending on the future of the refineries, there may be more imported refined product. We will need to evaluate those scenarios with a wide range of options.

- This could potentially cause a problem. When you have different lines and different products, how do you look at scheduling? Different vessels, fuels, storage, and use will have to be studied.

  Scheduling will be managed by harbor operations as they see fit to best utilize the harbor facilities in the most efficient manner. Sufficient piping would need to be developed by the users for their particular needs and to alleviate conflicts as necessary.

- Does the project limit the number of pipelines?

  Not at this time. Above ground piping is more flexible to accommodate additional piping as racks can be added. If below ground piping is desired, this may be an issue due to limited space, and will be considered as part of the planning process.

- Will there be individual company lines or a consortium?

  DOT-H is currently reviewing the pros and cons of a consortium to manage the pipelines.

Consider Safety and Security

- Pre-staged boom equipment will save everyone time and effort in day to day activity. It is important to think through the design with consideration to response, maintenance, and vessel water access. In responding to oil spills, may want to consider a 3-stage containment boom for the fuel berth, similar to Piers 5 and 6.

  First response and in water boom systems will be considered and incorporated into the planning alternatives.

- Locating spill response at Pier 8 could be a possibility, but the current location puts us in front of spill instead of chasing it. We also have an 800ft boom, which would be nice to have in an area that is accessible.

Relocate Existing Tenants

- A new tenant location should allow for lay space, cleaning tugs, and dry dock.

  Preliminary thoughts on locations include Piers 8 and 9.

- Does tenant relocation trigger an EIS for master plan?

  The Fuel Pier EIS will generally discuss reasonably foreseeable tenant relocation(s), however, the tenant(s) will be responsible to comply with Chapter 343 individually and provide details of their specific improvements and operations.

Opportunities

Evaluate Fuel Pier Design Alternatives

- The design should take into consideration berthing scenarios for Piers 3, 4, and 5a. It is important to avoid conflicts while providing maximum utilization. What is accessibility to P5a if a 750' ship is located at Pier 4? The key to 5a and 5 is where will the hatches and manifolds be placed? It should also be recognized that when pilots charter a ship within a class, it could be a variety of sizes.

  Berthing conflicts with Pier 5A will be considered as part of the planning process. Specific information from users will need to be considered. Phasing construction of Pier 3 first will alleviate these concerns initially.

- What is the full length of the pier?

  Approximately 1200' – 1400'

- So may be able to fit both a 720' and 400' ship.

  Yes, we can put the larger ship first at Pier 3 then 4, freeing up 5a.

- But we still wouldn't be able to fit a 750'. Would have to go to Pier 5.

  At present the pier design alternatives will handle up to a 750 foot panamax tanker (although current harbor draft would require it to be only partially loaded).

- Will the ferry pier where the tugs are have to be relocated? What are we looking at for relocating the tugs?

  Pier 8 might be a possible area for layberth if it was expanded. Could double or even triple breast here. The fuel pier can be phased so that Pier 3 is built first, leaving the finger pier available for as long as possible.

- Is it possible to put in a 2 point - 4 point mooring at the north quadrant of the harbor basin that is currently undeveloped, towards the golf course side? This may provide a layberth for small vessels, and a floating catwalk could also be provided if need be. May need a 4 point mooring because of the wind.

  A lay berth mooring area is being considered as part of the Master Plan.

- Will there be bunkers at the fuel pier? Currently only done by barge.

  This is dependent on users demand and supplier's ability to supply, and the type of bunkers available.

- Is the fuel pipeline system above or below ground? The less expensive system may be best.

  Both above and below ground pipeline infrastructure designs are being considered as part of the planning process. Safety issues for each will need to be considered. Because it is a fuel pier only, it could be partially above ground, and below ground for Stevedores forklift crossing.

- When determining dolphins and mooring points, need to take into consideration ship sizes and berthing techniques.

  The fuel pier will be flexible to accommodate a range of vessel and berthing techniques wherever possible.

- If we expand the entrance, then Pier 3 is sticking out there. Would this need to be shortened?

  USACE is investigating widening the entry channel to facilitate navigation, but this would not affect the Pier 3 jetty.

- Where do you put things while you are dredging and building?

  There will be some operational service disturbance, although the USACE tries to minimize disruption and work around the harbor schedule.

Consider Vapor Control Systems

- Will the Fuel Pier need vapor control?

  This may be a requirement of Department of Health.

Constraints

New Dredging Requirements

The federal line is a concern for dredging of the Fuel Pier. If construction of the pier is pushed past this line, federal regulations will apply.

Neighbor Island Capacity

- The Neighbor Islands have storage limits, and fuel is a priority.

  Several of the commercial harbors throughout the state are undergoing planning improvements as a result of the Governor's "New Day Initiatives" which may increase storage on neighboring islands. Demand for fuel on neighboring islands is being considered as part of the KBPH planning process.

Funding

- Who will pay for the Fuel Pier?

  A bond sale may be used to fund the Fuel Pier. DOT-H is looking to those that will use the pier (the fuel industry) to pay for the new pipelines. At this point, it is important to look at what we want in the Fuel Pier, and then determine financing later. We may have to push the pricing down to the user (i.e. per barrel charge/pipeline toll) – it depends on how we can finance the bond.

Those Present:

AES – J. Holden
Aloha Gas – J. Lovan
Amergent Techs – W. Anonsen, R. Beauchamp, F. Whipple
Chevron – H. Maxie, K. Jacobsen
Clean Islands Council– K. Beasley, J. Jacobi
DOT Harbor Division – D. Ancheta, S. Dale, R. Grune, C. Luke, A. Murakami, D. Watase, D. Yogi
FACTS Global Energy – I. Nasseri, S. Wee
Group 70 – B. Natale, J. Overton
Hawaii Gas – T. Young, J. Strickler, R. DeGarmo, J. Vient
Hawaii Pilots – T. Heberle
Healy Tibbitts Builders, Inc. – D. Masumoto
HECO – C. Barnes, J. Arakaki
Kirby Offshore – D. Naungayan, R. Brown
Mid Pac Petroleum – R. Whang
PENCO/AMC – D. Carter
Petrospect – D. Harrington
Sause Bros., Inc. – D. Won
Tesoro – R. Rivas, C. De Almeida, G. Merchant
Transmarine – K. Kinerney
USCG – C. Petersen

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION

79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA BARBERS POINT HARBOR 2040 MASTER PLAN AND FUEL PIER EIS

Notes from Public Meeting #1
September 3, 2013

The meeting was opened by Jadine Urasaki, Department of Transportation (DOT), Deputy Director for Projects. Carter Luke, DOT Harbors Division (DOT-H), Engineering Program Manager introduced the project team. Jeff Overton of Group 70 presented the power point presentation on existing conditions and known issues. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity after the presentation to provide input and ask questions.

Below is a summary of the various topics and the discussions. DOT-H and Group 70 responses were included are *italicized.*

EIS Process

- When you complete the EIS and submit for approval, can you renew it if a change happens?

  An EIS should disclose the full range of reasonably foreseeable actions contemplated in a project. Chapter 343 environmental documents have no shelf life. However, if a long period of time passes, or major changes occur in the project, a supplemental EIS might be requested by the courts (e.g. Turtle Bay).

Harbor Dredging

- What is the basin depth are you targeting?

  The U.S. Army Corps of Engineers (USACE) is conducting a feasibility study for deepening the harbor up to minus 45 feet, depending on the outcome of the feasibility study. DOT-H is sponsoring this study. The basin is currently at minus 38 feet. The 2040 Master Plan will support the USACE feasibility study by indicating the potential future ships that could call the harbor. The feasibility study is undergoing its own EIS review process. There will need to be dredging specifically associated with the fuel pier under the State's jurisdiction. A hydrographic survey has been completed.

  [Channel has a design controlling depth chart datum minus 42 feet Mean Lower Low Water (MLLW) and the Harbor Inner Basin controlling depth of chart datum minus 38 feet MLLW. Maximum vessel draft permitted is minus 36' 00" with under keel clearance of 2 feet. Additional allowance for a vessel's draft can be requested to minus 36"06" on a 1-foot rising tide.]

- What will you do with the dredge spoils?

  The first choice would be ocean disposal, if it is suitable and clean. This will require early consultations with US Environmental Protection Agency (EPA) and will need a USACE Section 103 permit application. Those spoils not suitable for ocean disposal will be disposed of at a landfill or stored onsite for reuse pending space availability.

- Many fuel tankers currently in use are expected to be taken out of service by 2040. The new tankers will be larger. Draft for new LNG ships is over 40 feet, and longer than 750 feet. When Panama Canal is widened, the new ships are expected to be wider (i.e., greater than 106 feet wide). Kalaeloa Barbers Point Harbor (KBPH) may not be able to accommodate these ships.

  This raises an interesting question of when will the harbor improvements be ready for these larger ships? Until then, users at KBPH will continue to function with vessels that are able to access under current conditions. Some of the activities may be happening at a faster rate than the harbor will be built. The 2040 Master Plan will help the USACE to support the need for basin deepening. Until then, KBPH will continue to function with vessels that are able to function under current conditions.

- There was a concern stated that widening or deepening will likely witness some pushback from the community.

Marine Life

- This area is very shallow – when you dredge, when you dig deep, you will destroy a lot of the marine life – the limu and the fish. How much are you going to destroy? You can study the Ewa Marina / Haseko report on the damage that is being done from the sand.

  The focus of this planning effort is within the harbor and not the entrance channel. USACE is conducting a separate feasibility study for widening the channel, including an EIS. The interior areas of the harbor do not contain rich marine communities like those found outside of the harbor.

Accidental Fuel Spills and Safety

- One of the concerns from the community was regarding construction of the new Fuel Pier (i.e., Piers 3 and 4) near the ocean. How are you going to be able to protect the ocean if there is a spill?

  Present fuel transfers at Piers 5 and 6 cannot occur without all of the spill protection protocols set in place. One of the steps is to have a floating boom deployed before the fuel transfer can take place. Due to harbor configuration, prevailing trade winds help to contain spills against Piers 3 and 4. The oil response boats are also at a location to trap any accidental spills before it would leak out into the ocean.

- As far as a catastrophic spill, we encourage the State to work with the hui of oil response teams. Realistically, if you had the facilities in place and the people, you would reduce the spills. But no one wants to spend the money. If the State and US Coast Guard were to force this cost on all users, it would reduce the cost for all overall. KBPH, and nowhere else in the state, mandates the use for tugs. A discussion of tug use and safety is needed. It is important to look at incorporating the best and safest technology with as big of ships that we are bringing in today, and what you are considering for the future. You need to build in these safety costs today. You don't want to have the discussion/conversation with representatives bringing in their cargo safely. If you want all business to conduct operations safely, need to plan to spend that money today, before the catastrophic event happens.

  The 2040 Master Plan will include a safety assessment reviewing tug operations, docking procedures, spill containment, and other operational safety concerns.

Surge Conditions

- Concern was expressed about surge conditions inside the harbor.

  At this point, there are no plans for reducing the surge / current conditions. There is 4,700 linear feet of wave absorbing material within KBPH. Some of the channel plans have considered construction of a groin to mitigate cross currents; however, USACE has since removed this alternative from the feasibility study. Surge mitigation is not currently part of the 2040 Master Plan.

Fuel Pier

- Is Pier 1 going to be part of the Master Plan?

  Yes, the 2040 Master Plan may consider cross connection of the Fuel Pier with Pier 1.

- HawaiiGAS currently has liquefied petroleum gas (LPG,i.e., propane) operations at Pier 1, and is requesting access to the Fuel Pier in order to continue these operations.

- There was some discussion of potential for incorporating a liquefied natural gas (LNG) terminal into the Fuel Pier. Could use Piers 3 and 4 and not use Pier 1. There is a big concern for harbor traffic, having to compete at Piers 5 and 6 with large tankers. Anytime that happens, cargo vessels are forced to hold offshore doing donuts in the ocean, waiting for the Pier. Use of Pier 1 would help with traffic until USACE comes in to widen and deepen the channel. Until then, we can't bring in certain ships, and have to go to the offshore moorings. The Fuel Pier is really important for keeping the harbor open and moving traffic.

  The anticipated volumes of dry-bulk cargo, particularly with the construction demands for cement and aggregate, will increase harbor traffic between 30 to 40% within the next 5 years. Other materials include grain and ash exports. Construction of the Fuel Pier will help in alleviating the congested berthing conditions that will arise from these dry bulk increases.

Phasing

- Do you have an idea of sequence of modifications to the Harbor?

  Implementation scenarios will be studied as part of the 2040 Master Plan. We know we can't do everything at once, and there will be a need to prioritize projects due to constrained financial resources. We will need to look at cost-benefits of each project.

Layberth

- *The project team recently performed a berthing analysis to determine how to accommodate all the different uses. The analysis found that between 18 and 20% of the activity is not cargo – it is tugs, support vessels, and idle vessels. One of the components of the 2040 Master Plan will likely recommend a layberth area be provided.*

Storage

- The harbor lacks storage for bulk cargo. We bring the products in and it goes on the shelf. All of the companies do not have enough storage capacity. The EIS should look at facilities for storage and fuel lines to their terminals. So unless we increase the storage, the harbor will only function as a transfer facility.

  Additional storage will be considered as one of the components of the 2040 Master Plan. Another component to the Plan is the land availability. If there becomes a need to store large amounts of equipment (i.e., for hurricane recovery), a large available laydown area is strongly needed, and KBPH is the only place in the State where this can happen. [The only two harbor facilities that are built to handle their receiving cargo capacity are bulk cement and liquid asphalt.]

Night Operations

- KBPH could increase pier usage with the proper lighting.

  The technology is available and will be considered. At night the depth perception is lacking.

Liquefied Natural Gas (LNG)

- Will this EIS look specifically at LNG for transfer?

  The project team will look at LNG/LPG as part of the 2040 Master Plan. Our best information has come from HawaiiGAS. We appreciate the input they have given us. DOT cannot state if LNG will be in the 2040 Master Plan for certain because the study hasn't been completed. We have to do our job, and look at the options, because there are constraints that are associated with certain fuels. We must consider that there are not any other bulk harbors in the state, and KBPH has the most shipments of fuel to the Neighbor Islands. As part of the planning effort, we are conducting a fuels demand assessment; however, it is a challenge for the fuel consultants to define the most likely scenarios. We recognize that this project is important for the State, and part of the governor's New Day Initiative, and will do our best to accommodate a balance of uses.

- Piers 1, 2, 3, and 4 may be difficult locations to site a terminal for bulk LNG. Compressed natural gas for transfer at these locations to the neighbor islands may be a more feasible option.

Fuels Scenarios

We are finalizing a comprehensive fuels demand assessment. The most likely fuels scenarios will dictate the energy demand. The challenge will be evaluating these scenarios and remaining flexible for the range of fuel types that may need to be accommodated. Demand will also change over time, for example, this analysis would have been different 15 years ago.

- You are looking at fuels and berthing?

  Yes, Amergent Techs is doing the berthing analysis, and FGE is doing the fuels demand assessment.

- I assume you are going to look at vapor control, etc.?

  Requirements for vapor recovery will be addressed in the Fuel Pier Development Plan and 2040 Harbor Master Plan.

- When harbor operations are slowed, this has a ripple effect on providing jet fuel in a timely manner, which slows the economy. The money that is being spent will be better for the state of Hawai'i. We need to realize how important the harbors are to the State, not just O'ahu.

  Yes, and there is a misperception that energy is the largest user of fuel, when jet fuel actually has the largest share.

- Even with the increase in wind electricity, Hawai'i will still need oil as a backup. We will still have the demand for oil. LNG may replace it, but there will still be a need for additional fuels. Wind energy does not produce consistent power.

  The energy market is evolving, and until all these renewable pieces come into play, Hawaii will remain very dependent on petroleum. The fuel pier still makes sense - that is why the State has embarked on this planning process. The 2040 Master Plan will consider a wide range of options.

Those Present:

A. Arnaho, T. Arnaho
Alston Hunt – B. Kaneko
Amergent Techs – W. Anonsen
BAE Systems – J. Cummings
Chevron – A. Chee, B. Liu, H. Maxie
City Council – K. Pine, J. Schaedel
Consumer Advocate – J. Ono
Department of Business Economic Development (DBEDT) – M. Glick
DOT – J Urasaki, C. Sluyter
DOT Harbors – C. Luke, B. Toba, A. Liu, D. Vo, D. Watase, S. Dale, G. Gomes
Foss Maritime – S. Merritt
Group 70 – B. Natale, J. Overton
Hawaii Gas – J. Boivin, M. Futrell, R. Sterzenbach, J. Strickler, B. Treat, T. Young
Hawaii Public Policy Advocates – P. Kaneshige
HTB/YB – M. MacDonald
Healy Tibbitts Builders, Inc. – G. Toyama
HECO – J. Hichborn, T. Kanja, T. Koyamatsu
Honolulu Fire Department – S. Lawton
Kirby Hawaii – J. Patmont
Marisco – F. Anawati, J. Stewart, M. Stewart
Pacific Shipyards – B. Nakaoka
P&M / P&R Water Taxi – S. Morita
Sause Bros., Inc. – D. Pomaikai, P. Pomaikai
Senator Gabbard's Office – R. Riggs
State Harbor Pilot – E. Enos
State House of Representative – K. Awana

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA HARBOR 2040 MASTER PLAN

Notes from Planning Workshop #2
April 3, 2014

The meeting was opened by Jadine Urasaki, Department of Transportation (DOT), Deputy Director for Projects. Carter Luke, DOT Harbors Division (DOT-H), Engineering Program Manager introduced the project team. Jeff Overton of Group 70 presented the PowerPoint presentation on proposed harbor improvements. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity after the presentation to provide input and ask questions. Below is a summary of the various topics and discussions.

HawaiiGAS Presentation
Due to the impact a proposed Liquefied Natural Gas (LNG) terminal could have at Kalaeloa Barbers Point Harbor (KBPH), HawaiiGAS was allowed the opportunity to provide a presentation at the workshop. Their presentation is posted on the above website. An LNG terminal would allow HawaiiGAS the ability to have backup LNG supply, serve the neighbor islands and potentially serve the marine industry.

LNG Import and Distribution
- Jones Act feeder ships bring LNG to the Floating Storage Regasification Unit (FSRU).
- LNG is re-gasified and travels as a gas through a pipeline to the Oahu distribution system.
- A 474-foot length overall (LOA), 8 million gallon (30,000 m^3) vessel loads LNG from the FSRU, or the West Coast, and brings it into KBPH.
- The LNG is transferred into a storage tank, where it is later transferred into ISO containers.
- ISOs are stored on land for distribution on Oahu via trucks or Neighbor Islands via barges.

Zones of Concern
- A 100-foot security zone surrounding the transfer connection prohibiting combustible activities is in effect during LNG transfer.
- A control zone of approximately 700-foot radius, centered at LNG ship transfer is needed in case of emergency. Other compatible activities (including ship transport) can continue. The United States Coast Guard (USCG) will have final determination of acceptable activities, but they have not been engaged in the conversation to date.
- Zones of concern are primarily a function of the LNG transfer pipe size and flow rate.
- Another control zone of approximately 500-foot radius will be in effect at the point of transfer from the 15 million gallon storage tank to the ISO containers. The zone of concern will vary depending on the transfer rate from the tank to the ISO containers.
- Pending further modeling and engineering, the size of the control zones is approximate. These zones may be reduced with further engineering.

Harbor / Adjacent Neighbor Compatibility
- LNG vessel activity will occur approximately every 10 days for a 48-hour period (approximately 6 days/month total time).
- Pier 3 (HawaiiGAS' preferred alternative) or Pier 9 are being considered as possible LNG terminal locations.
- HawaiiGAS will need to prepare an Environmental Impact Statement determining risks and potential impacts to neighboring Ko Olina and the H-1 freeway as well as current and proposed residential housing.
- LNG bunkering opportunities are being considered as part of the Statewide LNG fuel supply plan.

Master Plan Proposed Improvements

Piers 3 and 4
- Piers 3 and 4 will be the site of the dedicated Fuel Pier.
- Phasing of the Fuel Pier will allow the Finger Pier to remain for as long as possible.
- The T-pier at the corner of Piers 4 and 5A will remain for spill response vessels.
- Financing options for pipelines at the fuel pier are still being discussed, with the options of a consortium or private funding.

Pier 7
- The berthing schedule at Pier 7 is already tight.
- The 2040 Master Plan recommends extending Pier 7 towards Pier 8 by 325 feet.
- Hawaiian Cement received approval for a larger barge, which will come into service towards the end of 2015. This will have an impact on the berth, so expanding capability on Pier 7 is important.
- Although a firm timeline for construction has not been set, the 2040 Master Plan recommends that Pier 7 as a designated priority project to be built in the early stages within the next 10 years.
- In the interim, Hawaiian Cement may extend their pipeline, allowing the cement ships to fall back further and provide for more berthing space at Pier 6.

Pier 8
- The 2040 Master Plan recommends that Pier 8 be improved to serve as additional layberth.
- Improvements to the pier face will not extend far enough into the basin to affect the turning area within Piers 7, 8 and 9.
- Construction of layberth at Piers 8 and 9 will be phased in coordination with the Fuel Pier.
- The need for this layberth may be approaching quickly with the LNG and LPG demand in addition to activity at Piers 5 and 6.

Pier 9 and 10
- Marine support will be relocated to Piers 9 and 10 in the Alternative A, Dry Bulk Focus.
- In one of the two options in Alternative B, Energy Focus would place an LNG facility at Pier 9 next to a marine support facility at Pier 10. Healy Tibbitts currently has a yard at Pier 9 and does not do any hot work at this location, but the effects to Marisco operations need to be determined.
- Healy Tibbitts currently enjoys the convenience of loading supplies directly onto ships from their Pier 9 location. Moving their operations inland and transporting supplies by truck to ship is a possibility, but an inconvenience.

Infrastructure
- Kapolei Properties, a neighboring landowner, will develop the new Harbor Access Road depending on demand within the next 10 years. This road will meet with H-1 and replace the current Malakole Street entrance.
- A 250-foot wide drainage channel bordering the KBPH property is currently being excavated. This channel will drain 4,000 acres from upland developments.

Phasing
- The 2040 Master Plan will identify when construction activities are recommended to take place.
- Phasing will be tied to basin deepening, under United States Army Corps of Engineers (USACE) jurisdiction. If deepening and bringing in larger ships, the channel will need to be flared. A groin at the access has been ruled out.
- Although there are depth perception issues, 24-hour navigation would be helpful in harbor efficiency, requiring additional lighting and other navigational aids.
- The 2040 Master Plan will recommend that these improvements occur within the proposed 25-year time horizon.

Potential Harbor Users

Kaiuli Energy

- Kaiuli Energy is proposing Sea Water Air Conditioning (SWAC) as an alternative to traditional air conditioning. The system pulls in cold water from the ocean to a heat exchanger that cools freshwater used in the air conditioner.
- There is enough demand for SWAC at KBPH. Potential customers are nearby hotels and big box stores, as well as harbor users with central air conditioning.
- This would temporarily affect harbor operation due to the potential location of the pipeline through the harbor. Pipeline construction would involve trenching and then burying the pipe. Kaiuli doesn't want to affect the tugs in the area. Pipes would need to be timed with dredging or buried well below current harbor basin depths.
- Kaiuli would like to site their operations on approximately one acre in the Maritime Support-designated area of the harbor.

Zilkha

- Zilkha is proposing to bring in a solid fuel (wood pellets). There is no need to establish safety zones. Wood pellets have storage properties similar to coal.
- The fuel is flexible and could unload at Piers 5, 6, or 7 and then be transported to a storage facility. No further special consideration is needed.
- Ten acres of land storage would be the maximum, but could be reduced to five acres.
- Ultimately the end user would be one of the power plants, fulfilling EPA emission standards and proving less expensive than current fuels. Agreements with the utilities are ready – the timeframe for implementation is dependent upon decisions made. Short term service to the utility would transport the fuel by truck. Long term service might require a conveyance system.
- The product is coming from the U.S. and British Columbia. Millions of dead pine trees need to be removed which were killed by a beetle in Colorado up through Canada. This could supply fuel to all of Kahe power plant if necessary.

Hidden Villa Ranch

- An egg production farm will require bulk cornmeal to mix with supplements for chicken feed. Hidden Villa would like to import via KBPH but doesn't want to affect current operations. Fertilizer from this operation may be reused on Oahu.

Those Present:

Aloha Petroleum – J. Finch
Amergent Techs – W. Anonsen
DBEDT - M. Glick
DOT Harbors – S. Dale, R. Grune, A. Liu, C. Luke, B. Toba, A. Murakami, J. Urasaki, D. Vo, D. Watase, L. Williams
DOT Statewide Transportation Office - M. McLaurin, A. Setogawa
Facts Global Energy - S. Wee
GMP / KCR - J. Littenberg
Group 70 – B. Natale, J. Overton
Hawaii Gas – J. Boivin, R. DeGarmo, B. Treat, T. Young
Hawaii Pilots Association – S. Brown
Hawaiian Cement – J. Gomes
Healy Tibbitts Builders, Inc. – D. Masumoto
HECO – J. Arakaki, C. Barnes, T. Koyamatsu
James Campbell Co. - S. Kelly
Kaiuli Energy - D. Nakamoto
Marine Cargo Surveys of Hawaii – R. Lund
Oahu Gas Service – B. Kawano
P & R Water Taxi / P & M Marine - S. Morita
PENCO/AMC – D. Carter
Petrospect – D. Harrington
Sause Bros., Inc. – P. Pomaikai, D. Won
Tesoro Hawaii – L. Tanaka
Transmarine – S. Lambert
USACE - M. Yoshimoto
USCG – C. Petersen, B. Marhoffer, S. Whaley
Wespac Midstream – B. Thompson
Zilkha - T. Tolkinen

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA HARBOR FUEL PIER DEVELOPMENT PLAN

Notes from Planning Workshop #2
April 3, 2014

The meeting was opened by Carter Luke, DOT Harbors Division (DOT-H), Engineering Program Manager. Jeff Overton of Group 70 presented the PowerPoint presentation on proposed Fuel Pier improvements. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity after the presentation to provide input and ask questions. Below is a summary of the various topics and discussions. DOT-H and Group 70 responses where included are *italicized.*

Fuel Forecast

- Do the vessel forecasts (slide 12 in presentation) include Liquefied Natural Gas (LNG) ships? Offshore moorings access for refined fuels import will also change these numbers.

  No, this vessel forecast does not include the number of ships that will come in to unload at an LNG terminal. These calculations will be reviewed and updated.

Alternative Pier Designs

It is a balancing act for DOT-H to try to design the project with funding constraints. By understanding what options are best for operations and other considerations, DOT-H can have a better idea of what to look out for when reviewing the design.

Alternative A: Segmented Pier Design

- This configuration has been done in Alaska and elsewhere, and is not uncommon.
- It seems that the choice for having a segmented pier is driven by its low cost. Prevailing tradewinds will be pushing the ship into the pier. Has the mass of fuel ships and side loads been considered in this design? With a segmented pier, the lateral forces are not distributed evenly. A 750-foot length overall (LOA) ship coming up to a segmented pier may displace the whole pier. Wouldn't there need to be as many piles in this configuration as a continuous pier?
- Hoses laid all over the pier may be a problem, as space will be at a premium. Stevedores need to know that the pier design will work functionally and operationally.

  This is a 20% design, but these details will need to be fleshed out.

- Sustaining the weight of the ship is one thing, but allowing the ship flexible berthing also helps. If you build the whole pier at once and place all the manifolds at once, it would be more accommodating.

  The need for phasing of the fuel pier is being analyzed.

- Allowing the ship to take on provisions at one place instead of going to another pier would be beneficial to shippers. What about accommodating larger vehicles on the segmented pier, in the case of offloading an 18-wheeler and using forklifts?

  The design incorporates the turning radius of trucks and other factors of forklift operation, but other larger vehicles have not been considered. Designing the pier to accommodate a large vehicle like an 18-wheeler would compromise some of the inherent features of a fuel pier, making the pier operationally unusable for its design characteristics.

Alternative C: Continuous Sheet Pile Bulkhead

- The surge in the winter months is excessive. If a bulkhead system is installed, it could increase surge within the harbor. This should be reviewed. Piles are preferred, allowing for surge to be attenuated under the pier and on the revetment.
- It would depend on whether the pier was built strictly for a fuel pier or not. Eventually there may be overflow of dry goods (i.e., if other piers are being fixed, etc). If so, then a backfilled pier (i.e., continuous sheetpile pier) would offer the most flexibility.

  To design the fuel pier as a multi-purpose pier to accommodate dry bulk / break-bulk cargo vessels is not practicable as the jetty does not have sufficient yard area to support this type of activity. The use of the fuel pier with the presence of an LNG (or LPG) terminal further compounds its infeasibility. We feel the expansion of the linear feet of Pier 7 (extending an additional 325 feet) coupled with the increased access of Piers 5 and 6 for dry bulk / break-bulk cargo vessels provides sufficient cargo handling areas that will be available to meet future demand.

Infrastructure

Pier Construction

- The Fuel Pier will have approximately the same elevation as the other piers in KBPH.
- Do we know the composition of the harbor floor? If it is solid coral, the piles will be able to support better than if there is soft material. Otherwise, the piles would not be able to hold up a ship.

  Yes, the bed of the harbor is solid coral.

Pipelines

- Above-ground racks to secure the pipelines to are preferred to underground galleries. Because a gallery is an enclosed space, it would require a chemist each time it is accessed to determine the safety. Europe has raised steel platforms supporting pipelines on either side.
- It would be advantageous for potential Fuel Pier users to talk with DOT and determine their needs.

  Group 70 has met with most groups and will need to meet with them again for additional details.

- Will pipelines tie into the refineries?

  Yes, pipelines will be needed for exports and trans-shipments of fuels to Neighbor Islands.

Loading Arms vs. Hoses

- Loading arms restrict pier operations because of their fixed nature, unlike hoses. Just like a segmented pier, the fixed loading arms restrict the ship docking flexibility.

Fire Suppression

- Anything on land that is intended to shoot water onto a ship will need to account for the 25-30 knot prevailing tradewinds in KBPH.

Spill Response

- Spill response will need to have storage on land like they do now.

  Storage will be included in Fuel Pier concept plan.

Impact

- There are 58 corals across the US proposed for candidate species, and 30 in Hawaii. This may make construction of the pier difficult.

  Initial studies have indicated a limited number of corals with one candidate species in the vicinity.

Pipeline Ownership / Financing

- The Port Authority of Guam has shared ownership of lines with fuel companies. This has become a bit of a contractual nightmare when looking at upgrading 60 year old lines.

  DOT-H will not retain ownership of any fuel lines.

- Will the pipelines be a part of the proposed action of the Environmental Impact Statement (EIS)?

  Yes, the pipelines will be part of the proposed action in the EIS. DOT-H will not provide pipelines, but will look at putting in what is needed to support the pier users. The number of pipelines that will be needed has not been determined at this time – this will occur in the future when more detailed plans are made. Proposed actions of pipeline users will not be incorporated into the EIS.

.

Master Plan Related Comments

Piers 9 & 10

- Pier 10 with a dry dock is possible, but downwind of LNG is not preferred. If ship repair was located upwind of LNG, there would be much less of a problem for hot work, sources of ignition and sandblasting activities. Even with lunch trucks there will be open flame.

  Yes, but the operating range is a 100-foot radius zone for all hot work activities and possible sources of ignition. The 700-foot safety zone is just for planning and control purposes to shut down operations and/or evacuate if there is a spill or leak. Also depending on the authority having jurisdiction, it is possible that no non-facility structures could be constructed within this zone, i.e., no churches or schools. The 700-foot radius control zone is contingent on the size of the pipe and the flow rate, i.e., smaller pipe, smaller zone, but longer unloading time.

- By berthing an LNG ship at Pier 9 instead of Pier 10, there would be an impact every ten days for about two days or about six days per month in an extended control zone with a 700-foot radius. This zone would be larger than the 500-foot radius of the control zone created by filling the ISO containers. That smaller zone, however, would be in effect continually as the ISO filling would be continual, and would restrict some neighboring activity on a daily basis.
- Would the LNG facility conduct LNG bunkering activities from the pier as well?

  HawaiiGAS would not offer bunkering from the fuel pier, as current practice is for a fuel barge to bunker the ships while they are parked at a pier. An ISO container bunker barge will fuel the ships with LNG and the ISO containers could be filled at the pier or moved to another pier and be transferred onto the bunker barge.

- An LNG barge will supply KBPH with LNG six days per month from the Floating Storage Regasification Unit (FSRU). Where will it go the other 24 days per month?

  HawaiiGAS – Shipping logistics are still in the preliminary stage and we are reviewing multiple options depending on the timing, volume, number of ships, and infrastructure size. However, one option is to have one of the feeder ships bringing LNG from the Mainland to come straight into KBPH and unload its cargo directly into the LNG storage tank, instead of at the FSRU. This would keep that vessel dedicated to delivering gas straight into land-based storage.

- Will LNG occur within the next seven to nine years? If/when Marisco is moved, will the pier be developed for them to continue operations?

  Introduction of LNG in large quantities is moving at a rapid pace. The 2040 Master Plan will determine the timing of the projects based on need and financial availability.

- If extending Pier 7, might as well construct Piers 8 and 9 all at the same time.
- The Pier 9 area is in need of electricity.

Dredging

- DOT-H is working with USACE regarding future dredging. The new Fuel Pier will accommodate a 45-foot draft instead of the current 38 feet. Ships are currently not fully loaded, and there will probably be an interim phase of light loads at the Fuel Pier until the harbor is dredged.
- The dry dock will need to have further dredging to accommodate its size.

Lighting

- When will there be lighting in the harbor for 24-hour navigation?

  This has not yet been determined. Lighting for the 24-hour navigation ability is under the jurisdiction of DOT-H and navigational aids under the jurisdiction of USCG.

Those Present:

Aloha Petroleum – D. Belknap, J. Finch
Amergent Techs – W. Anonsen
Dalian Inteh Group Co. Ltd. – V. Yu
DBEDT - M. Glick
DOT Harbors – S. Dale, C. Luke, B. Toba, A. Murakami, D. Vo, D. Watase
DOT Statewide Transportation Office - M. McLaurin, A. Setogawa
Facts Global Energy - S. Wee
Foss Maritime Co. - M. MacDonald
Group 70 – B. Natale, J. Overton
Hawaii Gas –R. DeGarmo, B. Treat
Hawaii Independent Energy – D. Richards, R. Rivas, L. Tanaka
Hawaii Pilots Association – E. Enos
Healy Tibbitts Builders, Inc. – D. Masumoto
HECO – J. Arakaki
Kirby / GM - M. Lewis
Marisco - F. Anawati, M. Stewart
Mid Pac Petroleum - R. Whang
PENCO/AMC – D. Carter
Tesoro Hawaii – L. Tanaka
USCG – B. Marhoffer
Wespac Midstream – B. Thompson
Zilkha - T. Tolkinen

STATE DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION

79 South Nimitz Highway • Honolulu, HI 96813

KALAELOA BARBERS POINT HARBOR FUEL PIER AND HARBOR IMPROVEMENTS EIS AND 2040 MASTER PLAN

Notes from Public Meeting #2
October 13, 2014

The meeting was opened by Mr. Ford Fuchigami, Interim Director of Department of Transportation (DOT). Mr. Randy Grune, Deputy Director of DOT Harbors Division (DOT-H), briefly described the importance of Kalaeloa Barbers Point Harbor (KBPH) and the collaborative process undertaken for the *KBPH 2040 Master Plan* and *KBPH Fuel Pier and Harbor Improvements Environmental Impact Statement* (EIS) efforts. Mr. Carter Luke, Engineering Program Manager of DOT-H, introduced the project team and elaborated on the efforts to gather information from harbor users and the public throughout the process to date. He also noted DOT-H is enterprising and independent of the Hawaii State Government's general fund, wholly dependent on revenues generated by relevant user fees. Mr. Jeff Overton, Principal of Group 70, presented the power point presentation on the EIS and the *2040 Master Plan*. The presentation is posted on the following website: http://kalaeloaharbor2040.com. Meeting participants were given the opportunity during and after the presentation to provide input and ask questions.

Below is a summary of the various topics and the discussions. DOT-H and Group 70 responses where included are *italicized.*

Fuel Pier and Harbor Improvements EIS

Dredging at the Fuel Pier

- There is a need for dredging at Piers 3 and 4 to allow for larger tankers to come in.

  A hydrographic study was completed and volume calculations estimate approximately 580 cubic yards of sediment will need to be dredged in the area outside of the Federal Project Line. This will be maintenance dredging, but any increase beyond the minus 38 feet will be new, 'virgin' dredging. The Piers 3 and 4 structures (e.g., pilings or sheet piles) will be designed and built to accommodate a minus 45 feet design depth to accommodate the future deepening project. The U.S. Army Corps of Engineers (USACE) will be dredging the remainder of the harbor basin and the entrance channel once the Feasibility Study is complete and federal funds are available to complete the design and construction phases.

Liquefied Natural Gas (LNG)

- Does this EIS preclude a bulk LNG storage facility from being built?

  No, the EISPN determination at this time does not preclude an applicant from seeking to develop bulk LNG at KBPH. LNG may be considered at such time that there is enough information to evaluate the feasibility, proposed land requirements, operational needs, and specific impacts on other users within KBPH.

- Are LNG International Standards Organization (ISO) containers being reviewed in the EIS?

  ISO containers would be considered as containerized cargo at Piers 5 and 6, and are not part of the EIS proposed action. Environmental review for ISO containers activity would need to be undertaken by an applicant seeking to lease land at KBPH for storage.

Public Access

- Will the boat ramp be cut off from public access?

  No, the restricted access will just be for entry to the Fuel Terminal (i.e., the Piers 1, 3 and 4 area). The current access to the ramp is through the Phoenician lease area and is assumed to remain unaffected at this time.

Accidental Fuel Spill

- In the event of an accidental spill at the Fuel Pier, how would you contain it, and would you have containment material on site? You have the Ko Olina Marina and the open ocean. You have two cross currents not too far offshore – one heading 'Ewa, and the other heading Diamond Head.

  Yes, by law, spill response organizations are already at KBPH. Each vessel licensed to carry fuel is required to prevent spills and to rapidly respond to any spills. Oil spill response equipment and personnel are staged at KBPH during fuel transfers as back-up. Coverage outside of the harbor has not been conducted as the scope is focused on containment within the harbor.

  At present, there is an absorbent boom mounted within the piling system under Piers 5 and 6, and U.S. Coast Guard regulations for the commercial harbors require vessels be encircled by absorbent booms prior to fuel transfer. A boom would be put across the opening of the harbor entrance in the event of a spill. One advantage to the Fuel Pier at this location is that the harbor configuration in prevailing trade winds would push spills against Piers 3 and 4. Spill response boats within KBPH would quickly respond to trap any accidental spills before spreading out into the ocean.

<u>2040 Master Plan</u>

Roadways and Access

- It is highly urged to open up the Kalaeloa Harbor Access Road as soon as possible, and should coincide with the building of the Fuel Pier. Right now, Sause Bros imports between five and ten tons of cargo every month. This translates to a significant number of trucks on the road. DOT did a good job on Kapolei Highway that links Campbell to KBPH. Traffic from North / South Road (Kualakai) has increased. This new access road will help with emergency response if something happens at Malakole Road.

  The timing for the construction of Kalaeloa Harbor Access Road will depend upon the development of neighboring Kapolei Harborside.

- Wasn't there an overall master plan for the area to have a road out to Honokai Hale?

  There was a road planned for Kapolei West, but it did not tie in to relieving harbor traffic.

- The controlled access near the new harbor entrance would not work very well for those that have to go in every day to access Maritime Support Services.

  This controlled access could be moved further south and S-7 cargo yard fenced in to allow for uninterrupted access to daily users.

Master Plan Projects Phasing

- When will some of these projects occur? It seems like the access road is important, and some of these projects are tied in to other processes. If the Fuel Pier is initiated, utilities will need to be installed.

  Initial projects that the 2040 Master Plan will recommend includes the installation of electric and water utilities in the Pier 9 / Maritime Support Services Area. This will prepare the site for the Marisco move from their current location at Pier 3 to the new location at Pier 9. During this time design of the Fuel Pier will take place. Appropriations have been requested to start the design of the Fuel Pier in fiscal year 2016. The 2040 Master Plan will recommend the installation of a bollard at Pier 6 and the extension of Pier 7 and its associated cargo yard to occur within the next five years. Construction of Kalaeloa Harbor Access Road will be dependent on the development of neighboring Kapolei Harborside.

Liquid Bulk at Piers 5 and 6

- Will Piers 5 and 6 no longer be available for fuel transfer use?

  Piers 5 and 6 will be available as a backup fueling berth to Piers 3 and 4 as long as the pipelines are maintained. This will also allow for redundancy and ensure the security of fuel supply.

- Sause Bros. contends with the fuel tankers that are at Pier 5, and are getting squeezed by berthing space and time. The Fuel Pier will help to relieve this pressure.

Harbor Dredging

- Will planning for the Fuel Pier re-engage the harbor dredge study that was previously initiated? How long will the process take, and will this affect the Fuel Pier? If fuel companies lean on Congress, will it help the USACE to progress on the study?

  Yes, the Feasibility Study for the deepening of the harbor will restart. The USACE has to complete the Study within three years per new requirements. This Study is independent of the Fuel Pier and will not affect construction schedule of it. One thing industry can do to support the process is to respond to upcoming requests from USACE for specific information in a timely manner.

Those Present:

A and B Electric – M. Barcurle, Jr.
Aloha Petroleum – J. Finch
Alston Hunt Floyed & Ing – B. Kaneko
Amergent Techs – W. Anonsen
AmeriGas – B. Kawano
Campbell Companies – S. Kelly
City and County of Honolulu, Department of Planning and Permitting – G. Atta
Clean Islands Council – K. Beasley
Councilmember Pine's Office – K. Polk
Grace Pacific – J. Shacat
Hawaii Army National Guard – A. Kieran-Vast
Hawaii Fire Department – J. Pacheco
Hawaii Independent Energy – J. Hibner, L. Tanaka
Hawaii Pilots Association – S. Brown, E. Enos
Hawaiian Cement – J. Gomes
HawaiiGas – J. Boivin
HDR, Inc. – G. Haraguchi, K. Komatsubara
Healy Tibbitts – C. Hutchinson
Kanehili – P.K. Pomaikai
Ko Olina Marina – D. Everson
Ko Olina Resort – K. Vasquez
Marisco – F. Anawati, M. Anawati, J. Stewart, M. Stewart
Resident – G. Gomes, L. Leonardi, D. Pomaikai
Road & Highway Builders – M. Mooney
State of Hawaii, Department of Business Economic Development – L. Viray
State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources – P. Murakawa
State of Hawaii, Department of Transportation (DOT) – F. Fuchigami
State of Hawaii, DOT, Harbors Division – R. Grune, C. Luke, B. Toba, D. Watase, S. Dale, S. Rossetter, D. Vo
State of Hawaii, House of Representatives – K. Awana
State of Hawaii, Public Utilities Commission – M. Tome
U.S. Army Corps of Engineers – M. Yoshimoto
U.S. Department of Homeland Security – R. Mitchem
Villa Rose – D. Lawson
Wespac – B. Thompson
Zilkha – T. Tolkinen

Appendix B

Fuels Market in Hawaii:
Current Situation and Future Prospects
(Facts Global Energy)

Fuels Market in Hawaii:

Current Situation and Future Prospects

Submitted to

Department of Transportation, State of Hawaii

Revised March 2014

Table of Contents

1. Fuels Market in Hawaii 7

1.1. Energy Overview 7

1.2. Current and Historical Petroleum Product Demand 15

1.2.1. Gasoline 18

1.2.2. Jet Fuel 19

1.2.3. Diesel Fuel 20

1.2.4. Fuel Oil 22

1.2.5. Other Oil Products 25

1.3. Fuels for Electric Power 28

1.4. Main Oil Supply Infrastructure 31

1.4.1. Oahu Oil Ports 31

1.4.2. Main Pipeline Connections 33

1.4.3. Bulk Product Storage 37

1.4.4. The Refineries 43

1.4.5. The Chevron Refinery 54

1.4.6. The HIE Refinery 58

1.5. Oil Product Trade 62

1.6. Concluding Remarks 65

2. Fuels Demand in the Future 66

2.1. The Hawaii Clean Energy Initiative (HCEI) and the Renewable Portfolio Standard (RPS) 66

2.2. Scenarios of HCEI Effectiveness 67

2.2.1. Scenario 1: Business-As-Usual 68

2.2.2. Scenario 2: RPS Falls Short 68

2.2.3. Scenario 3: RPS Succeeds 69

2.2.4. Scenario 4: HCEI Mostly Succeeds 69

2.2.5. Summary 69

2.3. LNG Imports 69

2.3.1. Offshore versus Onshore/Nearshore 69

2.3.2. Stepwise Analysis 71

2.3.3. LNG Assumptions 71

2.4. Other Key Assumptions ... 72
2.4.1. Power Sector Fuels ... 72
2.4.2. IMO/MARPOL Standards ... 73
2.5. Demand Results From the Scenarios ... 74
2.6. Implications for Product Imports ... 76
2.6.1. Projected Output Patterns of the Refineries ... 76
2.6.2. Imports: Refinery Operation Cases ... 79
2.6.3. General Implications ... 82
2.6.4. Implications for KBPH ... 85
2.6.5. Quantification of Uncertainties: Specific Scenarios ... 87
3. Overall Energy Demand: Implications for the Environment ... 104
3.1. Outlook for Energy Demand of All Fuels by 2020 and 2030 ... 104
3.1.1. Current and Historical Energy Demand ... 104
3.1.2. Energy Demand Outlook ... 107
3.2. Implications for the Environment ... 109
3.2.1. GHG Emissions Reduction Goals ... 109
3.2.2. Other Environmental Regulations and Compliance ... 112
3.2.3. Emissions Outlook ... 117
3.3. Concluding Remarks ... 120

Table of Figures

Figure 1: Primary Energy Sources, US vs. Hawaii (1990 and 2011) ... 8
Figure 2: Per-Capita Primary Energy Demand, US vs. Hawaii (mmBtu/capita) ... 9
Figure 3: Per-Capita Primary Energy Demand by Type and Source (mmBtu/capita) ... 10
Figure 4: Hawaii's Sources of Crude Oil, 1989 and 2012 (% of total) ... 11
Figure 5: Hawaii and US Shares of Fuels in Final Energy ... 12
Figure 6: Final Energy Per Capita, Hawaii and US Average (mmBtu/capita) ... 13
Figure 7: Final Energy Use Shares by Sector, 2011 ... 14
Figure 8: Hawaii Oil-Product Demand Shares, 2011 (vol %) ... 15
Figure 9: Hawaii Oil-Product Demand by End-Use, 2011 (vol %) ... 16
Figure 10: Hawaii Oil-Product Demand, 1980-2012 (kb/d) ... 17
Figure 11: Hawaii's Gasoline Demand, 2006-2012 (kb/d) ... 18
Figure 12: Hawaii's Jet Fuel Demand, 2006-2012 (kb/d) ... 19
Figure 13: Hawaii's Diesel Demand by Sector, 2011 ... 21
Figure 14: Hawaii's Diesel Demand, 2006-2012 (kb/d) ... 22
Figure 15: US West Coast Fuel Oil Demand in Electric Power, 1960-2011 (kb/d) ... 23
Figure 16: Hawaii's Fuel Oil Demand, 2006-2012 (kb/d) ... 24
Figure 17: Hawaii's Demand for "Other" Oil Products, 2006-2012 (kb/d) ... 28
Figure 18: Hawaii's Power Generation by Source, 2006-2012 (GWh) ... 29
Figure 19: Oil Demand in the Power Sector by Fuel and Location, 2006-2012 (kb/d) ... 30
Figure 20: Simplified Schematic of Pipeline and Tankage Connections ... 34
Figure 21: Main Pipeline Connectivities Between Ports—Clean Products ... 35
Figure 22: Main Pipeline Connectivities Between Ports—Black Products ... 36
Figure 23: HIE Refinery Storage Capacity ... 40
Figure 24: HIE Storage Capacities on Neighbor Islands ... 40

Figure 25: Chevron's Main Storage Capacities 41
Figure 26: Other Major Storage Capacities on Oahu 42
Figure 27: Main Oahu Oil Storage Capacities and Days of Supply 43
Figure 28: Straight-run Yields of Crudes Commonly Refined in Hawaii 44
Figure 29: Sulfur Distribution in Two 33/34 API Crude Oils 46
Figure 30: Generic Refinery Flows 47
Figure 31: Size of Selected Refining Industries, Asia and US West Coast (kb/cd) 48
Figure 32: Uplift Indices: Uplift Capacity Compared to Crude Distillation 49
Figure 33: Sources of Hawaii's Crude Imports, 2012 (kb/d) 51
Figure 34: Tesoro Gross Refining Margins, 2010-2012 ($/barrel) 52
Figure 35: Configuration of Hawaii's Refineries (kb/cd) 54
Figure 36: Chevron Hawaii Crude Capacity versus Crude Imports, 2006-2012 (kb/d) 55
Figure 37: Simplified Diagram of Chevron's Downstream Processing Flow 56
Figure 38: Typical Chevron Output, kb/d (estimated) 57
Figure 39: Tesoro Hawaii Refinery Crude Runs versus Capacity, 2006-2012 (kb/d) 59
Figure 40: Simplified Diagram of HIE's Downstream Processing Flow 60
Figure 41: Tesoro Output by Product Group, 2006-2012 (kb/d) 61
Figure 42: Jet Fuel Imports, 2006-2012 (kb/d) 63
Figure 43: Estimated Ethanol Imports by Source, 2006-2012 (kb/d) 64
Figure 44: Underlying Power Demand Forecast (No Conservation), GWh 67
Figure 45: Key Statewide Parameters for HCEI Scenarios in 2030 69
Figure 46: Oil Product Demand in 2030 Under the 8 Scenarios (kb/d) 74
Figure 47: Oahu Total Oil Demand in the 8 Scenarios, 2010-2040 (kb/d) 75
Figure 48: Neighbor Island Total Oil Demand under the 8 Scenarios, 2010-2040 (kb/d) 76
Figure 49: Hawaii's Refineries: Typical and Lighter-Slate Outputs at Higher Utilization (kb/d) 78

Figure 50: Product Import Scenarios (Typical Output Slates), (kb/d) 80
Figure 51: Inferred Product Exports, 'Both Refineries', kb/d 81
Figure 52: Hawaii Energy Demand, 1980 – 2011 (tbtu) 104
Figure 53: US Energy Demand, 1980 – 2011 (tbtu) 105
Figure 54: Hawaii Energy Demand by Source by Sector, 2011 (tbtu) 106
Figure 55: State Energy Demand by Source, 2020 and 2030 (tbtu) 108
Figure 56: Hawaii GHG Emissions Profile by Sector, 1990 and 2007 (mmtCO_2e) 110
Figure 57: Hawaii GHG Emissions Profile by Gas, 1990 and 2007 (mmtCO_2e) 111
Figure 58: Hawaii Direct CO_2 Emissions by Sector from Large Facilities, 2011 112
Figure 59: Hawaii Sulfur Dioxide Emissions by Source, 2008 (metric tons) 113
Figure 60: Hawaii Nitrogen Oxides Emissions by Source, 2008 (metric tons) 114
Figure 61: Hawaii PM Emissions by Source, 2008 (metric tons) 115
Figure 62: NAAQS Summary of Selected Pollutants 115
Figure 63: Change in CO_2 Emissions relative to 2011 (%) 117
Figure 64: Change in SO_2 Emissions relative to 2011 (%) 119

1. Fuels Market in Hawaii

1.1. Energy Overview

It is often said that Hawaii is the most fossil-fuel-dependent state in the US. Depending on how the issue is defined, this may or may not be correct. States like North Dakota both use and produce more fossil fuels per capita, or as a percent of energy supply, than Hawaii.

In truth, such hair splitting metrics are unimportant. Hawaii is unique among US states in that almost all of its energy is imported from foreign sources. Hawaii has very little access to primary energy apart from foreign imports.

'Primary energy' includes all energy inputs—including the energy used to make other energy. Primary energy includes crude oil, coal, natural gas, nuclear energy, the heat generated from burning biomass, the energy contained in hydropower or wind, the heat captured by solar water heaters, etc.

Electricity, on the other hand, is a secondary energy source, which is generated from primary energy. Oil products such as gasoline, jet fuel, or diesel, are also secondary energy sources, as they are made from crude oil.

Hawaii's primary energy demand pattern is dramatically different from the pattern seen in the US as a whole. The figure below shows the shares of primary energy provided by different energy sources in Hawaii and the US for 1990 and 2011.

In 1990, oil was about 40% of total primary energy demand, while in Hawaii oil was an amazing 91% of primary energy.

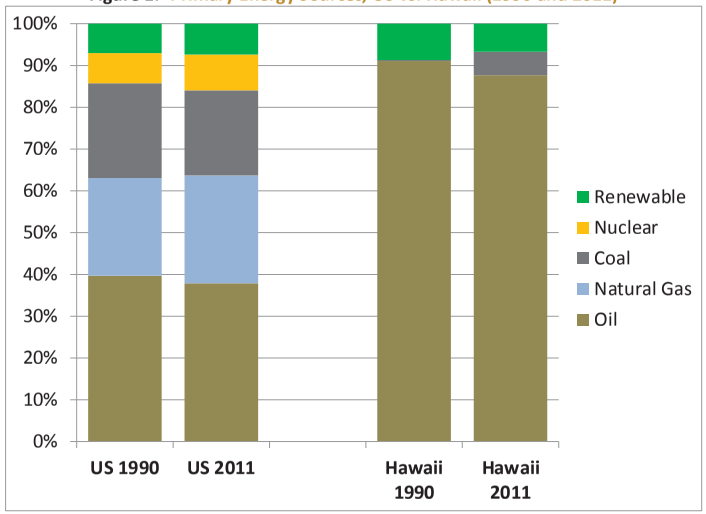
By 2011, oil's share of primary energy supply had fallen in both the US (38%) and Hawaii (88%). In the US overall, this was largely the result of increased use of natural gas, which pushed down reliance on both oil and on coal.

By contrast, in Hawaii the big change was the introduction of large-scale coal use at the AES power plant on Oahu.

It is surprising to note that renewable energy's share of total consumption in Hawaii actually dropped between 1990 and 2011. In fact, absolute consumption of renewable energy in Hawaii

dropped by nearly a third in this period—largely owing to the contraction of Hawaii's agricultural sector, which used a large amount of renewable agricultural waste (notably bagasse) as an energy source.

Figure 1: Primary Energy Sources, US vs. Hawaii (1990 and 2011)

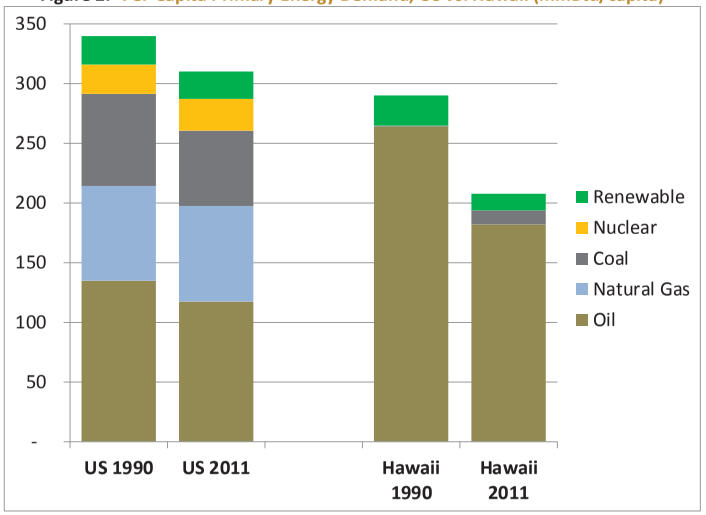


If we add up the fossil fuels (oil, natural gas, and coal), it is clear that Hawaii's percent reliance on fossil fuels is somewhat above the national average (84% fossil fuels in the US total, 93% in Hawaii).

However, working solely with percentages masks some important facts. While the share of fossil fuels in Hawaii's overall primary energy supply is considerably higher than the US average, the average use of primary energy per person is far higher in the US than in Hawaii.

This is shown clearly in the figure below, which shows use of energy by source per person. In 2011, the US used about 310 mmBtu per person, while Hawaii used only 208 mmBtu/person. (For reference, these correspond to the energy of about 53 barrels of oil per person for the US average, and 36 for Hawaii.)

Figure 2: Per-Capita Primary Energy Demand, US vs. Hawaii (mmBtu/capita)



There are many reasons that Hawaii uses less energy per capita than the US average. Space heating in Hawaii is nearly non-existent, and air conditioning is less common than on the mainland. Heavy industry and manufacturing, which tend to be energy-intensive, are more important on the mainland but relatively minor in Hawaii. Moreover, energy on average is far more expensive in Hawaii, giving stronger incentives to conserve.

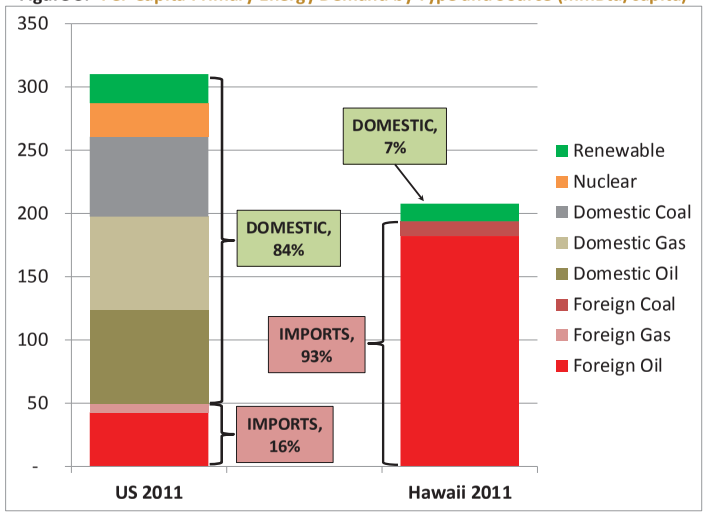
It is worth noting that Hawaii does not have the lowest per-capita consumption among US states. Several highly urbanized states—California, New York, Connecticut, and Rhode Island—have similar per capita consumption levels. States with highly energy-intensive industries and small populations, such as Wyoming, Louisiana, and Alaska, top the list, using more than four times as much primary energy per capita as Hawaii.

It is interesting to see that energy use per capita has fallen across these two decades—and fallen most strongly in Hawaii (a 9% drop in the US average versus a 28% drop in Hawaii). Some of this substantial decline is undoubtedly due to conservation (both policy and price-induced), but some of it is also due to curtailment of energy-intensive activities in Hawaii. (The drop in

renewable energy supply, as mentioned before, is largely due to the decline in plantation-style agriculture.)

Perhaps a more useful way to characterize the problem is by looking at the geographical sources of the energy supply. As the figure below shows, the US as a whole imports only about 16% of its energy supply (figured on a net basis). In Hawaii, the share of imports is 93%.

Figure 3: Per-Capita Primary Energy Demand by Type and Source (mmBtu/capita)



In both cases, the bulk of the imported energy is oil, but in the US today imported oil is a small fraction of the total; in Hawaii, it is the dominant energy source. (It should be noted that both Hawaii and the US as a whole do import some volumes of renewable energy, notably ethanol, but the volumes are too small to show on this graph.)

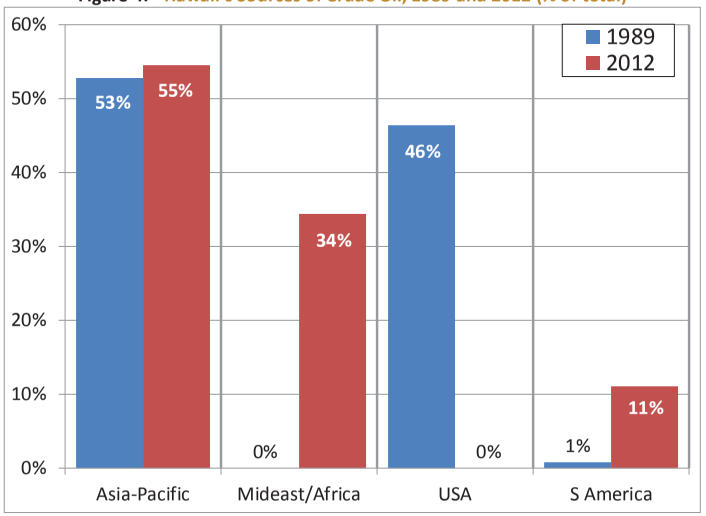
Some people are surprised to discover that Hawaii's energy imports are virtually all from foreign sources. In the case of coal, sulfur is a major determining factor, and coal imports generally arrive on term contracts from Indonesia and Australia.

Although occasionally some volumes of finished oil products are imported from the US mainland, US crude oil has virtually vanished from the crude diet. As the figure below shows, US

crudes—mainly Alaskan North Slope crude (ANS)—were once about half of the total crude supply to Hawaii.

The situation changed rapidly in the 1990s. In the 1970s and 1980s, there was a large surplus of ANS on the market. Even after US West Coast markets (including Hawaii) had been served, there was still so much crude that cargoes were shipped all the way to the US Gulf Coast and Caribbean via Cape Horn—a long and expensive voyage. But ANS production dwindled, and the 'surplus' vanished.

Figure 4: Hawaii's Sources of Crude Oil, 1989 and 2012 (% of total)



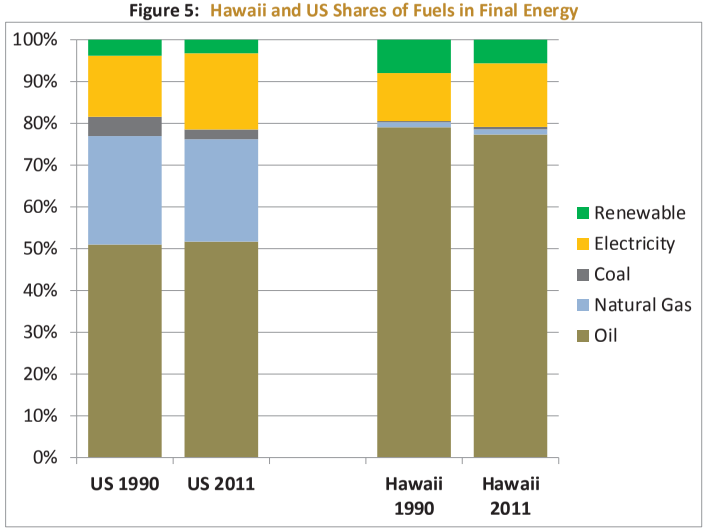
Perhaps even more important, environmental specifications began to change across the US, including in Hawaii. ANS produces fuel oil of about 1.8% sulfur, as compared to the 0.5% sulfur LSFO now used on Oahu. As will be discussed in the section on refining, for many good reasons the Hawaiian refineries did not make the kinds of investments most US West Coast refiners made; but tightening sulfur specifications made them increasingly dependent on imports of low-sulfur crudes.

Although the US does produce low-sulfur ('sweet') crudes, most of them are produced on the Gulf Coast and in the Great Plains. US West Coast (and most Canadian crudes) are largely heavy, high-sulfur crudes than cannot be processed in Hawaii's refineries. The quest for low-sulfur crudes has taken the purchasing patterns of Hawaii's refiners far afield: substantial volumes are now imported from as far as Argentina and West Africa.

Thus, Hawaii's crude imports are virtually all low-sulfur crudes—the least common and most expensive sorts of crude. Add in long sea voyages that stretch to the South Atlantic and Hawaii ends up with one of the most expensive crude slates on the planet.

Up to this point, we have focused on primary energy. The overall picture does not change much if we consider final energy, the energy used by ultimate customers (excluding transformation industries such as power generation).

Figure 5: Hawaii and US Shares of Fuels in Final Energy



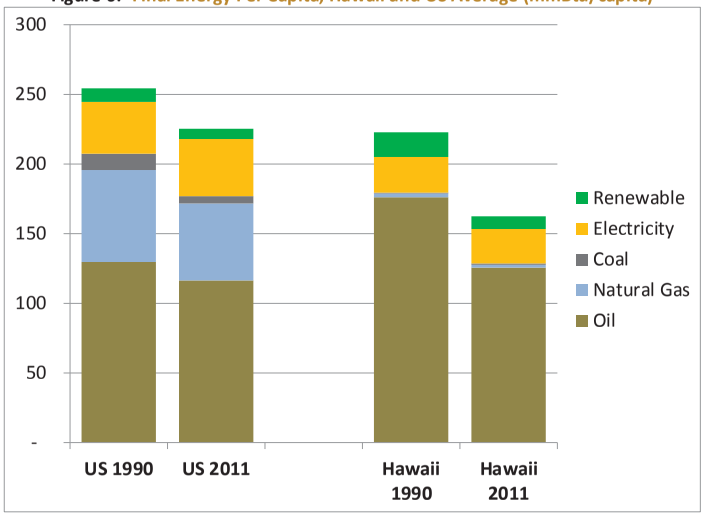
Hawaii's share of oil in final energy is much higher than the US average—but the total fossil-fuel shares in end-use energy are quite similar. The difference is that Hawaii end-users consume very little coal or natural gas, and this share is made up for by oil. (The small amount of natural

gas consumed in Hawaii is not in fact natural gas at all, but SNG—synthetic natural gas—manufactured from oil products.)

As with primary energy, looking at shares of demand demonstrates one kind of point, but masks others. For completeness, it is worth looking at comparative per-capita final energy. In terms of energy used by final consumers (as opposed to utilities or other energy enterprises), the results are rather surprising.

In 2011, the per capita demand for oil by final users is only about 8% higher than the national average. The much higher consumption of oil per capita in Hawaii compared to the US average is largely at the level of primary energy demand, and the difference is largely explained by the large volume of oil used to generate electric power.

Figure 6: Final Energy Per Capita, Hawaii and US Average (mmBtu/capita)



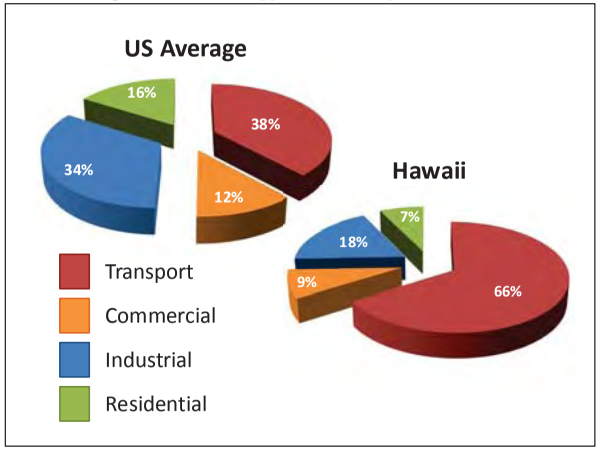
Hawaii's electricity demand per capita is lower than the US average. Much of this can be explained by the lower use of air conditioning, but the fact that Hawaii's electricity prices are the highest in the nation also plays a role.

At the end-use level, Hawaii uses more renewable energy than the national average. In earlier years, this reflected a higher use of biomass for direct heat, but it has recently been supplemented with a rapid growth in solar water heating.

Hawaii's final energy demand also differs in terms of which sectors consume the energy. There are many different ways of calculating sectoral energy use, which yield somewhat different results. The numbers used here are EIA's sectoral consumption excluding electrical line losses.

As the figure shows, the two biggest sectors in both Hawaii and the US at large are Transport and Industrial—but the proportions are quite different. Transport is 38% of US average demand, but two-thirds (66%) of demand in Hawaii. As might be expected, Industrial use is much more important on the US mainland. (Refinery energy use is a significant portion of Industrial use in Hawaii.

Figure 7: Final Energy Use Shares by Sector, 2011



In both Hawaii and the US as a whole, transportation energy use is largely provided by oil. This underlines an important point: even though Hawaii may be able to move away from oil in power generation (as is common in most of the world), unless other, more speculative measures are implemented, Hawaii is likely to remain heavily oil dependent owing to transportation energy use.

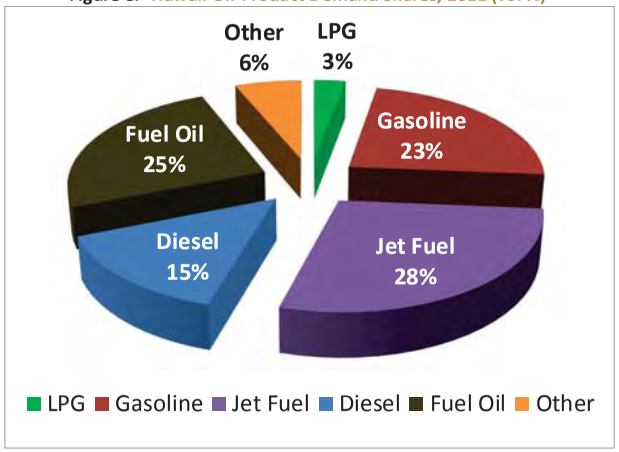
There are options for conserving transport energy—increased mass transit, more efficient vehicles, and increased use of bicycles or walking. There are also options for moving away from oil in transport—biofuels, natural-gas fuelled vehicles, or electric cars—but as of yet none of these provide comprehensive answers to oil dependence in transport. Of the goals set by the Hawaii Clean Energy Initiative, it is the transportation goals that have been assessed as possibly not feasible (in a report by NREL, the National Renewable Energy Laboratory).

As will be discussed later, this poses serious problems for Hawaii's refining industry. If fuel oil is driven out of the power sector but major demands for transport fuels remain, this creates a demand slate that is impossible for the refineries to match.

1.2. Current and Historical Petroleum Product Demand

When the press talks about oil, the discussion tends to focus on gasoline. In the US overall, gasoline is by far the most important fuel, accounting for 54% of all oil product demand.

Figure 8: Hawaii Oil-Product Demand Shares, 2011 (vol %)



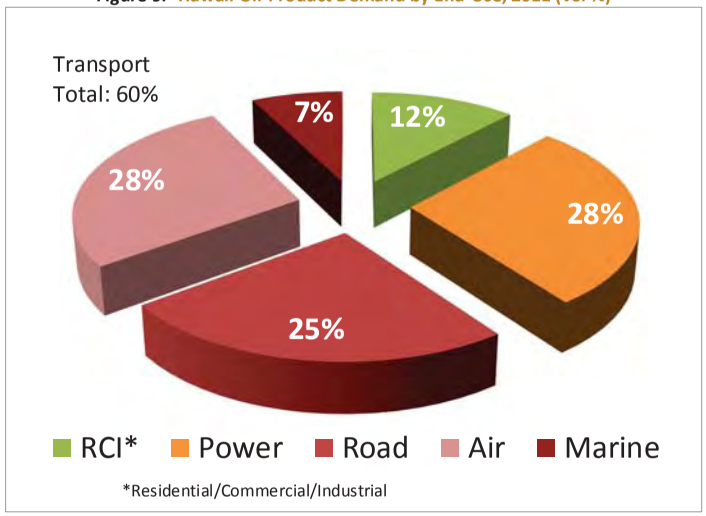
As the figure shows, however, in Hawaii it is a very different story. For Hawaii, jet fuel is the most important product, followed by fuel oil, with gasoline coming in third. Diesel, the second-most important fuel in the US (23% of demand), comes in fourth in Hawaii, at a mere 15%.

In terms of how oil products are used in Hawaii, transportation use accounts for 60% of the total volume. (The end-use distribution shown here should not be confused with final sectoral demands show earlier. Not only were those for total energy rather than barrels of oil, but they also did not include the demand of the power sector.)

The two largest demands for oil are air transport (which accounts for almost half of total transportation oil demand) and fuel for the power sector. Behind air transport comes road transport, which is dominated by gasoline.

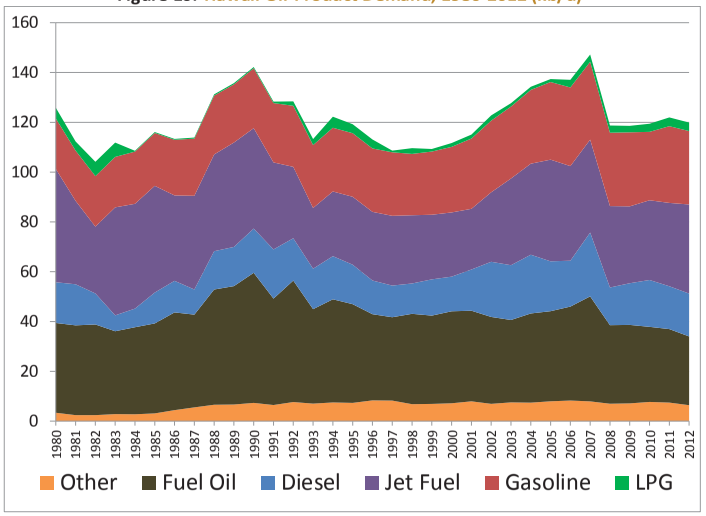
The total use of oil products in the residential, commercial, and industrial sector is a small share of the total. The smallest sector shown here is nonetheless one of the most important for Hawaii: marine transport, which accounts for almost all of the flow of goods in and out of the state and between the various islands.

Figure 9: Hawaii Oil-Product Demand by End-Use, 2011 (vol %)



The long-term history of Hawaii's overall oil demand doesn't show any clear trend. There are peaks and troughs, but total oil demand in recent years is not much different from the early 1980s or the mid-1990s.

Figure 10: Hawaii Oil-Product Demand, 1980-2012 (kb/d)



Although the picture suggests that Hawaii's demand is quite volatile, much of the volatility is a result of exposure to the world market. In the case of jet fuel, tourist arrivals are an obvious factor—but so is the growth of 'overflights,' where planes that once would have stopped in Hawaii partially as a convenient refueling site now fly direct between the US mainland and Asia. Similar volatility can be seen in the sharp peaks in demand for fuel oil and diesel. In typical years, most of the marine bunkering done in Hawaii is to serve ships that are loading or unloading cargoes in Hawaii. But in some years, logistics and pricing draw international marine traffic (such as the Japanese long-line fishing fleet) to Oahu specifically to purchase bunkers. This accounts for the recent sharp peak in demand in 2007, as well as much of the apparent surge in demand in the 1988-92 period. Onshore demand for fuel oil and diesel in those years was much flatter.

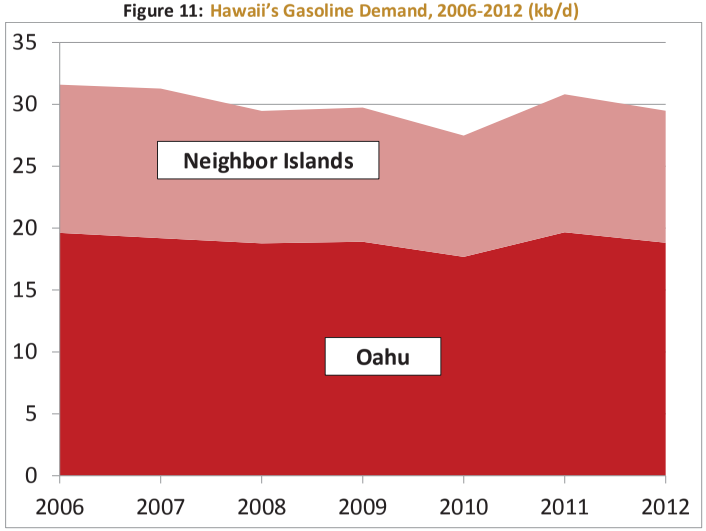
The 2007 peak is also accentuated by a significant drop (17%) in jet fuel demand between from 2007 to 2009. Higher oil prices and the world financial crisis hit travel hard, and was especially challenging for tourism.

To look at the more stable underlying trends in recent years, it is necessary to look at the most important individual fuels.

1.2.1. Gasoline

Gasoline is the most familiar oil product, and also generally the easiest to understand. Although there are uses for gasoline apart from ground transportation—such as aviation gasoline, some farm equipment, or small consumer items such as lawn mowers—the vast majority of consumption is for automobiles and small trucks.

Figure 11: Hawaii's Gasoline Demand, 2006-2012 (kb/d)



About two-thirds of Hawaii's gasoline is consumed on Oahu, which is slightly less than Oahu's share of state population. Longer driving distances, more dispersed population, and less mass transit on Neighbor Islands result in slightly higher consumption per capita.

Gasoline demand is sensitive to both price and to economic conditions. At the margin, it is affected by tourism, since tourists require ground transportation. In the 2006-2012 period, demand has been relatively flat, with a distinct decline in 2007-2010.

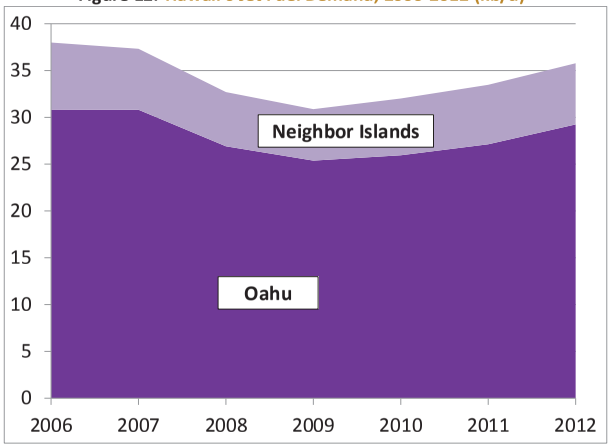
As will be discussed in Chapter 2, both State and Federal policy measures will affect Hawaii's gasoline demand in coming years.

1.2.2. Jet Fuel

Jet fuel is a special case in Hawaii. Not only is it the dominant fuel, it is also the only major fuel where the state is highly reliant on product imports. At present rates of throughput (see refinery sections later in this chapter), the Oahu refineries cannot meet demand, and significant imports of jet fuel have been a fact of life for many years.

It should be mentioned that the 'official' demand figures published by the State or by EIA generally underestimate jet fuel demand by a significant amount. In the case of State figures, the problem is that the data is garnered from tax assessments—and fuels for international flights are exempted. Therefore, the State data on Neighbor Island jet demand is relatively accurate, but underestimates jet demand on Oahu.

Figure 12: Hawaii's Jet Fuel Demand, 2006-2012 (kb/d)



In the case of EIA, the problem seems to be definitional with respect to bunkers, bonding status, and the Hawaii Free Trade Zone. Some of the fuel loaded onto some international flights has

never technically entered the US, and some international bunkers are not considered to be part of Hawaii's demand.

Despite any definitional quibbles, jet fuel is by far the most important fuel in Hawaii's demand barrel, and it is vital to account for the full volume of demand. HFFC has been kind enough to provide us with annual demand figures. As expected, their numbers match quite well with State data for the Neighbor Islands, but are considerably higher for Oahu.

Oahu's demand is consistently slightly more that 80% of the State's demand, which is not surprising giving that it is the site of arrival for international flights. Although direct flights between the Mainland and Neighbor Islands are common, Oahu is still the main portal to Hawaii for most travellers.

This may change somewhat in coming years, as more flights connect directly from the Mainland to Neighbor Islands. In addition, many tourism projections show the growth in tourist days on Neighbor Islands to increase more rapidly than tourism on Oahu. Nonetheless, any change in the proportions of consumption will be slow and incremental.

1.2.3. Diesel Fuel

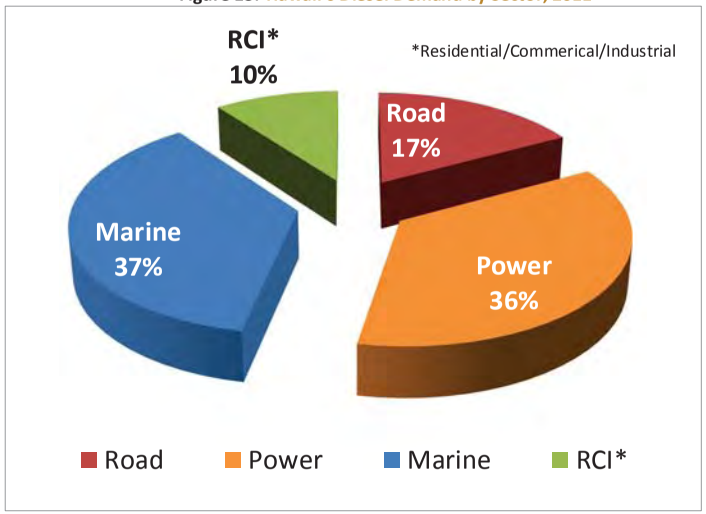
Diesel is in many ways the most complex of the major fuels—and its naming reflects this. Diesel is also referred to as distillate, home heating oil, light marine fuel, #2 fuel oil, gasoil, and several other names. Diesel is used in ground transport, marine transport, industrial heating, home heating, and in power generation.

Diesel specifications also vary widely. US road diesel today is ultralow sulfur diesel (ULSD), with a sulfur content of 0.0015% wt—far lower than almost any other product. (Compare this to the maximum of 0.3% allowed in international jet fuel—two hundred times higher!) Prior to 2007, however, 0.05% was allowed in road use in the US, and before 2000 much higher levels were allowed except when banned by state or local regulations.

In much of the world (including Europe) diesel rather than gasoline is the dominant fuel for road transport. Although Europe's road diesel is ultraclean, in other countries, sulfur content of road diesel still runs as high as 0.5%, and sulfur contents in the range of 0.5-1.5% are still common in non-road uses such as power generation or marine bunkers.

Although Hawaii has no demand for diesel in space heating, as the Figure below shows, diesel demand is scattered over many uses.

Figure 13: Hawaii's Diesel Demand by Sector, 2011

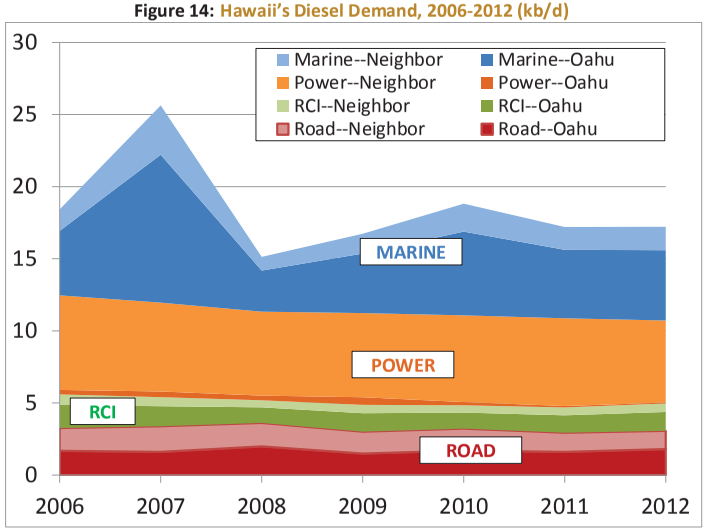


Marine and Power use account for nearly three-quarters of total demand, with the most familiar use of diesel, road transport, at only 17%.

The use of diesel in the Marine and Power sectors is not evenly spread across the state, however. As the figure below shows, most marine bunkering of diesel takes place on Oahu. As mentioned earlier, this market accounts for a great deal of the occasional large swings in oil demand; the Road, RCI and Power sector demands for diesel show little variation apart from a slow general decline.

The disproportion in demand between Oahu and Neighbor Islands is even larger for diesel in the Power sector. In this case, however, almost all the demand is in the Neighbor Islands. Diesel is a key fuel for power generation in the Neighbor Islands (particularly on Maui). On Oahu, diesel demand in the power sector is quite small, and diesel is used mainly for supplemental power in following fluctuating loads.

Figure 14: Hawaii's Diesel Demand, 2006-2012 (kb/d)



1.2.4. Fuel Oil

At one time, heavy fuel oil (also referred to as residual fuel oil, bunker fuel oil, Bunker C, Number 6 fuel oil or resid) was a widespread and important product. It was the main fuel for large international shipping, a key fuel for power generation, and an important direct-heating fuel for heavy industry.

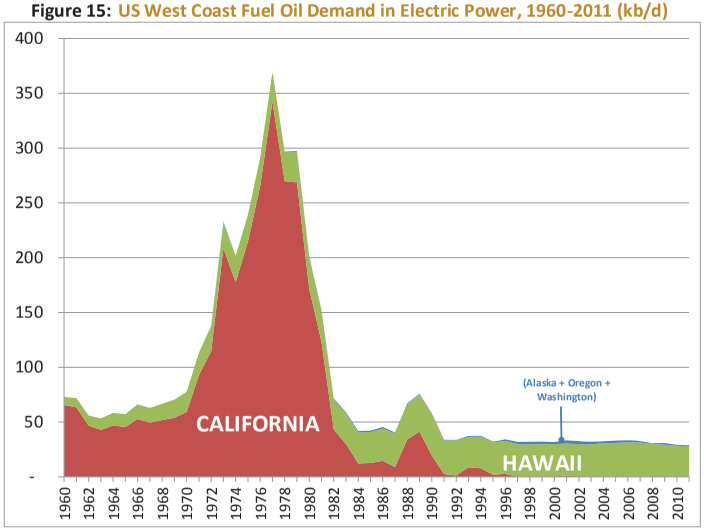
Two factors have changed this. First, beginning in the mid-1970s, the increase in oil prices drove users to replace oil with cheaper fuels wherever possible. In the case of power and industrial heat, the easiest oil to replace was fuel oil.

Second, tightening environmental standards have pushed fuel oil out of many uses. Heavy fuel oil is "the bottom of the barrel"—the portion of oil that is so heavy it did not boil at the temperatures of 650-700°F in a refinery's crude distillation tower. The pollutants such as sulfur, metals, and ash, are disproportionately concentrated in the heavy fuel oil.

For example, in the world's most-traded crude, Arab Light, the sulfur content of the crude oil is 1.8%. The sulfur content of the heavy fuel oil from Arab Light is 3.1%. For a low-sulfur crude, like Indonesia's Minas, the crude sulfur is 0.08%, but the sulfur in the fuel oil from Minas is about 0.13%. There are no hard-and-fast rules, but in general a heavy fuel oil can be expected to have 60-80% more sulfur than the crude from which it is made.

Although fuel oil demand in the power sector surged in the US in the 1960s and early 1970s, new environmental restrictions quickly drove it back out of the market. The figure below shows US West Coast demand for fuel oil in the power sector by state.

Figure 15: US West Coast Fuel Oil Demand in Electric Power, 1960-2011 (kb/d)



California's demand for fuel oil in electric power reached nearly 350 kb/d in the mid-1970s, but virtually vanished by the mid-1990s (and is zero today.) By contrast, Hawaii's demand for fuel oil in power grew to near its present level by the late 1970s, and has been comparatively steady across the period.

To put this in a broader context: In 2011, Hawaii consumed 98% of all the fuel oil consumed in the US West Coast power sector, and 70% of all the fuel oil consumed in the entire US power

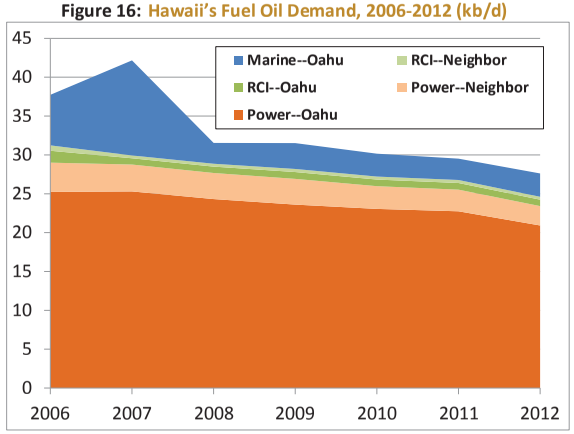
sector. It is somewhat astonishing that one small state can account for 70% of the nation's fuel oil consumed in electrical generation.

At the risk of belaboring the point, in 2011 despite the AES coal plant and various renewable energy projects, 82% of all of Hawaii's electrical power came from oil—most of it fuel oil. By contrast, oil generated less than 0.4% of the nation's total electricity.

Although the use of fuel oil in the power sector is now uncommon in the US (and rapidly disappearing in many countries), it is by far the dominant use of fuel oil in Hawaii. In 2011, 86% of all fuel oil use in the state was for electrical power (77% on Oahu and 9% on Neighbor Islands). As a result of conservation and the deployment of renewable power generation, the total demand for fuel oil in the power sector is on a slow decline.

As with diesel, the one volatile element of the overall demand picture is marine bunkering, where there was a sharp upward swing in 2007. In general, marine bunkering of fuel oil is small and tending to shrink; there is only a tiny volume used in interisland shipping (mainly for cruise ships), and in normal years bunkering is limited to ships that are already calling at Honolulu to discharge or load cargoes.

Figure 16: Hawaii's Fuel Oil Demand, 2006-2012 (kb/d)



The bulk of Hawaii's demand for fuel oil in the power sector is for the 0.5% sulfur fuel burned on Oahu. This low-sulfur fuel oil (LSFO) is a very minor product in the Pacific. Japan and Korea

continue to burn some volumes of LSFO, but it has been driven out of the market in most countries. The LSFO market long-ago disappeared on the US West Coast, and there is no Singapore spot market in LSFO. (There is still a market in the related product, low-sulfur waxy resid, but the supply of this product is now so thin and unpredictable that many buyers and sellers refuse to use it as a pricing basis.)

1.2.5. Other Oil Products

There are six other significant classes of oil products used in Hawaii:

- LPG
- Naphtha
- Lubricants
- Asphalt
- Unfinished oils
- Refinery gases

LPG. LPG in Hawaii is almost exclusively propane rather than the propane-butane mix common elsewhere. This is used as a heating and cooking fuel, and is a substitute for synthetic natural gas (SNG) where SNG is not available. Much of the LPG supplied to Hawaii is from the local refineries, but refinery production is insufficient to keep up with demand, so about a third of supply is imported.

LPG is presently somewhat less than 3% of Hawaii's oil-product demand, though its share has shown general growth in recent years.

LPG is unique in the Hawaiian context in that propane is frequently imported directly to Neighbor Island ports from foreign countries. With only rare exceptions, all other supply of products to Neighbor Islands originates from Oahu.

Naphtha. Naphtha is a light product in the same general boiling range as gasoline. Indeed, distillation of crude oil does not produce any gasoline; in that boiling range, it only produces naphtha, which may then be further processed (or blended with other intermediates) to produce saleable gasoline. Because of this, refiners tend to regard naphtha as gasoline that couldn't make the grade.

Apart from its use in gasoline, naphtha is primarily used as a solvent, or as a feedstock to various petrochemical processes. The main demand for naphtha in Hawaii is as a feedstock: all of Oahu's SNG is produced by HawaiiGas from naphtha (presently supplied by the HIE Refinery). There is a lot of confusion about 'naphtha,' however. There is material produced by the local refineries that is similar to naphtha in boiling range, but might be classed as 'naphtha' or as 'unfinished oils' or simply as 'other oil products.' Small but significant volumes (1-3 kb/d) of naphtha-range material is supplied to power plants on Kauai and Hawaii for use in gas turbine power plants. Different sources report these volumes under different names.

In addition, some classes of naphtha may be reported as 'gasoline blending components' (GBCs) depending on their planned use. Naphtha is not a major product in the state, but it is presently vital for a few uses (SNG, small power stations)—and also accounts for why many oil statistics in Hawaii do not balance out.

Lubricants: Lube oils are familiar to all car owners, but they are vital in a vast array of uses in virtually every sector. Because so many of these products are delivered in a packaged fashion, they are often treated as finished goods rather than fuels or oil products. Hawaiian refiners do not produce lube oils. Official statistics give the sale of lube oil in Hawaii as about 0.2 kb/d, but this is probably an underestimate.

Asphalt: Both of Hawaii's refineries have asphalt manufacturing units, but changes in product specifications over the previous decades have meant that the crudes now imported by the refiners (generally low-sulfur, and non-asphaltic) are poor inputs for producing asphalt. For this reason, asphalt and similar products are now generally imported.

Because of the small and specific nature of the trade, and because much of the asphalt supply comes from California and is not therefore 'imported,' official estimates of asphalt demand in Hawaii tend to be too low. Based on import levels and conversations with industry observers, asphalt consumption in Hawaii is typically in the range of 0.5-1.5 kb/d. Official numbers from EIA are considerably lower.

Unfinished Oils. This category has a large overlap with other categories, and reporting is inconsistent (not only from source to source, but from year to year from the same source). In Hawaii, naphtha is the material most likely to bounce back and forth between classification as a

product and classification as 'unfinished,' but it is also a problem for material in the diesel and fuel oil ranges.

The biggest issue with this is consumption inside the refineries themselves. When a refiner sells a product, it generally meets certain standards (many of them quite obscure to outsiders). When the refiner chooses to burn the same material inside the refinery, how it is classified is rather arbitrary, and it may simply be reported as 'internal fuel.'

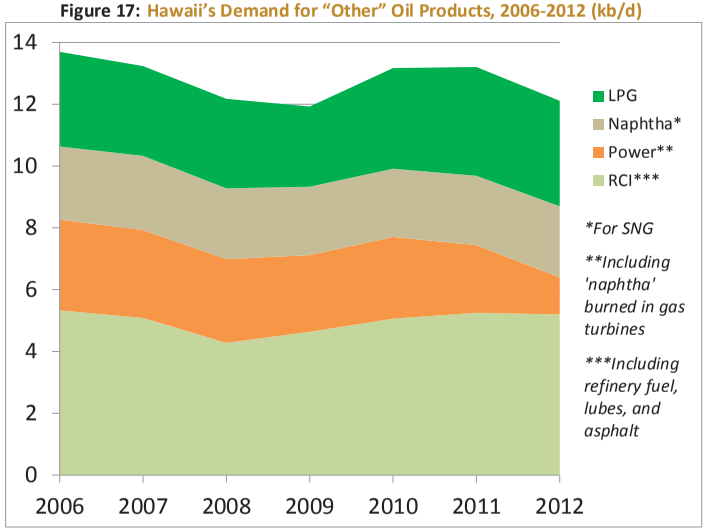
Refinery Gases: Refinery Gases are generally a mix of methane, ethane, light olefins, and miscellaneous compounds. Some of them are stripped out for feed to hydrogen units, but most of them end up burned as fuel inside the facility. Once again, these may be separately reported in this category, or lumped into 'internal fuel.'

Summary—Other Products: LPG is thankfully a separate and agreed-upon product. The other products here overlap, are underreported, and/or can change classification from year to year.

None of these are large-volume products, but all are important. Some of them—such as imports of asphalt and lubricants—can go on mostly below the radar in terms of existing infrastructure.

Some of the most important components of "Other Products" in terms of volume are the materials used as refinery fuel. These enter the state as crude oil, and never leave the refineries as finished products. In energy terms, they might amount to as much as 3% of consumption, but in volume terms (barrels) they are likely to be smaller because of volume gain in processing (and because some share of consumption is met by imports of products, notably jet fuel). Obviously, they are not an inherent element of required supply; that is, in the absence of refineries, there would be no production or demand for refinery fuels, and they do not affect product import needs.

Figure 17: Hawaii's Demand for "Other" Oil Products, 2006-2012 (kb/d)



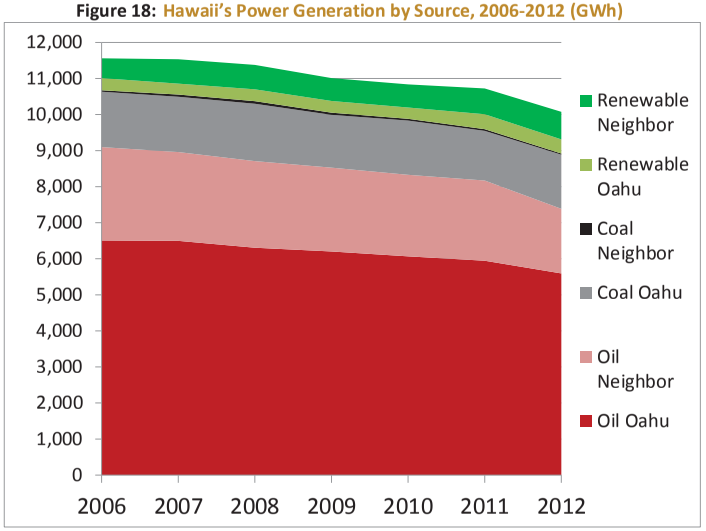
1.3. Fuels for Electric Power

The electric-power sector in Hawaii has undergone many changes in recent years. A combination of deliberate conservation plus price-induced conservation has pushed demand down slowly but steadily.

At the same time an increased drive for generation from renewable sources has taken the share of renewables in Hawaii's power mix from 7.5% of generation in 2006 to an estimated 11.5% in 2012.

With declining demand for power, a relatively steady role for coal, and increasing generation from renewables, the net effect has been a rather steep decline in power generation from oil—especially on the Neighbor Islands. Across the 2006-2012 period, generation from oil fell at an annualized rate of -3.4%, while renewables rose at 4.5%.

Figure 18: Hawaii's Power Generation by Source, 2006-2012 (GWh)



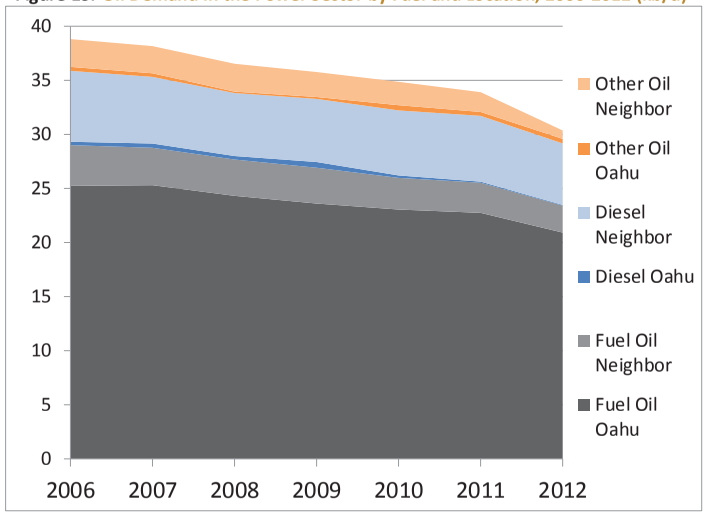
(Some caution needs to be applied in looking at power generation from various fuel sources, incidentally. The figures above are actual generation, but the most commonly cited figures are sales numbers. Power stations use significant amounts of electricity with the stations, and there are also losses in transmission lines. In total, the station consumption and the line losses amount to about 8% of the power generated—although that percentage varies by island, and tends to be lowest on Oahu. To determine future fuel demand, it is necessary to project future power sales, and also to project losses, since fuel is needed for the total of the two, not sales alone.)

The types and specifications of oil-products differ considerably between Oahu and the Neighbor Islands. On Oahu, the largest demand is for LSFO, low-sulfur fuel oil; this is supplemented with small volumes of very low-sulfur diesel and a tiny quantity of unfinished oil (burned mostly in the refineries).

Neighbor Islands burn fuel oil as well, but these volumes are much higher in sulfur than allowed on Oahu, consisting of various grades of MSFO and IFO (medium-sulfur fuel oil and industrial

fuel oil). The largest demand for oil in power on Neighbor Islands is for diesel, which also is allowed higher sulfur content than power diesel on Oahu. Finally, both Kauai and the Big Island burn significant volumes of unfinished oils, most of them with boiling points in the naphtha range.

Figure 19: Oil Demand in the Power Sector by Fuel and Location, 2006-2012 (kb/d)



There have been significant declines in every category of oil product in the power sector since 2006. The largest decline in volume terms has been LSFO on Oahu, which is by far the source of power in Hawaii; demand dropped by more than 4 kb/d (17%). In percentage terms, however, the largest decline has been in "other oil" on Neighbor Islands, where preliminary figures for 2012 suggest a decline of about two-thirds since 2006.

This chapter is intended to give an overview of the current situation in Hawaii; forecasts and scenarios are left for the second chapter. Nonetheless, it is useful to note that three major factors could (and likely will) alter the size and structure of oil demand in Hawaii's power sector:

1. **The HCEI and the Renewable Portfolio Standard (RPS).** HEI and others have signed agreements with the state to adhere to the renewable goals of the HCEI. There are various milestones, but the ultimate goal is for renewables to provide 40% of Hawaii's electric power by 2030. At the same time, conservation goals will rein in growth in power demand.
2. **LNG Imports.** LNG imports into Hawaii have been studied for several years, but only in the last year has the concept gained real traction. The largest and most obvious market for LNG is in the power sector, where it is possible that large volumes of oil could be displaced.
3. **New EPA emissions standards.** Although LSFO is generally considered a clean fuel, the new EPA standard coming into effect before the end of the decade places a whole series of tight new controls on emissions, especially emissions of metals and particulates. In general, fuel oils cannot meet these standards without adding 'scrubbers' at the back-end of the power plant. The cost of such changes in Hawaii has been estimated at over $1 billion. An option is to convert from fuel oil to low-sulfur diesel. Another option, which has not been well-studied, is to convert to a diesel-fuel oil blend.

The implications of all three of these factors will be examined in our scenarios in the next chapter.

1.4. Main Oil Supply Infrastructure

1.4.1. Oahu Oil Ports

Oahu is served by four major oil ports. Two are the offshore mooring buoys owned by the refiners. The other two are the Honolulu Marine Terminals (HMT, more than one pier in oil service), and the Kalaeloa Barber's Point Harbor (KBPH, presently only one pier in service).

The vast bulk of Hawaii's oil supply arrives through the Chevron or HIE offshore moorings, primarily in the form of crude oil. As will be seen below, a huge fraction of Oahu's overall oil tankage is at these two ports (especially if the Navy's underground reserve is excluded). The pipeline facilities themselves are capable of delivering more oil than Hawaii is ever likely to need, but the throughput system is designed for fairly large tankers.

Both Chevron and HIE have the capability to receive and send out products as well as crude oil—although the actual permits for their pipelines specify relatively limited movements of refined products. In practice, however, the system was designed for relatively large (by Hawaii standards) tankers, and the logistics of supplying small units such as barges for interisland traffic are unattractive. In general, both of the refinery terminals are designed for large-scale movements.

The oil-product piers at HMT and KBPH are primarily in the business of moving refined products from Oahu to Neighbor Islands via barge. There are some small exceptions to this, and one major exception (HFFC).

Both KBPH and HMT serve the needs for occasional imports of products for smaller buyers, as well as imports of minor products. They are also capable of supplying volumes of imports to the systems of the refiners, although they are not used for this purpose for crude oil or for large volumes of major products.

There are two major import terminals apart from those of the refiners. One is the Aloha terminal, which is served by the KBPH port facility. Aloha's tankage is not fully utilized for imports, but it is an important third oil-company presence in the market

The other major terminal is HFFC, which is served by Pier 51A at HMT. Although HFFC deals solely in aviation fuels, it is by far the largest importer of oil products into Hawaii, and is the third largest importer of oil (crude or products) overall.

HFFC's supply via Pier 51A faces serious supply difficulties. The pier is shared with a container operation, which are given priority over deliveries of jet, as well as other non-oil cargo operations. This problem became especially acute following the shutdown of the HIE refinery (although the HIE terminal remained active). When a tanker cannot berth and deliver its cargo on time, the buyer must generally pay demurrage fees, which significantly raises the cost of delivery (and the cost to the consumer).

KBPH faces similar problems in that the existing piers share functions between fuel and non-fuel uses.

The Oahu supply system has evolved in the presence of the refineries. If refinery operations were to close, the system could survive on product imports. But if the ports and terminals and

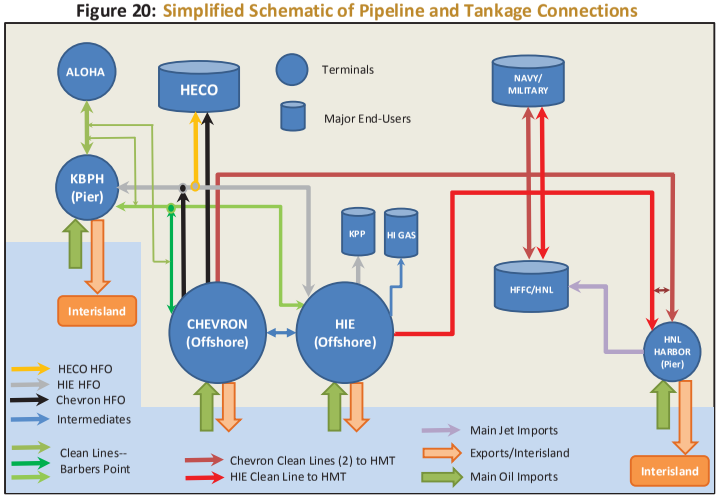
pipelines associated with both refineries were to close as well, KBPH and Pier 51A are not capable of handling Hawaii's import needs. Indeed, most observers would concede that Pier 51A is already overstretched by current demands.

1.4.2. Main Pipeline Connections

Pipelines, pipeline throughput agreements, and pipeline easements are a complex topic. The goal here is not to give a detailed description of the pipeline system, but to give a functional overview of the major connections. Even at the simplified level shown here, the system may seem somewhat Byzantine.

The figure below gives an abbreviated indication of how the pipeline system works. In some cases, a single pipeline shown here (for example, Chevron's clean products pipeline to Honolulu Harbor) is actually more than one line. In other cases, clean and dirty products may be carried on the same line. ('Dirty' or "black' products are crude oils and fuel oils whose properties are not harmed by mixture with other products. 'Clean' or 'white' products are those that must be kept clearly segregated, and, if there is any contamination, the contaminated portion must be downblended to lower grades of product. For obvious reasons, jet fuel is product which must be kept most segregated and uncontaminated.)

Figure 20: Simplified Schematic of Pipeline and Tankage Connections



HIE has two black lines, one from the refinery to KBPH, and one to the Kalaeloa Partners (KPP) power plant. The HIE-KBPH line has a HECO-owned spur line that serves HECO's fuel storage and distribution system.

HIE and KPP are tightly integrated. The power plant receives fuel oil (LSFO) from HIE, and has lines to return byproduct process steam to the refinery.

In earlier days, Chevron had a black line running to Honolulu Harbor, delivering fuel oil to the military and to HECO's Waiau power plant on the way. After HECO's supply line from Barbers Point to Waiau (not shown) was completed. Chevron then converted the black line to a clean line carrying gasoline and diesel.

Chevron has a direct connection to HECO's Barber Point tank farm and distribution system. Chevron can deliver fuel oil to KBPH through a tie-in to HIE's line.

Aloha has lines between its tankage and KBPH, as well as lines connecting to both refineries, and HFFC has lines for aviation fuels from Pier 51A at HMT to its tank farms.

Like Kalaeloa Partners, HawaiiGas has a direct connection to the HIE refinery for its unstabilized naphtha feedstock. Although HawaiiGas can receive naphtha from Chevron, this requires a transfer from Chevron to the HIE system, and from HIE through the pipeline to HawaiiGas.

Figure 21: Main Pipeline Connectivities Between Ports—Clean Products

FROM: \ TO:	CHEVRON	HIE	KBPH	HMT
CHEVRON		connected	only through HIE pipeline	connected
HIE	connected		connected	connected
KBPH	only through HIE pipeline	connected*		through HIE, then via Chevron or HIE*
HMT	connected*	connected*	through HIE, then via Chevron or HIE*	

*** not a common flow**

In terms of clean products, Chevron is well connected to HMT, but must rely on HIE pipelines to reach KBPH.

HIE has excellent connections to both KBPH and HMT.

KBPH and HMT are connected…but only through the HIE-KBPH line first, and then through either the Chevron or HIE clean lines to HMT.

The general situation is similar for black products, except that there is no longer (after conversion of the Chevron black line) any connection to HMT.

Figure 22: Main Pipeline Connectivities Between Ports—Black Products

FROM: \ TO:	CHEVRON	HIE	KBPH	HMT
CHEVRON		connected	only through HIE pipeline	no connection
HIE	connected		connected	no connection
KBPH	only through HIE pipeline	connected*		no connection
HMT	no connection	no connection	no connection	

*** not a common flow**

What are the key points of all these connectivities? Obviously Chevron is now less connected than HIE; and neither party can deliver fuel oil to neighbor islands via HMT.

These are minor issues, however. The most important point is that KBPH and HMT are only connected through the refiners' pipelines. Any product movement between the two ports must pass through the HIE-KBPH line, and then must further transit through either the Chevron-HMT clean lines or the HIE-HMT clean line.

In the normal course of events, this would probably not be a problem—although someone might have to pay high transit fees to move product from one port to the other. The situation today, however, is outside the normal course of events. One or both refineries might close. If this happens, their own port facilities and tankage might close. More important, their pipelines might close.

This would be an emergency. Obviously, no major oil company wants to create an emergency—apart from basic civic responsibility, it is bad for business elsewhere. And it is unlikely that both refineries would close rather than at least one converting to an import terminal, and the

pipelines are so vital that undoubtedly some purchase or handover agreement would be reached.

The pipelines are critical infrastructure. Without the refinery-owned infrastructure, there is essentially no overland connection between KBPH and HMT. So even if KBPH is expanded to handle product imports and storage to replace one or both refineries, there is no way to get the products from KBPH to HMT. This may not be critical for some uses—presumably KBPH could pick up much of HMT's service of Neighbor Island needs—but there is no way in such a scenario to, for example, import jet fuel at KPBH and service the needs of the airport (except of course by shipping to Pier 51A—which is already overloaded).

The point is that harbor infrastructure is only part of the system. 'Redundancy' has a bad sound to it, but redundant infrastructure is safer infrastructure. There are largely unnoticed bottlenecks in Oahu's oil-supply infrastructure that are privately owned—and that have no backup systems. At the minimum, there should be a plan for orderly handover of this infrastructure in case an owner wants to leave—and perhaps contracts between the State and the owner that guarantee certain kinds of access under certain conditions.

1.4.3. Bulk Product Storage

1.4.3.1. Overview

This is intended only to cover the major bulk storage units. There are many tanks of various capacities at smaller end-user locations (including underground tanks at fueling stations).

There are many different types of storage tanks, and some, for products like gases, are quite specialized. Concentrating on liquids, for our purposes here, the most important distinction is between floating-roof tanks and fixed-roof tanks.

The empty space inside a tank is called "ullage." If the ullage is large and becomes filled with evaporated gases, there is a serious chance of an explosion or fire. Obviously, fixed-roof tanks develop ullage as the tanks are drawn down. Therefore, fixed-roof tanks can only hold non-volatile products such as fuel oil and diesel. (Jet is a marginal case, but is usually stored in floating-roof tanks.)

Floating-roof tanks effectively have no ullage, because the roof follows the surface of the liquid. That means that volatile products such as gasoline and naphtha can be stored safely in floating-roofed storage.

Surprisingly to some, crude oil also must usually be stored in floating roof tanks. Although the vapor pressure of crude oil is lower than, say naphtha, there is naphtha and LPG in the crude oil, and these light components can evaporate and create hazardous conditions.

So, in general, fixed-roof tanks can hold only non-volatile oils. Floating-roof tanks can hold volatile oils, but they can also store non-volatile oil just as well. For this reason, many facilities install the more-expensive floating-roof tanks so they can switch easily between products.

Tanks for high-viscosity fuels usually must be heated. This includes some fuel oils, many heavy intermediate products, and some crude oils. Details on which tanks in Hawaii are heated are not publically available. We know that at one time HIE had only one heated crude tank (and several heated tanks for intermediates).

In Hawaii, the refineries sometimes hold fairly large inventories of certain products (gasoline and diesel in particular). Many other products, however, are transferred to buyer tankage fairly rapidly. For example, the bulk of the fuel oil stock held on Oahu is stored in HECO facilities. Similarly, little jet is held at the refineries; most is quickly transferred to HFFC or sent to airports at neighbor islands.

Some product tanks are licensed and permitted only to hold one or two products, while others may have wide-ranging permits.

In refinery-to-terminal conversions, it is quite common for crude tanks to be converted to product storage. Since they are floating-roof tanks, this means that crude tanks are usually suitable for conversion to most products. This process is usually straightforward and cheap by oil-industry standards, though it may require repermitting and additional investment.

In some cases, the seals and vapor-control gaskets on crude tanks may not be suitable for high-volatility products, and may need to be changed. Repiping is usually necessary; crude tanks are usually piped to serve the crude tower, not to deliver refined products to outside pipelines or end-users.

If one examines the capacities of the refineries and the capacities of the crude tanks, it is clear that both refineries were designed for about four weeks of crude storage.

At recent rates of throughput, though, HIE has more than six weeks, and Chevron has about 4 ½ weeks.

These are very high numbers for the US. West Coast refiners on average hold only about 7 days of crude storage. Most West Coast refiners outside Hawaii, however, receive the bulk of their crude oil via pipeline plus various short-haul voyages.

Hawaii has longer supply lines, and needs a cushion against possible shipping accidents or disruptions. Data on Hawaii's crude stocks at the refineries is gathered by EIA, but it is not released to the public because of confidentiality. While there is no firm, data long-term data crude stocks in Hawaii appear to average a little in excess of two weeks of refinery runs.

In terms of maintaining supply security, it needs to be understood that a significant fraction of Hawaii's product supplies are held "inside the crude" waiting to be refined. This means that in the absence of one or both refineries, the actual stocks of products would have to be expanded to maintain the same number of days of on-island supply.

1.4.3.2. HIE's Storage Capacity

HIE's tankage for some products seems small. In the case of jet, this is because jet is not stored in large volumes before being dispatched to HFFC or airports on Neighbor Islands.

In the case of gasoline, most of the naphtha and mixed-use tanks are only a short step away from being blended in gasoline. Therefore, most of the naphtha and mixed-use capacity is effectively gasoline capacity.

The table below is focused only on oil liquid storage. HIE also has pressurized storage for LPG and SNG feed, as well as assorted wastewater and slurry tanks. These specialized uses are in a completely different category from oil storage.

Figure 23: HIE Refinery Storage Capacity

FLOATING ROOF	# tanks	kb
Crude	8	2,772
Fuel Oil /1	3	212
Heavy Oils /2	2	231
Diesel	1	5
Jet /3	8	525
Gasoline	4	204
Naphtha	9	452
Mixed Use	1	110
TOTAL	**36**	**4,510**

FIXED ROOF	# tanks	kb
Asphalt	2	41
Diesel	6	300
Heavy Oils	10	216
Fuel Oil	11	851
TOTAL	**29**	**1,409**

TOTAL CAPACITY	# tanks	kb
Crude	8	2,772
Fuel Oil + Heavy	26	1,510
Jet	8	525
Oth. Products	23	1,112
TOTAL	**65**	**5,919**

1/ including mixed-use fuel oil/heavy oil tanks
2/ mostly VGO (cracker feed), cutter stock, and fuel oil blendstock
3/ includes one 126 kb tank that also has stored naphtha and gasoline

HIE maintains some clean-product storage on the Neighbor Islands, but it amounts to only about 4% of the storage capacity at the refinery. HIE also supplies fuel oil to the Neighbor Islands, but it is received and stored by the utilities.

Figure 24: HIE Storage Capacities on Neighbor Islands

	Big Island (Hilo)		Maui		TOTAL	
	# tanks	kb	# tanks	kb	# tanks	kb
Gasoline			3	60	**3**	**60**
Naphtha	2	50			**2**	**50**
Jet	1	12	2	65	**3**	**77**
Diesel	2	24	1	20	**3**	**44**
TOTAL	**5**	**86**	**6**	**145**	**11**	**231**

HIE also maintains a small volume of storage at the Honolulu Marine Terminal. This storage is largely a buffering system for the pipeline supplies.

1.4.3.3. Chevron's Storage Capacity

Chevron's refinery tankage differs from HIE's in a number of ways. First, all but two of the tanks are floating-roof, meaning that almost all of its storage can easily be repurposed. Second, almost all of the tanks other than crude and jet are declared in their licenses as being for "Gasoline Intermediates or Finished Products." In other words, Chevron has a great deal of flexibility in how it handles its storage.

Although Chevron is the smaller refinery, Chevron maintains more Neighbor Island storage than HIE. In part, this is because of significant storage on Kauai, where HIE does not have a terminal. Chevron's storage capacity on Neighbor Islands amounts to about 11% of its storage capacity at the refinery.

Like HIE, Chevron has some storage capacity at Honolulu Harbor, but this is mainly to serve exports to Neighbor Islands rather than to provide bulk storage.

Figure 25: Chevron's Main Storage Capacities

	Refinery	Big Island	Maui	Kauai	TOTAL
	kb	kb	kb	kb	kb
Crude	1,469				1,469
Fuel Oil	420	43	11		474
Jet	130	8	14		152
Oth Products	730	48	54	111	944
TOTAL	**2,749**	**99**	**79**	**111**	**3,039**

Chevron also has pressurized storage for LPGs, as well as assorted wastewater and slurry tanks.

1.4.3.4. Other Major Oahu Storage

Apart from Chevron and HIE, Aloha Petroleum is the only oil company with an import terminal on Oahu. It has about 530 kb of gasoline and diesel storage that receives deliveries via Kalaeloa Harbor. The storage is underutilized, as with the lack of growth in demand, Aloha can generally strike better terms for supply from the refiners than importing from the international market.

There are three very large storage systems on Oahu that are not owned by oil companies. The biggest is the Navy's underground strategic storage at Red Hill. The tankage at this site is roughly equivalent to all of HIE's storage.

Figure 26: Other Major Storage Capacities on Oahu

	Aloha	Red Hill (Navy)*	HECO	HFFC
	kb	kb	kb	kb
Gasoline	436			
Jet		3,000		1,000
Diesel	93	3,000	159	
Fuel Oil			1,900	
TOTAL	**529**	**6,000**	**2,059**	**1,000**

*** Jet and Diesel. Exact split varies and can be altered**

Of course, Red Hill is not designed for general or commercial use, but it means that neither of the refiners needs to hold jet or diesel stocks for eventual supply to the Navy; any volumes produced can be accommodated by the end-user.

HECO has more than 2 million barrels of storage (mostly fuel oil) on Oahu. For reliability and supply security, a high capacity has always been maintained; with the decline in fuel-oil demand, the storage at HECO has become very large compared to daily consumption.

HFFC is the final major storage site, but the HFFC facilities are dedicated to jet fuel. HFFC has roughly a million barrels of storage, with the major facility on Sand Island, and additional tankage at the Honolulu airport.

Ignoring the Navy's storage, the figure below gives a general understanding of Oahu's storage infrastructure and capabilities. In terms of days of storage, these are underestimates, since this looks at storage capacity relative to statewide demand, and there is also some storage on Neighbor Islands. Nonetheless, this is a good gauge of overall capability, as most of the Neighbor Island's supply must be held on Oahu before movement to local storage.

Figure 27: Main Oahu Oil Storage Capacities and Days of Supply

	HIE Refinery	Chevron Refinery	Aloha	OIL COs	HECO	HFFC	NON-OIL COs	OAHU TOTAL
	kb	kb	kb	kb	kb	kb	kb	kb
Fuel Oil	1,510	420		1,930	1,900	-	1,900	3,830
Jet	525	130		655	-	1,000	1,000	1,655
Oth Products	1,112	730	529	2,371	159	-	159	2,530
TOTAL	**3,147**	**1,280**	**529**	**4,956**	**2,059**	**1,000**	**3,059**	**8,015**
Products Only	**days***	**days***	**days***	**days***	**days***	**days***	**days***	**days***
Fuel Oil	55	15	-	70	69	-	69	139
Jet	15	4	-	18	-	28	28	46
Oth Products	21	14	10	45	3	-	3	48
TOTAL	**27**	**11**	**5**	**133**	**18**	**9**	**26**	**69**

* based on 2012 demand, excluding LPG. Does not account for the Navy's 6,000 kb of storage.

With an average of 69 days of tankage, Oahu is quite well supplied, even without considering the Navy tankage or tanks on Neighbor Islands. In addition, if one or both refineries were to convert to import terminals, there is another 4.2 million barrels of crude capacity that could be converted to product storage.

In light of likely declines in product demand, there is more than enough tankage on Oahu—unless a refinery closes entirely without converting to an import terminal. In fact, there may be enough tankage even minus the tanks of one refinery.

A major question going forward is whether HFFC's capacity is sufficient for the long term; jet fuel is the one product that seems to have substantial growth potential.

1.4.4. The Refineries

1.4.4.1. Refining Basics and Hawaii's Refineries

A study of this size and nature can cover refining in only the most rudimentary way. Nonetheless, some details of the industry are needed to understand the challenges the Hawaiian refiners face.

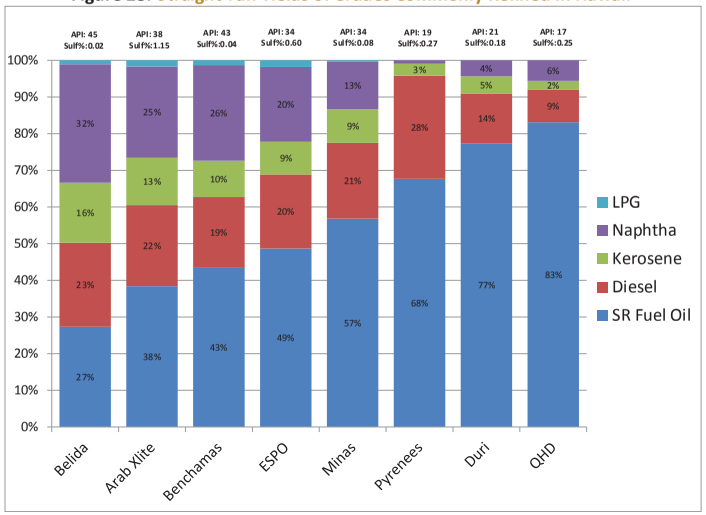
It is common to talk about "the price of crude oil," but crude oils differ widely in characteristics—and these characteristics strongly affect the price. The most important characteristics are API gravity, and sulfur content.

API gravity—measured in degrees API, and often just called "the API of the crude"—is a measure of the density of the oil, but it is "upside-down:" the less dense the crude oil, the higher the API. A very heavy crude oil might be 10°API. A very light crude might be 50°API. Most crude oils are in the range of 30 to 40°API.

Refined products have specific density ranges as well. Lighter products boil at lower temperatures. Gasoline is a light product, and boils or evaporates easily. Fuel oil is a heavy product, and is usually that part of the crude oil that still doesn't boil at 650 °F. Jet fuel and diesel are somewhere in between (and are often called "middle distillates"). Very heavy (fuel oil, asphalt) products tend to be worth less than products such as gasoline, jet fuel, and diesel—although low-sulfur fuel oil can be an exception.

The most basic refining process is crude distillation, which splits the crude oil into different boiling ranges. The figure below—which compares crudes that are often imported into Hawaii for refining—shows how much difference this can make. (The cut called "naphtha" in the figure is the material from which gasoline is made.)

Figure 28: Straight-run Yields of Crudes Commonly Refined in Hawaii



On seeing this graph, it is reasonable to ask: where is the gasoline? The answer is that in general marketable gasoline cannot be distilled directly out of a crude oil. Heavy naphtha is commonly run to a catalytic reformer, which increases the octane; other components, from more complex processing units, are blended in; and some light naphtha is also blended. Many people wonder why gasoline is priced so much higher than crude oil; this is one of the reasons.

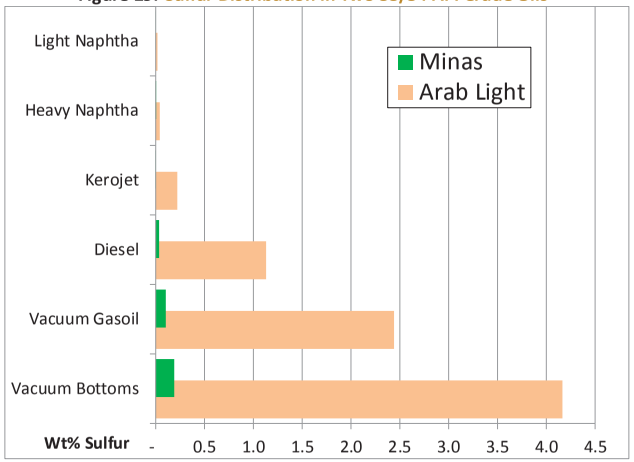
Some crudes imported to Hawaii yield less than 20% fuel oil; some are more than 80% fuel oil. All else held equal, lighter crudes—with less fuel oil—are usually more expensive.

But, as mentioned above, crude oils also differ in sulfur content. Sulfur is the main pollutant from oil; when sulfur is burned, it forms sulfur dioxide (the compound responsible for the smell of rotten eggs), and, when it encounters water in the atmosphere it forms "acid rain." Crude oils are often 1-3% sulfur by weight. Some crudes, however, have almost no sulfur.

Crudes with less than 0.5% sulfur by weight are called "sweet" crudes; crudes with more sulfur are called "sour" crudes. In general, sweet crudes are more expensive than sour crudes.

To complicate matters, sulfur is not evenly distributed in the crude oil. The light cuts, like naphtha (the gasoline cuts) contain very little of the sulfur; the vacuum gasoil and vacuum bottoms (fuel oil cuts) have sulfur contents much higher than the crude. The figure below shows the distribution of sulfur in two well-known crude oils with similar API gravity: Arab Light (Saudi Arabia, 1.8% sulfur), and Minas (Indonesia, 0.08% sulfur).

Figure 29: Sulfur Distribution in Two 33/34 API Crude Oils



As a point of reference, on Oahu the maximum sulfur content of fuel oil is 0.5%. Minas achieves this easily, but Arab Light—the crude with the largest production on the planet—doesn't even come close.

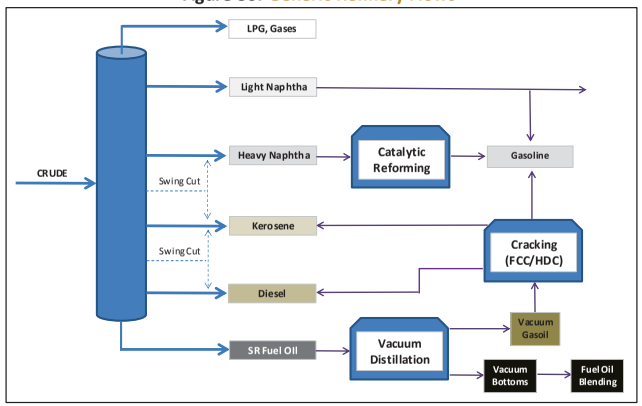
Thus, the most expensive crudes tend to be light, sweet crudes; the cheapest tend to be heavy, sour crudes.

Refinery technology has been developed to alter the yields and quality of straight-run products after crude distillation. Fuel oil, which consists of long, heavy molecules, can be "cracked" into lighter products such as gasoline and diesel. High-sulfur products can be hydrodesulfurized to remove most of the sulfur. Both of these processes, however, use considerable energy, and are hugely expensive. A single fuel oil desulfurization unit can cost up to a billion dollars.

The following figure gives an overview of generic refinery processing. The left half of the diagram shows the crude distillation process. Crude distillation operates at about 650-700 F. The material that boils below this temperature is piped out the side of the tower, with the lightest (lowest boiling point) materials coming out successively higher on the distillation column. Liquids coming directly from to distillation tower are called "straight-run" products.

The material that still has not boiled at 650-700 F comes out the bottom of the tower, and is called straight-run fuel oil.

Figure 30: Generic Refinery Flows

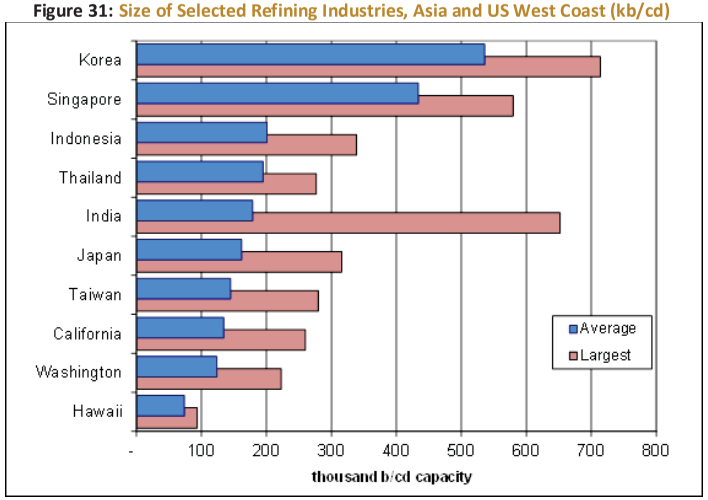


The processes on the left are common to all refineries. The processes on the right—vacuum distillation, cracking, reforming—differ dramatically from refinery to refinery, and not all refineries have these "downstream" units. (The configuration and process flows of Hawaii's refineries will be discussed further below.)

Hawaii's refiners have certain advantages. They are considerable distances from possible competitors, and they operate in a market with major barriers to entry. In general, however, Hawaii's refiners face major challenges in today's international market.

Hawaii's refineries are relatively small, which results in high overhead costs per barrel processed. Chevron is 54 kb/cd, and HIE is about 95 kb/cd. By way of comparison, the average Californian refinery is almost 135 kb/cd, and the largest is 260 kb/cd. As the figure below shows, however, the Californian refineries are no longer considered "worldscale."

Figure 31: Size of Selected Refining Industries, Asia and US West Coast (kb/cd)



The average Korean refinery is 536 kb/cd, and the largest is 840 kb/cd—both more than seven times their Hawaiian equivalents. Singapore's average is 434 kb/cd, and the largest is 580 kb/cd. Even a "small" refiner like Thailand has refineries that are two to three times larger than their Hawaiian counterparts.

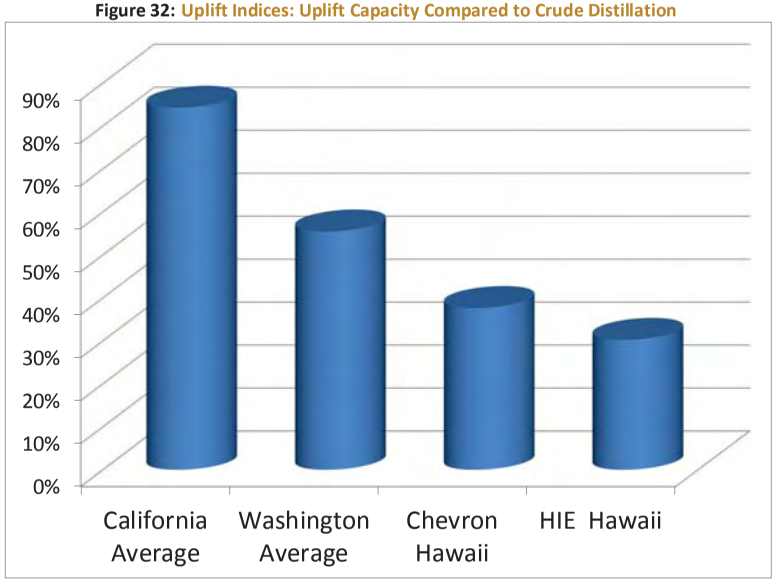
Hawaii's demand is below refinery capacity, so the refiners cannot run at full capacity without exporting. But export markets are distant, and Hawaii does not set the price in importing areas. Except for a market center that sets regional prices (such as Singapore), oil-product exports are almost never as profitable as local sales, since exports must be delivered to an external market at a competitive price. In general, this means that the exporter must absorb the freight costs.

Hawaii's refiners have about 150 kb/cd of refining capacity. In 2012, total oil product demand was about 117 kb/d—but about 11 kb/d (mostly jet fuel) was imported. So product demand was only about 71% of refining capacity.

Ideally, a refiner likes to see product demand higher than refining capacity. At present demand levels, Hawaii has a surplus of refining capacity.

Hawaii's refiners have limited "uplift" capacity. Uplift capacity is shorthand for processes that change lower-value products (such as fuel oil, naphtha, or LPG), into higher-value products (gasoline, jet fuel, and diesel). Typical uplift processes are cracking, catalytic reforming, and alkylation. (Hawaii's refiners have had little incentive to expand cracking because the market for fuel oil in the power sector has been fairly robust. With higher prices, the advent of the HCEI, and the possibility of LNG imports, this situation may be on the verge of dramatic changes.)

Figure 32: Uplift Indices: Uplift Capacity Compared to Crude Distillation



Hawaii's refiners have no vacuum bottoms destruction capacity, and are reliant on a good market for fuel oil sales. This seemingly obscure statement requires some explanation. In a refinery, much fuel oil from distillation is split into a lighter component (Vacuum Gas Oil, VGO), and a heavier component (Vacuum Bottoms, VB).

The VGO is commonly used as feed to the more common sorts of cracking units (such as Fluid Catalytic Crackers or Hydrocrackers). To crack VB requires specialized, extremely expensive

cracking units, such as Cokers (or specially modified Resid Cat Crackers or Hydrocrackers, which are even more expensive as well as being costly to operate).

If the VB is not cracked into lighter products, then it must be blended to fuel oil and sold. In California, where fuel oil demand all but vanished long ago, units for cracking VBs have been widely installed. The result is that even though California runs a heavy, low-API crude slate, Californian refiners output of fuel oil is only about 3% of the total. This is burned inside the refineries or exported into the bunker market.

In Hawaii, fuel oil is the only outlet for the VBs, so a healthy demand for fuel oil is important to the refiners. In addition, if the refineries are run at full capacity, there is not enough VGO cracking capacity to handle all the VGO, and any excess VGO must also be blended to fuel oil.

Hawaii's refiners have very little desulfurization capacity. Modern environmental specifications are increasingly strict about the percentage of sulfur that oil products can contain. There are two ways to produce low-sulfur products. One is to run only low-sulfur crudes. The difficulty with this approach is that low-sulfur crudes are not plentiful, and they tend to command premium prices.

The second way to produce low-sulfur products is to install desulfurizers. Desulfurization is expensive to install, and also expensive and energy-intensive to operate. (In general, the heavier the fuel, the more expensive to desulfurize; it is far more expensive to desulfurize fuel oil than gasoline.) In addition, even the lowest-sulfur crudes cannot produce modern US road diesel (ULSD) without a diesel desulfurizer or equivalent technology.

The one "equivalent technology" is a hydrocracker, which desulfurizes as a side effect of the cracking process. HIE has a hydrocracker as its main cracking unit.

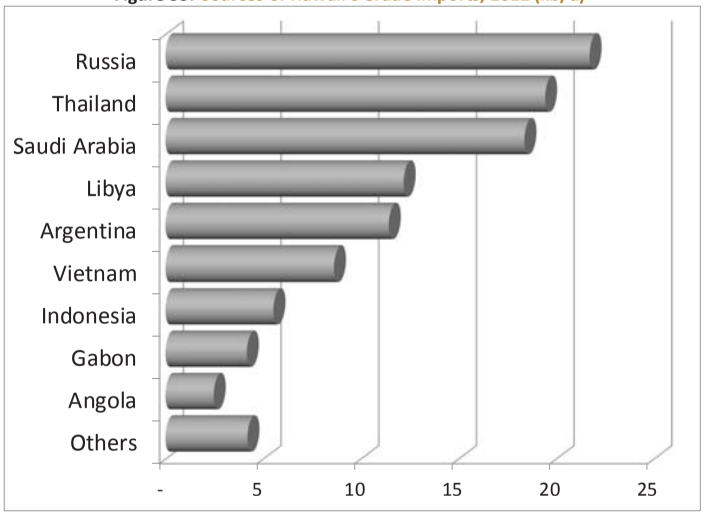
Hawaii's refiners are at a serious geographical disadvantage in terms of procuring crude supplies. The US West Coast and Asia as a whole are both crude-short; the crude-surpluses of the Middle East, Africa, and Venezuela are distant. Moreover, although in the past Hawaiian refiners were able to run some US West Coast crudes (notably Alaskan North Slope), these crudes are too high in sulfur to meet today's sulfur standards—and are also in tight supply.

The Asia-Pacific region is well-known as a producer of low-sulfur crudes; the problem is that the region is the world's largest crude importer. Not only do the producers themselves use up most

of what they produce, but the region as a whole is massively short of crude. Therefore, the volume of low-sulfur crudes available is small, and the prices demanded are high.

Unfortunately, the next-nearest major supplies of low-sulfur crudes are in the Atlantic (Eastern South American and West Africa) and the Mediterranean (North Africa). This is shown clearly in the figure below: Libya, Argentina, Gabon, and Angola are all on the other side of the world.

Figure 33: Sources of Hawaii's Crude Imports, 2012 (kb/d)



As a side note, although Saudi Arabia is known mainly as an exporter of heavier, high-sulfur crudes, the crudes imported into Hawaii are grades of Saudi Extralight and Saudi Superlight, which have much lower sulfur than the Saudi average. Nonetheless, they are high enough in sulfur that they are imported only by HIE (which can handle more sulfur than Chevron because of the hydrocracker).

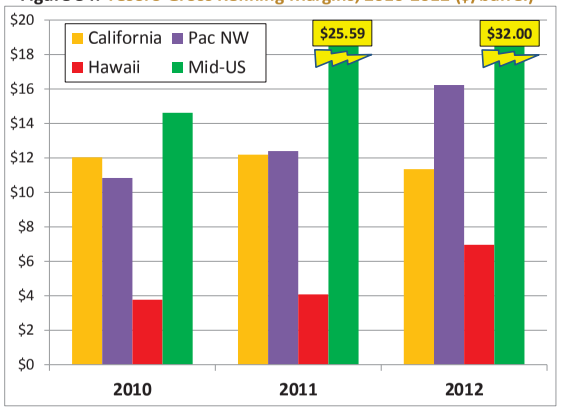
Hawaii has no cheap local sources of refinery fuel. Refining uses prodigious amounts of energy. Not only are large quantities of heat needed, but refining also uses large amounts of electricity. Hydrogen is also important for many purposes, including desulfurization and some forms of cracking—and marginal supplies of hydrogen are usually made from natural gas.

Countries where refiners can buy natural gas and electricity cheaply have an important advantage in operating costs. Hawaii, of course, does not have low-cost sources of electricity (at least not near the refiners on Oahu), and natural gas in Hawaii is all manufactured from oil.

In context of the regional market and competitors, the Hawaiian refiners have a generally poor outlook. This is not a revelation. Both of the Hawaiian refiners have complained about poor financial results for many years, and both have examined selling or closing their refineries (particularly after the disastrous results in 2009, which was a painful year for refiners worldwide).

Chevron does not publish results for its refining regions. (Refining is only a small part of Chevron's business, and Hawaii is only about 3% of Chevron's refining capacity, so nothing happens at Chevron's Hawaii refinery that moves the company's results in a way worth reporting.) Tesoro, however—which is only in the downstream business, without any oil or gas production—publishes details on the performance of its refining groups, and Hawaii is in a group of its own. The gross refining margin (GRM) for these groups is shown in the figure below. (The GRM is the margin between sales value and costs before accounting for depreciation and amortization, so it is possible—even common—to have a positive GRM and have a loss for the year.)

Figure 34: Tesoro Gross Refining Margins, 2010-2012 ($/barrel)



Although Hawaii's results improved substantially in 2012, the HIE Hawaii refinery is always its worst-performing refining group. This reflects the problems discussed above. And, although Chevron does not publish these statistics, Chevron faces the same problems.

Although it has no real bearing on the discussion of Hawaii, the startling GRMs for the mid-US deserve an explanation. HIE's mid-US refineries are in North Dakota and Utah—near the glut of light, sweet crude from the shale revolution. There isn't enough pipeline capacity to move these crudes to other regions, and so they are moved out by railcar—or sold at huge discounts to anyone who can process them locally.

It is important not to let the massive Mid-US GRMs distract from the main point: Even in California and the Pacific Northwest, the GRMs are generally 200-300% of the Hawaii GRM. When HIE announced the sale or closure of the Hawaii refinery, it took some people by surprise, but it was expected by anyone who had been following HIE's filings with SEC.

1.4.4.2. Overview of the Refineries

As mentioned, Hawaii's two refineries face many of the same challenges and share a number of similarities with respect to the external market. Yet they are very different facilities, and are owned by very different kinds of oil companies.

Most of these details will be of interest only to those familiar with oil refining. Three things are easy to note, however. First, the configurations are quite different, with each refinery operating very different kinds of process units. Second, Chevron has far more cracking capacity relative to its crude distillation than does HIE. Third, although HIE does not have a great deal of desulfurization (hydrotreating plus hydrocracking) capacity by Californian standards (only 32% as compared to 107% in California), it has much more desulfurization than Chevron, which has only a tiny 3 kb/cd hydrotreater.

Figure 35: Configuration of Hawaii's Refineries (kb/cd)

Refinery Unit Capacities, kb/cd

	Chevron	HIE
Crude Distillation	54.0	93.7
Vacuum Distillation	30.0	39.5
Hydrotreating	3.0	12.8
Isomerization	1.2	
Alkylation	4.0	
Polymerization	1.0	
Catalytic Reforming		12.8
Fluid Catalytic Cracking	21.0	
Hydrocracking		17.6
Visbreaking		11.5
Asphalt	1.3	1.0
Cracking-to-Distillation*	***39%***	***19%***
Uplift-to-Distillation	***38%***	***30%***
Desulfurization-to-Distillation**	***6%***	***32%***

** excluding visbreaking*
*** including hydrocracking*

Even the most complex refinery in the world cannot make any set of products out of any set of crudes. The proportions of different products are always limited. A refiner cannot buy a barrel of crude oil and turn it into only gasoline, or, more relevant in the case of Hawaii, into only jet. Hawaii's refineries are not the world's most complex. Skills in crude selection and operational strategy can allow some adjustment of output patterns, but the flexibility is limited.

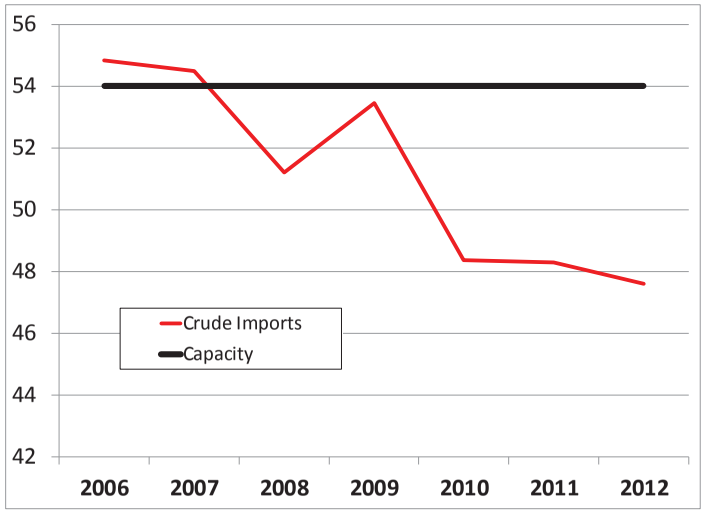
This means that any policy decisions taken by the state—for example, the role of renewables, or the entry of LNG into the market—has repercussions in terms of how well the refiners can match their outputs to Hawaii's needs.

1.4.5. The Chevron Refinery

The Chevron refinery is a small refinery, but is surprisingly sophisticated for a plant of its size. It is a gasoline-oriented refinery. Fluid cat crackers (FCCs) produce excellent gasoline (and comparatively poor diesel and jet fuel), and alkylation, isomerization, and polymerization are all technologies to make high-quality gasoline blendstocks.

Chevron does not publish its Hawaii crude runs, but its crude imports are known, and these form a rough proxy of refinery throughput. (It is only a rough proxy because of stock changes from year to year, and also because Chevron sometimes engages in the unusual practice of importing ultraheavy crude oils and blending them with cutter stock from the refinery to make saleable fuel oil.) Crude imports are shown against refinery capacity in the figure below.

Figure 36: Chevron Hawaii Crude Capacity versus Crude Imports, 2006-2012 (kb/d)

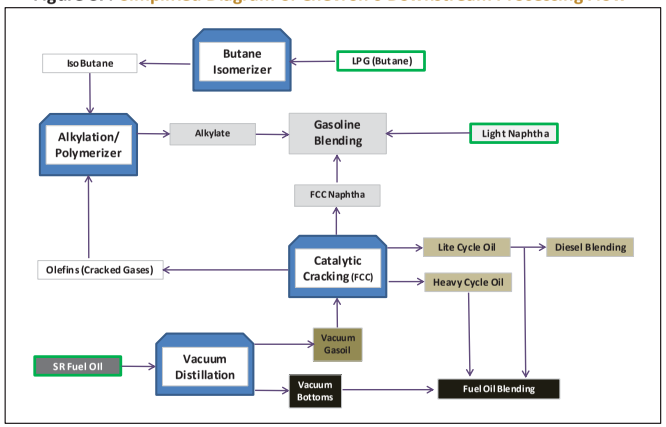


As the figure shows, Chevron typically runs at a fairly high rate of utilization—though imports have been declining since 2009.

Chevron has a global crude production and trading network that gives the company access to a wide variety of crudes. The refinery has at times in recent years imported some of the world's heaviest crudes and some of the world's lightest crudes in an attempt to maintain profitability and meet changing demand patterns and specifications. The one thing that is invariant is that all of the crudes are low-sulfur crudes. Chevron cannot produce road diesel (ULSD) because it has no diesel desulfurizer, but it can produce low-sulfur diesels suitable for other uses (such as utility and marine fuel).

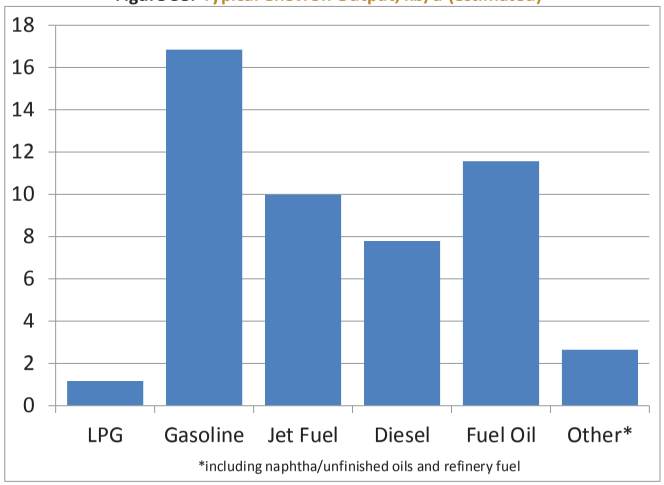
The figure below shows a simplified version of the "downstream" portion of Chevron's Hawaii refinery. The streams outlined in green come from the crude distillation process discussed previously. (Straight-run jet and diesel are not shown.) The diagram makes it clear how much of Chevron's downstream processing revolves around gasoline.

Figure 37: Simplified Diagram of Chevron's Downstream Processing Flow



Chevron does not publish its production or sales statistics. Based on industry sources as well as its crude slates and refinery capabilities, our estimate of 'typical' output at about 50 kb/d output is shown in the figure below.

Figure 38: Typical Chevron Output, kb/d (estimated)



It should be kept in mind that these relationships are by no means fixed. If the market for fuel oil were lower, then Chevron could run a lighter slate. Nonetheless, refinery flexibility is not infinite, and flexibility through adjusting crude slates can become an expensive proposition.

As stated before, Chevron faces many of the same kinds of problems as HIE. It has two advantages, however. First, the capital costs of the refinery were amortized long ago. Second, it has been able to maintain higher utilization rates.

Chevron would be well-placed to make a few further investments in its refinery to adapt to changing circumstances. For a number of reasons, at present this seems somewhat improbable. Hawaii's demand for oil has been declining, and there are strong possibilities that the introduction of LNG, or the effects of the HCEI, or both, will cause oil-product demand to fall further.

In addition, it is not a secret that Chevron is skeptical about investing additional money in refining in Hawaii.

1.4.6. The Hawaii Independent Energy (HIE) Refinery

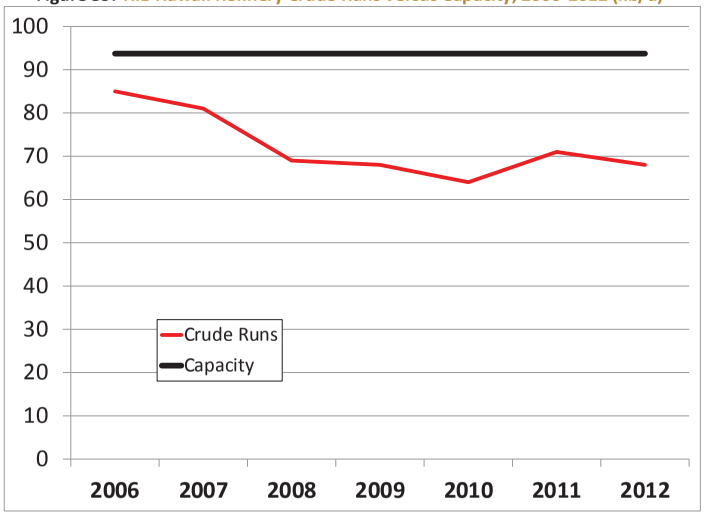
At the end of the summer of 2013, Tesoro sold their Kapolei refinery to Par Petroleum, which restarted the facility as the HIE (Hawaiian Independent Energy) Refinery. Although this name and ownership change took place after the writing of most of this text, throughout the report the facility is referred to as HIE refinery (except when the company Tesoro is meant specifically).

The HIE refinery might be thought of as two interconnected refineries. The original refinery, of less than 30 kb/cd capacity, was expanded slightly and a 17.6 kb/cd hydrocracker was added—a move aimed squarely at the jet fuel market. The hydrocracker gave the refinery a very high cracking-to-distillation ratio and uplift index. A visbreaking unit allowed the VBs to be processed into saleable fuel without large additions of cutter stock to control viscosity. Although hydrocrackers produce superb jet fuel and diesel, they produce poor gasoline blendstock. For this reason, a catalytic reformer was built.

Later, however, the decision was made to expand the refinery's crude capacity dramatically, and to further expand reforming. Conceptually, this amounts to adding a large but rather simple refinery (in industry jargon, a 'hydroskimmer,' because it 'skims' the light products off the top but leaves the fuel oil uncracked) to a highly sophisticated small refinery. This oversimplifies, as there is some synergy involved; but the point is that at higher throughput, the additional output is determined largely by the type of crude processed.

In the middle of the last decade, HIE's utilization was high, but as the figure below shows the trend has been downward. (Unlike the case with Chevron above, the data in the figure show actual crude runs for each year rather than crude imports.) Although the hydrocracker allows HIE to produce some volumes of road diesel, even if somewhat higher-sulfur crudes are used, at the margin HIE needs to buy low-sulfur crudes to meet specifications.

Figure 39: HIE Hawaii Refinery Crude Runs versus Capacity, 2006-2012 (kb/d)

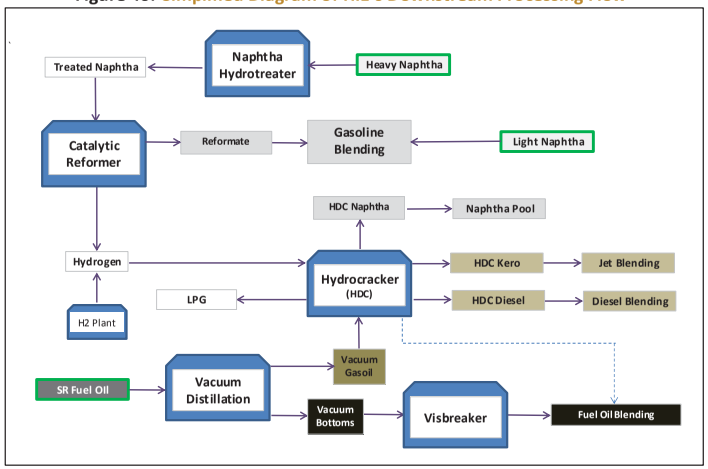


Since the expanded portion of the refinery is a hydroskimmer, when runs are high each additional barrel of crude run produces uncracked fuel oil. When fuel oil demand is high, of course, this presents no problem, but when fuel oil demand declines, HIE must shift to lighter (and usually more expensive) crudes. (To be fair, this applies to Chevron as well—but Chevron can crack a much larger proportion of its straight-run fuel oil output.)

The figure below shows HIE's downstream processing flow. (As with the Chevron diagram, the straight-run diesel and jet are not shown.) The key operation is the hydrocracker, which mainly produces quality jet and diesel, as well as low-octane naphtha. For gasoline blending, HIE uses a catalytic reformer to increase the octane of the heavy naphtha produced. In addition, where the Chevron refinery uses FCC cycle oils to reduce viscosity of VBs, HIE relies on a visbreaking unit.

An important point to keep in mind is that although the HIE downstream processing is sophisticated and somewhat complex, many of these downstream facilities were sized for a smaller original refinery.

Figure 40: Simplified Diagram of HIE's Downstream Processing Flow

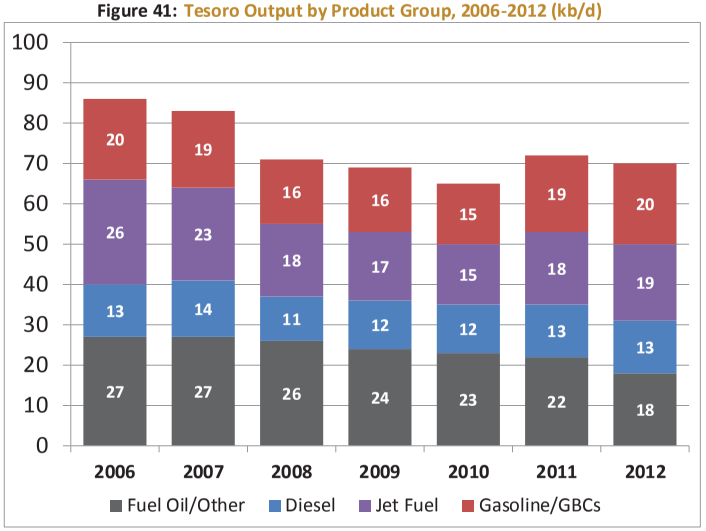


When throughput at HIE is high, the refinery can produce about 70% of Hawaii's jet fuel needs—but it also produces a substantial amount of fuel oil. At the risk of oversimplification, if fuel oil demand is not strong enough to support this volume, then refinery runs fall to cut fuel oil output, and jet fuel output falls as well. At recent levels of crude runs, HIE produces only about 45-55% of Hawaii's jet fuel needs.

Tesoro is a company that is relatively open with its stockholders and with the public, so it publishes a large amount of information about its operations. The numbers shown in the figure below are from Tesoro's reports submitted to the SEC.

Of course, the numbers are somewhat lacking in detail. Some blendstocks are lumped into the gasoline total, and the Fuel Oil/Other category includes refinery gases and unfinished oils burned in the refinery, LPG, and volumes of feedstock sent to the HawaiiGas syngas plant.

Figure 41: Tesoro Output by Product Group, 2006-2012 (kb/d)



The big question is what Par Petroleum has in mind for the refinery. Hawaii's plans to slash oil demand through the HCEI are well-known, and plans for importing LNG have been widely discussed. Par must know that it is entering a market where local demand is likely—though not certain—to decline.

One possibility is to focus more on product exports. Although Hawaii is not at a geographical advantage as an exporter, and Asia—which is expanding refining at a heated pace—is not a logical target, a number of Latin American countries on the Pacific, such as Chile, Ecuador, and Peru, have increased product imports from US refiners dramatically in the last few years. Moreover, the product specifications in these countries tend to be less stringent than in the US. The economics of such a strategy are questionable, but it is one approach.

Another possibility is to invest in the refinery. Like Chevron, Tesoro was not been anxious to put more money into a declining market, but the new operator might feel differently. Although it has been announced that Par agreed to pay roughly $390 million for the refinery, the majority of this was for working capital (in particular oil inventories on hand); the actual purchase price

excluding working capital is much lower, and includes the company's valuable retail network. If the plan is to upgrade the refinery, then the output pattern could change dramatically in the future.

1.5. Oil Product Trade

Oil trade in Hawaii is largely a one-way affair: Oil comes in, but little oil is exported.

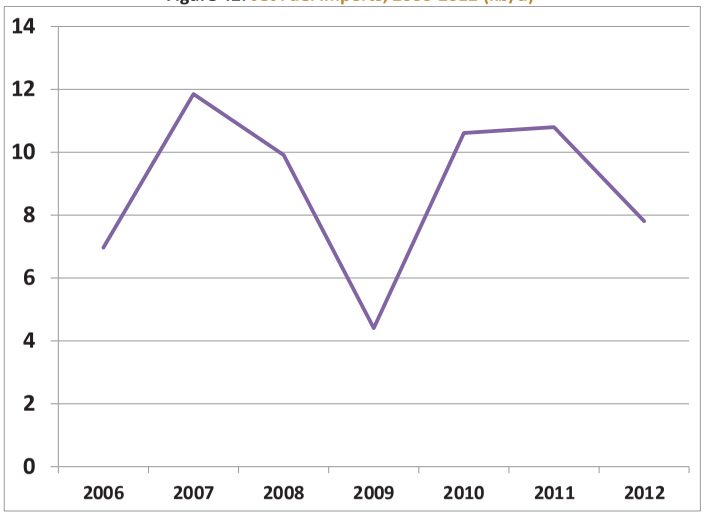
It is also important to note that trade has two possible meanings in the Hawaiian context. Strictly speaking, words like 'imports' are used to denote imports from foreign countries, but from an island perspective it is also useful to consider what is brought into the islands from other US sources.

Of course, official trade records do not track movements between states as imports or exports, so 'trade' statistics do not cover all movements of oil products.

Fortunately, movements of oil products between Hawaii and the US mainland are not frequent or large in recent years. The refiners do bring in small volumes of unfinished oils from the mainland, and sometimes move cargoes of gasoline blending components to US mainland refineries.

Only four products are imported on a regular basis. The most significant of these is jet fuel. Hawaii is chronically short of jet fuel, but imports vary based on fluctuating demand at airports, refinery throughput, and prevailing prices on the world market.

Figure 42: Jet Fuel Imports, 2006-2012 (kb/d)



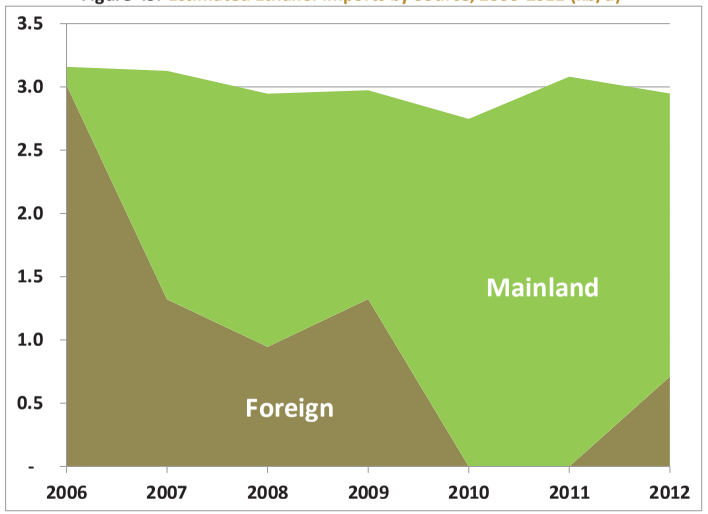
Import statistics for jet fuel are often conflicting depending on source, and with bonded products and a Free Trade Zone in Honolulu, not too much credence should be placed in the exact numbers. In addition, jet sometimes moves for purely commercial reasons; the airlines may import jet to try to push down the refiners' price demands, and the refiners in turn may export cargoes rather than lower their local price.

That said, the only consistent flow of jet is into rather than out of Hawaii, and the 'typical' level of imports in past years was been 9-10 kb/d. During the shutdown period of the Tesoro (now HIE) refinery, however, imports in the April-August 2013 period rose to more than 30 kb/d. (After refinery startup, the imports have declined to their previous levels.)

The second largest product import into Hawaii is not, strictly speaking, an oil product at all. Blending of ethanol into gasoline at 10% by volume is required by law, and Hawaii is not presently a producer. The US mainland is of course a major producer, as are many Latin American countries. Hawaii imports roughly 3 kb/d of ethanol for blending, but the source varies considerably. Initially most ethanol was sourced from the Caribbean, but recently it has

narrowed down to a duel between the US Mainland and Brazil. If the statistics are believed, then in some recent years all ethanol has been sourced from the US.

Figure 43: Estimated Ethanol Imports by Source, 2006-2012 (kb/d)



Hawaii also imports propane on an ongoing basis. Propane imports are unique in that they are primarily delivered directly to the Neighbor Island ports on very small (< 20 kb) tankers. These imports are low in volume (typically less than 700 b/d), but the overall volume in the last few years has increased to over 1 kb/d.

There is reason to believe that economics would favor replacing these long-haul, tiny ships with larger ships delivering to a central point for distribution on short-haul barges. This of course would require expanded storage and receiving on Oahu.

Finally, asphalt is now imported to Hawaii on an ongoing basis, in volumes of 0.5-1.2 kb/d. The Oahu refinery system actually has about 2.3 kb/d of asphalt capacity on the books, but it has been years since it was operational. The change in crude slates (because of the changes in environmental specifications) has pushed purchases of crudes to sweeter crudes. In general,

crudes suitable for asphalt manufacture are also high-sulfur crudes; low-sulfur crudes tend toward the waxy or aromatic end of crude compositions.

1.6. Concluding Remarks

Although Hawaii's oil-product demand has fluctuated over the last three decades, if observed from a distance there is no obvious trend. If viewed naively, the downward slope of recent years might look like one more trough in a series of slow peaks and troughs.

With more insight into the forces at work, however, this idea seems less likely. The following factors make it probable that many fundamentals are being transformed:

- Although oil prices may not stay at their recent peak levels, it is doubtful that they will plunge to anything like the lows of the last few decades: we are probably facing a prolonged high-price environment.
- The HCEI, and especially the RPS, have already begun to chip away at oil demand. If successful, their impact will be massive.
- LNG imports may offer a cheaper alternative to oil and could rapidly displace oil in many uses—especially in the power sector.
- New federal environmental standards mean that the continued burning of LSFO in the power sector has become more difficult and costly. (This may not mean that burning some modified version of LSFO will be impossible).
- Hawaii's refiners already face a challenging and relatively unprofitable outlook. Major shifts in demand patterns threaten their viability.

With all these factors in play, there is little certainty that Hawaii's future oil demand will look anything like the past. The next chapter looks at scenarios of future oil demand in detail.

2. Fuels Demand in the Future

2.1. The Hawaii Clean Energy Initiative (HCEI) and the Renewable Portfolio Standard (RPS)

The HCEI is a system of goals that run from the very specific to the somewhat abstract. The overarching goal is easy to state: 70% of Hawaii's energy from 'clean' sources by 2030. Clean sources are specified as conservation or renewables.

With conservation at play in the mix, it will of course be impossible to tell with any certainty whether the goals have been achieved or not, since this would involve knowing what energy demand would have been in the absence of conservation. (The HCEI acknowledges that some aspects of the goals are 'moving targets.')

The goals are clearest and easiest to measure for the power sector, where the goal is to provide (or, more accurately, to save) 30% of electricity demand by 2030, and to provide 40% of generation from renewable sources. While levels of conservation achieved will always be open to debate, 40% of power generation from renewable sources is a specific and measurable goal.

This level of renewables in power generation—40% by 2030, with milestones along the way—has been agreed to by the electric utilities as a binding plan, and is referred to as the Renewable Portfolio Standard.

In road transportation, the goals are also relatively specific—certain reductions in vehicle miles traveled, increased miles per gallon, increased numbers of electric vehicles, blending of biofuels in gasoline and diesel, and overall volumetric goals for biofuel use in road transport. (It should be noted that some of these measures, such as increased miles per gallon, are not a consequence of the HCEI itself, but will occur because of federal mandates. Similarly, ethanol blending standards exist in at least some seasons in most of the US.)

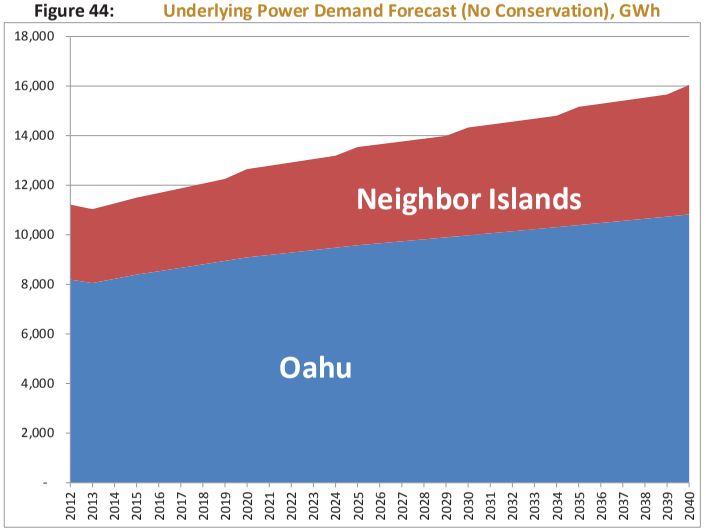
At the other end of the spectrum are aviation and marine fuels, where specific measures are difficult to imagine with present knowledge. The goals remain unaltered—increased conservation and a greater share of renewables—but how these should be achieved is not specified.

2.2. Scenarios of HCEI Effectiveness

It is always possible to imagine higher or lower drivers for scenarios. We have tried to devise scenarios that cover the range of likely outcomes, but this does not mean that these provide estimates of the highest possible demand or the lowest possible demand.

As mentioned before, when conservation goals are in play, there must be an underlying, hypothetical demand. Our underlying forecast—which is in general agreement with the reference basis used by the utilities—is shown in the figure below.

Figure 44: Underlying Power Demand Forecast (No Conservation), GWh



It needs to be understood that these numbers are purely hypothetical, as considerable conservation has already occurred, and these numbers include that conservation as part of demand. They simply form a reference basis for calculation.

None of our scenarios assume major replacement of jet or marine fuels with biofuels, nor do they assume that pure biofuels (rather than 10% and 20% blends) will be used in ground transport. Although there is presently considerable excitement about emerging biofuel

technologies (such as oils from algae, cellulosic ethanol, or renewable jet fuel), not enough is known about the commercial potential to make logical assumptions.

In addition, even members of the HCEI cooperative research team at NREL (National Renewable Energy Laboratory) have expressed doubts that Hawaii can meet the biofuel goals for ground transportation from local sources. In this case, such volumes would have to be imported—just like oil and oil products. Some may argue that there are major environmental benefits because such fuels are renewable—but there are also environmentalists who argue that imported biofuels cause major environmental damage, and are generally managed in such a way that they are not genuinely renewable fuels. We have no position on this topic, but contend that not enough is known to create sensible scenarios for these end-uses.

2.2.1. Scenario 1: Business-As-Usual

Our Business-As-Usual scenario assumes that many of the planned measures of the HCEI falter. In power this does not foresee a reversal of or end to RPS achievements or conservation. Instead, it assumes that the shares of conservation and renewables in power supply stall close to their projected 2015 shares of power. Statewide, this implies that conservation and renewables each provide ongoing shares of electricity of roughly 15%.

In ground transportation, all scenarios assume that planned US CAFE (fuel efficiency) standards will be in place. This scenario sees no change in vehicle miles traveled, but it does assume that electric vehicles will achieve a 3% penetration rate by 2040.

Ethanol blending in gasoline is assumed to continue at 10% volume, and the small share of biodiesel (B20) maintains its share of road diesel.

2.2.2. Scenario 2: RPS Falls Short

In this scenario, conservation goals are achieved in the power sector, but renewables grow their share more slowly that in the RPS, reaching 25% only in 2040 (as opposed to the goal of 40% of power generation by 2030).

In ground transportation, vehicle miles traveled are reduced 1% by 2030, and the penetration of electric vehicles rises to 12% in 2030 and to 24% in 2040.

Blending of ethanol at 10% in gasoline continues, and blending of biodiesel to road diesel rises to 20% by 2020.

2.2.3. Scenario 3: RPS Succeeds

This scenario is identical to the previous scenario except that the RPS achieves its goal of 40% of power generation by 2030.

2.2.4. Scenario 4: HCEI Mostly Succeeds

As in the previous scenario, this case assumes that all goals in the power sector are met. In ground transportation, vehicle miles traveled is cut by 8% by 2030, and the penetration of electric vehicles reaches 15% by 2030 and 40% by 2040.

2.2.5. Summary

The details of the scenarios by year and by Oahu and Neighbor Islands is given in the Appendices, but for easy reference the 2030 assumptions are tabulated below.

Figure 45: **Key Statewide Parameters for HCEI Scenarios in 2030**

	Business-As-Usual	RPS Falls Short	RPS Succeeds	HCEI Mostly Succeeds
POWER				
Conservation	15%	30%	30%	30%
Renewables	15%	21%	40%	40%
ROAD TRANSPORT				
VMT Reduction	0%	1%	1%	8%
MPG Improvement	33%	33%	33%	33%
Elec Vehicle Penetration	2%	12%	12%	15%
Ethanol Blending	10%	10%	10%	10%
Biodiesel Road Blending	1%	20%	20%	20%

2.3. LNG Imports

2.3.1. Offshore versus Onshore/Nearshore

In the wake of falling gas prices on the Mainland, LNG imports into Hawaii now seem like a practical possibility. Indeed, imports of small volumes of LNG in "ISO containers" (essentially tank-truck sized thermos bottles) have already been initiated by HawaiiGas. Real savings in cost terms, however, can only be achieved by bulk imports in tankers or large cryogenic barges.

There are still many unanswered questions about how bulk LNG can be brought in, where the facilities might be sited, and what their capabilities might be. One of the biggest debates has been between Offshore storage and gasification, and Onshore or "Nearshore" storage and gasification.

Without going into detail, Offshore storage and gasification has been generally assumed to mean that only regasified LNG could be brought onshore. This would restrict the use of gas to Oahu, and to uses such as the power sector and utility gas. It would largely bar the use of LNG or CNG in ground transport or shipping.

With Onshore LNG, or Nearshore LNG (where the floating storage unit is in a sheltered area), LNG can be used in transport and similar uses. In addition, the LNG can in principle be offloaded onto barges or ISO containers and transported to Neighbor Islands.

It has been concluded by most of the preliminary studies that offloading of LNG from deepwater, Offshore LNG is not generally feasible because of wave heights in the Pacific. But recently this has been questioned, and some now claim that it is feasible—or feasible under most ocean conditions. We are not marine engineers, and so cannot comment except to note that the experts are at odds on the subject.

Initially we planned to have three LNG scenarios: 1) No LNG; 2) LNG Offshore; and LNG Onshore/Nearshore. This has been reduced to two scenarios—No LNG Imports and LNG Imports, with the latter scenario assuming that LNG would be available statewide (whether offshore, onshore, or nearshore).

The former "Offshore" scenario (which might be called the Only-Gas-and-Only-On-Oahu scenario) has been abandoned partly because of possible misunderstandings or controversy, and partly because it increases the number of total scenarios by 50% (12 total scenarios as opposed to 8—see the next section for clarification) without adding much useful information. In terms of the impact on oil product demand and oil shipping demand, the "Offshore" scenario is between the No LNG Imports and the Onshore/Nearshore option. The possible outcomes in terms of oil-product demand are fully bracketed by the two scenarios we have selected.

2.3.2. Stepwise Analysis

For simplicity of assumptions, the LNG scenarios are subsidiary to the HCEI Effectiveness Scenarios. In other words, in a given case, LNG is only allowed to substitute for whatever is left over after the reductions of the HCEI assumptions are calculated. To take a simple example, if we choose a scenario where the RPS is successful and reaches 40% of power generation, then the amount of oil that can be substituted by gas is limited to whatever oil is left after renewables have been deployed.

It might seem that this is missing a key possibility: Suppose that LNG is so cost-effective and useful that the HCEI is derailed in favor of LNG? In the view of some, this is not an implausible conjecture.

This possibility is amply covered by the Business-As-Usual and RPS Falls Short Scenarios. The assumptions say nothing about why HCEI goals are not met; it could be a policy change, or it could be as a result of LNG stalling further renewable development. For purposes of projecting future oil demand, the why doesn't really matter.

At the opposite end of the spectrum, it would be possible to argue that the HCEI should take precedence. This is also covered by the stepwise approach, in that LNG only replaces what is left after the HCEI assumptions have been applied.

2.3.3. LNG Assumptions

In the LNG Imports scenario, we assume that bulk LNG will not be available until after 2020, but that LNG in ISO containers will be available much sooner. We assume that LNG will substitute for 15% of HawaiiGas' existing SNG by 2015, and increase to 100% by 2020.

In the power sector, it is assumed that 85% of remaining (after accounting from renewables and coal) oil-fired generation will be substituted by LNG on both Oahu and Neighbor Islands by 2025.

It is assumed that LNG will provide 20% of power for heavy-duty vehicles by 2030, and 50% by 2040. In CNG for light-duty vehicles (passenger cars and small trucks), the economics are less favorable, and penetration is limited to 3% by 2030 and 10% by 2040.

2.4. Other Key Assumptions

2.4.1. Power Sector Fuels

When the new EPA regulations were announced recently, it appeared that most fuel-oil burning power plants in Hawaii would either have to add expensive scrubbers or switch away from fuel oil. The problem with adding scrubbers is that in a situation where the industry is poised to switch away from oil in general, adding scrubbers that would be used for only a few years would result in massive additional costs to power consumers.

A fuel switch—assumed to be from fuel oil to low-sulfur diesel in most cases—would have come as soon as 2017/18. In some of our previous analyses, it was assumed that a large volume of diesel would be substituted for fuel oil unless a waiver could be obtained until alternative generation sources (additional renewables or LNG) could be brought online.

Since then, some of the dates for implementation have slipped. In addition, some test results suggest that the fuel oils burned in the power sector in Hawaii are not as far from meeting the new specifications as feared. It appears that a compliant fuel oil could be blended—possibly by the refiners, possibly through additives. In some cases, it appears that blending 10% or less diesel into the fuel oil might solve the problem.

There are reasons for everyone to hope that a solution other than a full diesel switch can be found, as such a switch would be hugely disruptive. Fuel oil demand would suddenly drop, leaving the refiners with excess fuel oil to export, and diesel demand would surge far beyond the capabilities of the refiners to produce, resulting in huge imports of diesel. And, then, after this major change, LNG might enter the equation and slash the diesel demand. It is a scenario that benefits no one (with the possible exception of shippers and some overseas diesel exporters—though even they might have a short ride).

We believe that the most likely solution is for some sort of modified fuel oil, or specially blended fuel oil, to be burned in coming years. But if this requires up to 10% diesel, or up to 10% additive, how can we account for this in our projections?

Our solution has been to calculate 10% of power fuel oil (10% PFO) in all scenarios. This is a rough gauge of the amount of fuel oil that might need to be replaced by diesel or additives. In

essence, this means that the fuel oil demands shown here might be too high by as much as the 10% PFO. If it is assumed that the volume needs to be made up from diesel, then the diesel demand might be low by that amount. (Actually, since diesel has lower energy content per barrel than fuel oil, the amount of diesel needed would be roughly 1.07 times the amount of the fuel oil decrease.) If the additives are non-refinery additives, then the fuel oil might be low by as much as 10% PFO, and imports of additives in a corresponding volume would be needed.

In the present state of knowledge, this is a way to provide a quantitative margin of uncertainty to the volumes involved. When the most likely approach to the problem becomes clear over the next year or so, the forecasts can be modified by knowing this margin.

2.4.2. IMO/MARPOL Standards

Hawaii is within the North American Emissions Control Area (ECA) designated by the International Maritime Organization (IMO). Beginning in 2015, ships inside the ECA will only be able to burn fuel with 0.1% sulfur or less—a level well below Oahu's low-sulfur fuel oil (0.5%). Fuel oil of 0.1% is virtually nonexistent.

A number of possibilities exist for meeting these new standards—including onboard scrubbers or conversion to LNG bunkering—but these are not practical alternatives in the immediate future.

What is most likely to happen, at least through 2020, is that ships moving interisland and ships moving between Hawaii and the North American Mainland, will burn low-sulfur diesel. Ships arriving in Hawaii from other areas will burn high-sulfur fuel oil until they enter the ECA, and switch to tanks holding low-sulfur diesel for their time in the ECA. (Time in the ECA could be quite extended if they then move on to the US West Coast.)

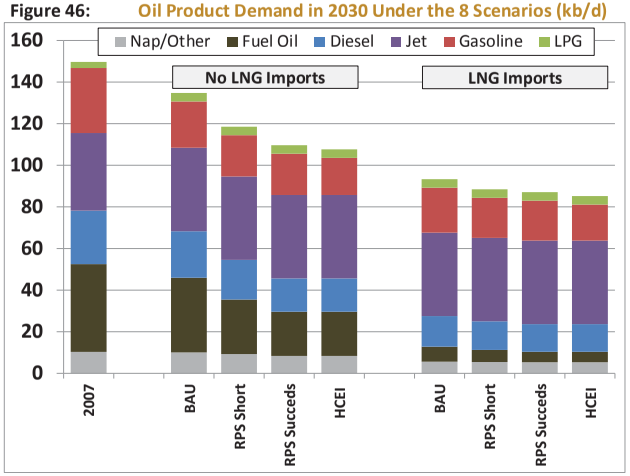
From the point of view of Hawaii's oil demand, this means that most fuel-oil bunkering on Oahu will switch to low-sulfur diesel beginning in 2015. We continue to carry forward a demand for 1 kb/d of fuel-oil bunkering for ships that may elect to pick up fuel in Hawaii (even if they cannot burn it in Hawaiian territorial waters).

2.5. Demand Results From the Scenarios

It is always difficult to summarize results that span multiple products over a range of years under several scenarios. All of the details by product, year, and scenario are given in the Appendices, but here is best to concentrate on a few key graphics.

The figure below shows demand by product for each scenario in the year 2030—the ultimate target year for the HCEI goals, and a year far enough in the future that LNG imports (if they come) could be fully deployed.

Figure 46: Oil Product Demand in 2030 Under the 8 Scenarios (kb/d)



Taking 2007—a peak year—as a base, even under the Business-As-Usual Scenario with no LNG, future demand is expected to be lower. This is partly the result of higher overall oil prices, but is also the result of conservation and renewable measures already undertaken, as well as national measures like the CAFE mileage standards.

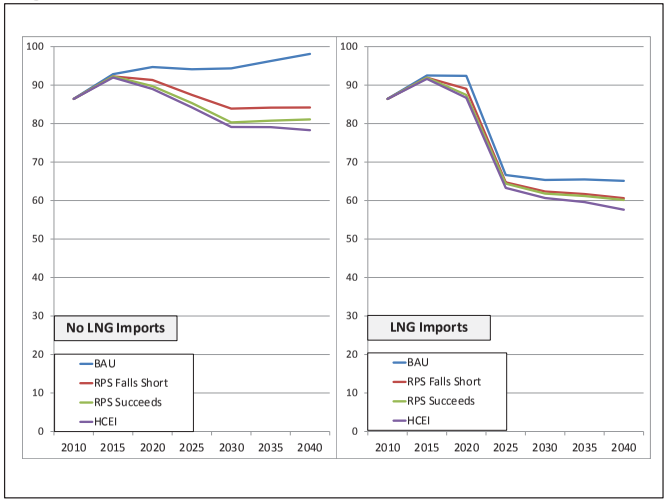
Additional scenarios with increasing success of the HCEI continue to whittle away at oil demand. Keep in mind that the underlying energy demand is relatively vigorous; it is oil that is being displaced.

It is also worth noting that it is the power-sector fuels that are affected the most, followed by road transport fuels. Jet fuel is not affected, and so its importance in the energy mix continues to rise.

LNG imports could take a huge bite out of demand—even in the Business-As-Usual case, where HCEI measures stall out. In this case, of course, fuel oil is driven near to extinction—and jet fuel rises vary close to half of oil demand. This is a demand slate no refinery can match.

The figure below shows the overall oil-product demand for Oahu in the various scenarios. An interesting feature for Oahu is how closely the scenarios are grouped when LNG imports are assumed. On Oahu, oil for power demand is readily substituted for by LNG, but many of the other oil demands that are not strongly affected by either LNG or the HCEI—jet fuel and marine bunkering, for example—are disproportionately concentrated on Oahu.

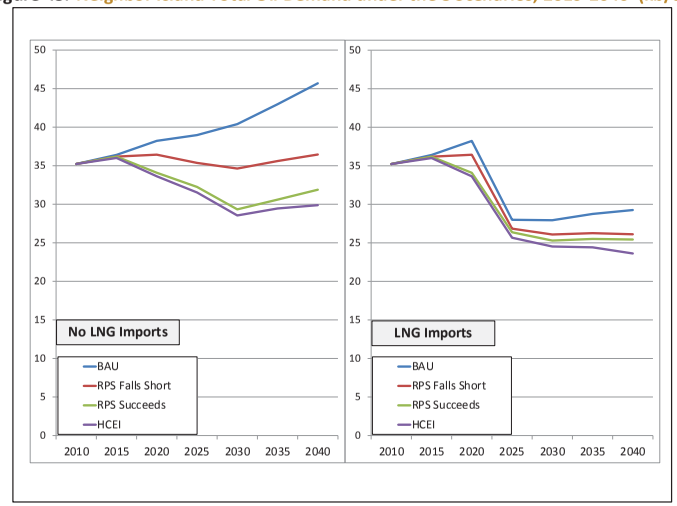
Figure 47: Oahu Total Oil Demand in the 8 Scenarios, 2010-2040 (kb/d)



Of special interest to the present project are the oil-import needs of Neighbor Islands under the various scenarios. In general, the "spread" of scenarios on the Neighbor Islands is wider than on Oahu—this again reflects the fact that the demand not affected by policy (jet and bunkering)

form a larger share of Oahu's demand. Put another way, demand on the Neighbor Islands is potentially much more policy-responsive.

Figure 48: Neighbor Island Total Oil Demand under the 8 Scenarios, 2010-2040 (kb/d)



2.6. Implications for Product Imports

2.6.1. Projected Output Patterns of the Refineries

Getting from product demand to product imports might seem like a relatively simple matter. All that is needed is to start with demand and subtract out whatever the refineries might provide. This is in fact the case, but the output pattern of the refineries is far from fixed. The crude runs for each refinery can be varied. In an abstract sense, the runs can be varied from zero up to the maximum capacity. In practice, overheads and various operational constraints are such that refineries normally only operate in the range of about 60-98% of capacity, and 75-95% is more commonly seen. Even that leaves a substantial range: with Hawaii's installed capacity, that represents a possible fluctuation of about 30 kb/d—nearly a quarter of today's total demand.

In addition, this simple calculation doesn't reckon with possible changes in the crude slate. Hawaii runs a very low-sulfur crude slate, but the API gravity (density) of the crudes is rather middle-of-the-road—typically 32-37°API, with Tesoro/HIE generally at the low end of the scale.

Recent years are not a good guide to the capabilities of the refineries. Chevron has been running somewhat below capacity, and Tesoro had been running considerably below capacity. The moderate API of the slate is partly because light crudes are more expensive, but also because there is still a substantial fuel oil market in Hawaii.

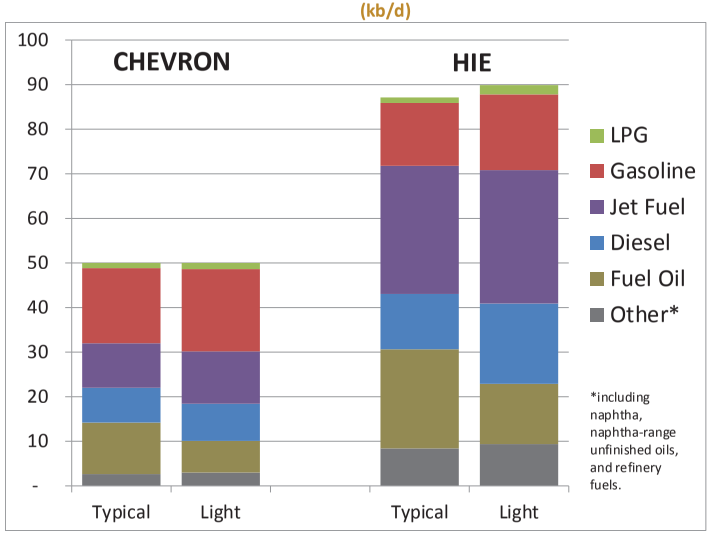
Although Hawaii's refineries are not the most flexible facilities in the world, they are still able to make substantial adjustments in their output patterns through a process of selecting the proper crude slate and changing the operating strategy. The strategy selected will invariably be a combination of adjusting the crude slate and strategy based on demand patterns, the differences in the cost of various crudes, and the strategies adopted by competitors.

It is possible to model such behaviors. Indeed, the refineries themselves employ complex optimization models (usually linear programming models or 'LPs") to select crudes, throughput levels, and operating strategies for their units. We have often constructed such models for various purposes, but applying LPs to behavior many years or decades into the future goes well beyond the scope of this study. (In addition, predicting relative prices and corporate investment policies out through 2040 involve huge uncertainties.)

Nonetheless, it is important to recognize that there is some flexibility in the refining system. The figure below shows our estimates of refinery output at high crude runs with lighter crude slates. In the case of Chevron (which already has a lighter crude slate), this assumes a switch to a 50:50 mixture of Benchamas (already an important crude) and a very light crude such as Bekapai.

In the case of HIE, the move to a lighter crude slate assumes an elimination of very heavy crudes like Duri, Pyrenees, and Escalante, in favor of light (38°API) crudes similar to Sokol. It also assumes running the hydrocracker at higher throughput rates. (This should be easy to accomplish at the high throughputs assumed here.)

Figure 49: **Hawaii's Refineries: Typical and Lighter-Slate Outputs at Higher Utilization (kb/d)**



These levels of production assume a slight increase in Chevron's total throughput of crude, and a substantial increase in Tesoro's recent throughput. (The new owner's at HIE have said that they plan to return the plant to high levels of throughput.) In that sense, these numbers represent upper limits of likely product output.

It is important to understand that these are essentially "reference" output slates. Either refinery could easily run at lower rates (they have been doing so for several years). Within certain limits, the crude slates could be adjusted, with consequent changes in output; in particular, it is always easy to move to a heavier slate and produce more fuel oil.

Furthermore, in the blending process in the refinery, some adjustment can be made between adjacent product classes. A classic example is jet fuel and diesel, where a fraction of the blendstock can be "upblended" to jet fuel or "downblended" to diesel. There are limitations (determined by product specifications) on how far this can be carried, and most refiners are typically pushed up against a specification constraint. (For example, in Hawaii, often the refiner is already upblending as much as possible to maximize jet fuel output.) The point is that the

lines between product categories are often not hard and fast boundaries, and can sometimes—but not always—be nudged a bit in favor of one product or another.

The levels and patterns of output shown in the figure above are certainly technically feasible. Whether they are economically practical—especially if demand continues to decline—is very much open to question. If both refineries are operating at these levels, in most years in most demand scenarios, Hawaii becomes a significant net exporter of refined products. To date, neither refiner has decided that this would be economically attractive. Once again, both refineries running at this level of throughput represents something near the upper limit of what is possible.

2.6.2. Imports: Refinery Operation Cases

While both refineries running indefinitely at high throughput seems improbable in the face of stagnant or declining demand, high throughput becomes more likely for either refinery if their neighbor closes.

There are essentially four possible cases:

- Both refineries operating
- Chevron operating
- HIE operating
- Both refineries closed

It is vital to recognize that as we move forward in time toward 2040, it is quite likely that the actual outcome will switch from one case to another, and possibly switch more than once. To take one possible outlook, it is easy to imagine that both refineries will be operating in the near future, but only one will be operating in 2020, and none might be operating in 2030.

For simplicity, in this chapter we do not discuss product-by-product import needs under the various cases, as the amount of data involved is huge. In addition, although the difference between "Typical" and "Light" output slates affects the pattern of product imports, it has very little effect on the total import needs.

In this chapter, we also exclude LPG imports from the total imports, as the types of ships and storage are quite different from other products. In addition, LPG imports seem likely to grow in all scenarios, irrespective of refinery operation levels.

Detailed results by products (and including exports) are given in the appendices. It should be mentioned that while determining the import levels involves no more than arithmetic, there are some nuances. In particular, if a refinery closes, it also slightly affects demand, since the need for refinery fuel drops (and refinery fuel is part of demand).

The results of the various demand scenarios and refinery-operation cases are shown in the figure below. These should be understood as indicative of minimum required levels of imports in the three cases where refineries are operating, since it is always possible for the refineries to operate at lower throughput.

Figure 50: Product Import Scenarios (Typical Output Slates), (kb/d)

Product Imports--No LNG	BOTH REFINERIES	CHEVRON ONLY	HIE ONLY	NO REFINERIES
	Business-As-Usual LNG Imports			
2015	0	74	39	122
2020	1	78	43	126
2025	3	78	43	126
2030	6	79	44	127
2035	9	84	48	132
2040	12	88	53	136
	RPS Falls Short--LNG Imports			
2015	0	76	39	122
2020	1	75	38	121
2025	1	70	33	116
2030	1	66	29	111
2035	2	67	30	112
2040	2	67	30	113
	RPS Succeeds--LNG Imports			
2015	0	76	39	122
2020	1	71	34	117
2025	1	65	28	110
2030	1	57	21	102
2035	2	58	21	104
2040	2	60	23	105
	HCEI Mostly Succeeds--LNG Imports			
2015	0	76	39	121
2020	1	70	33	116
2025	1	63	26	108
2030	1	55	19	100
2035	2	56	19	101
2040	2	58	18	100

Product Imports--LNG Imports	BOTH REFINERIES	CHEVRON ONLY	HIE ONLY	NO REFINERIES
	Business-As-Usual LNG Imports			
2015	0	74	39	122
2020	1	76	43	124
2025	1	44	23	87
2030	1	42	21	86
2035	2	43	22	87
2040	2	42	21	86
	RPS Falls Short--LNG Imports			
2015	0	76	39	121
2020	1	73	38	118
2025	1	44	21	84
2030	1	41	18	81
2035	2	40	17	80
2040	2	39	15	79
	RPS Succeeds--LNG Imports			
2015	0	76	39	121
2020	1	69	34	114
2025	1	44	21	83
2030	1	41	17	80
2035	2	40	17	79
2040	2	39	15	78
	HCEI Mostly Succeeds--LNG Imports			
2015	0	75	39	121
2020	1	68	33	113
2025	1	42	19	82
2030	1	39	15	78
2035	2	38	14	76
2040	2	39	12	73

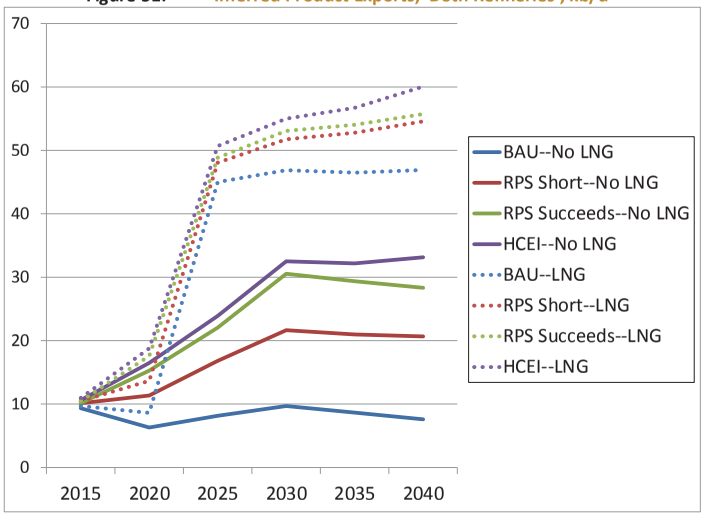
The overall results match with common sense: with both refineries running at high throughput, import needs are negligible. Import needs take a large jump if Chevron is closed and HIE continues operation, and an even bigger jump if the situation is reversed; this reflects the difference in capacity between the two refineries. Finally, with both refineries closed, product imports equal product demand.

As with most major industrial operations, the supply side of the equation is "lumpy." True, it is possible to scale back operations, but there comes a point where the economics of production no longer work; a plant closes and supply takes a sudden drop.

As in the demand scenarios shown earlier, the effects of the HCEI and of LNG substitution can both be seen, with each contributing significantly to the fall in import needs.

There is an important item that does not show in the previous figure, however, and that is the inferred product exports if both refineries are running at high throughput. In most scenarios other than the BAU with no LNG, the exports reach rather high levels.

Figure 51: Inferred Product Exports, 'Both Refineries', kb/d



This shows the challenge of running the refineries at high throughput. Even the exports of around 10 kb/d that would be seen in 2015 are not negligible: that amounts to about 3.7 million barrels each year. There may or may not be a loss associated with each barrel exported, but there is little doubt that the economics are less attractive than selling the products locally (thereby avoiding the transport cost).

With one or the other of the refineries closed, of course, export levels are negligible for most products—with one exception. When LNG imports displace oil in the power sector, fuel oil exports rise. This is especially significant in the case of HIE—although it can be partially ameliorated by moving to a lighter crude slate.

The fact that the viability of the refiners is severely challenged by both the HCEI and by LNG imports should not be surprising. The primary aim of both policies is to cut oil demand. To a refiner, that amounts to cutting the market for the refinery's output. That lowers revenues, and also increases the cost per barrel of product (since many refinery costs are fixed).

A question often posed is what effect would be seen if, for whatever reason, LNG displaced renewables. (We take no position on whether this is probable or desirable.) The answer is that it would obviously increase the need for LNG imports, but from the point of view of this study it would not have a major impact. The main displacement of renewables would be in the power sector, but it would amount to swapping one oil substitute for another: it does not have a substantive effect on oil-product demand.

2.6.3. General Implications

Product imports into Hawaii fluctuate, but in general they are less than 15 kb/d, with the bulk of that being jet fuel, along with a small but steady flow of asphalt and LPG.

With the closure of either refinery, the need for imports increases substantially. In cases other than the Business-As-Usual case, the increase is gradually eroded across time as the effects of conservation and fuel substitution become more pronounced.

Would these possible increases in imports present a crisis for Oahu's import infrastructure? The definitive answer is: It depends.

2.6.3.1. Refinery-to-Terminal Conversion

Either of the refineries could be converted into an import terminal. This practice is now so common on the US East Coast that it is often referred to as an acronym, RTT.

In event of RTT conversion of either refinery, Oahu's overall infrastructure is, if anything, overbuilt. As seen in the previous chapter, there is ample tankage on the island, and tanks at many end-user sites (notably HECO and Red Hill) are in excess of any envisioned needs. This is even more the case if crude tanks at the two refineries are repurposed to product storage.

The import capacity of the pipelines at the refineries is huge. At present, the pipelines are not licensed for anything near the volumes of product that would be required (they are licensed for large volumes of crude and small volumes of products), but repurposing should be relatively easy.

And, of course, if both refineries were to close and convert to import terminals, the import infrastructure would be far in excess of what is needed.

This sweeping statement requires two caveats. First, infrastructure for LPG is inadequate without the refiners operating, and requires different infrastructure from other oil products.

Second, conversion of one or both refineries to import terminals might or might not solve the problem of demurrage and operational constraints at Pier 51A. If a refinery is converted to an import terminal, the owner might or might not allow the new terminal to be used for third-party imports—and third-party imports are the bulk of jet fuel imports that arrive at Pier 51A.

2.6.3.2. Full Closure

If either refinery elects to close and is not repurposed as an import terminal, it would definitely stress the import system. Providing the state with needed fuel would be a major challenge, and would require the cooperation of everyone involved: in particular, the remaining refiner; Aloha (through its import terminal); HECO, and HFFC.

Our own evaluation is that it would be difficult, but not impossible, to meet fuel needs even if one refinery site were to close fully. We have also discussed the problem informally with a number of industry analysts, who agree that it would be possible—but all of whom emphasize that it would require some changes and considerable advance notice.

In the event one refinery closes and does not reopen as a terminal, the first response of the other refiner would be to increase crude runs—but this would not be nearly sufficient to solve the problem.

The second response would be to bring more products in through the refinery. This creates logistical problems for refinery operations (one reason for the need for advance notice), but in principle the refinery bring in considerable volumes of products and push them out to end-user storage as quickly as possible.

The third response would be to turn to Aloha. Aloha has import capacity through KBPH for gasoline and diesel, as well as interconnections with the refineries. It would certainly be possible to employ the Aloha terminal as a partial means of serving Oahu.

The fourth response would be to increase the use of KBPH and HMT for imports. A considerable volume of these could be transshipments—direct imports into KBPH, for example, which are then loaded for neighbor islands. This might be particularly important in the case of jet fuel, where transshipment of jet at KBPH could relieve pressure on HFFC.

A key problem is the pipeline infrastructure. This would be particularly important if the HIE infrastructure was taken out of commission, as Chevron's present connection to KBPH is through HIE.

Of course, it is unlikely that needed infrastructure would remain permanently unavailable, but at present there is no plan for how to handle a full refinery closure. As mentioned before, this is an emergency preparedness issue where the State ought to develop a plan in cooperation with the refiners for supply in event of a disaster that curtails operations. We consider this to be a bigger risk than a sudden and complete closure of a refinery, terminal, and pipeline system.

If Chevron fully closes and HIE remains open, many problems are minimized. Clean products, including jet, can be brought in at KBPH and moved to Aloha, and many end-users can be serviced, including HFFC…if the owners of the HIE facility allow it. (This is an issue related to competitive advantage. At present, for example, we are told that Chevron's agreement with HIE for use of the HIE line to KBPH rules out the transit of jet fuel.)

If HIE fully closes and Chevron remains open, then there are a number of infrastructure questions that need to be addressed. The first and most pressing is the use of the HIE pipeline

system—specifically the line connecting the HIE refinery to KBPH, which is Chevron's access to KBPH. Chevron has excellent clean line capacity to Honolulu and HFFC (including a dedicated jet line), but the interface between KBPH and the Chevron lines is the HIE-KBPH line. (The Aloha-KBPH and Aloha-Chevron lines may be a possible workaround, but this is bound to be suboptimal, and maybe not feasible for some products.)

Secondary—but vitally important—issues if HIE fully closes are the supplies of feedstock to HawaiiGas, and fuel oil to the Kalaeloa Partners power plant, which appear to be served directly from the HIE refinery.

In most of our demand scenarios, the need for fuel declines in the future, so that the full closure of a refinery becomes progressively less troubling as time moves on.

And if both refineries close and do not undergo an RTT conversion? This would be a true emergency, and would require that the State step in, probably invoking eminent domain. We consider this case to be an extremely remote possibility. Major refiners don't suddenly slam the doors and vanish; it's bad for business elsewhere. Furthermore, operation as a terminal allows the company to continue to maintain existing contracts as well as its own marketing network. There might or might not be enough demand to make two RTTs attractive in the future, but there is probably enough demand to justify at least one.

2.6.4. Implications for KBPH

- In most scenarios, apart from jet fuel and LPG, demand for fuels in Hawaii show a steep downward trend.
- LNG has the potential to be as important, or even more important, than the HCEI in cutting Hawaii's oil demand—but there appear to be few onshore or nearshore sites appropriate for siting an LNG import facility.
- Neighbor Island demand is subject to the same forces as Oahu's demand, but in most scenarios Neighbor Island demand is somewhat more resilient than Oahu's. Since the costs and details of LNG distribution to Neighbor Islands is less certain than on Oahu, the Neighbor Islands oil-product demand could easily be higher than shown in our LNG scenarios.

- If both refineries are run at full capacity, then in most scenarios the need for imports is small—but in most scenarios, this results in the need for large and growing product exports, which may face poor economics.
- If either refinery or both refineries are converted to import terminals, imports will increase—but the import terminals should be able to handle the additional load.
- In cases where a refinery closes, more LPG imports will be needed, and there are limitations on the infrastructure for this. Indeed, increased LPG import infrastructure may be desirable in any case to lower freight rates.
- If a refinery closes down without converting to an import terminal, then the demand for direct imports at Pier 51A, KBPH, and possibly HMT, could be increased—especially to serve transshipment needs to Neighbor Islands.
- There are other factors that could result in small increased imports above those cited here, as this analysis looked at net imports. Although jet fuel may be a major net import, it may also continue to be a two-way trade in some scenarios, as end-users may wish to procure some of their own deals internationally rather than buy from refiners (or importers after RTTs). Chevron is unable to produce ultra-low sulfur diesel and already imports its (relatively small) sales volume.

The baseload demand on KBPH will be its share of movements from Oahu to Neighbor Islands. Beyond this, there is the question of what might happen in a "one-refinery-only" Oahu, where one refinery closes and does not convert to an import terminal. In this case, KBPH might find itself receiving imports destined for Neighbor Islands—thereby effectively doubling the expected volumes of oil handled in the harbor. In addition, it is possible that pressure on Pier 51A might argue for some of Oahu's own jet fuel needs being imported at KBPH.

One limitation faced in using KBPH as a transshipment terminal for imports to serve Neighbor Islands is the possible lack of storage accessible from KBPH. The refinery tank farms are of course the first resource in this regard, but if one of the refineries is fully closed, then the storage situation could become a bottleneck.

Potentially the Aloha Petroleum terminal could serve to handle at least diesel and gasoline transshipments, receiving, holding, and re-exporting product through KBPH. This unfortunately

would not solve the critical issue of jet transshipment (unless Aloha chose to add jet tankage at its present tank farm).

In addition, if HECO builds an access line to import fuel directly from KBPH to their Barber's Point tank farm, this could potentially be used to receive and re-export fuels for power generation.

These considerations go beyond the scope of the present study, which was designed to be a description of the basic supply and demand situation, and scenarios of future demand and import requirements. Nonetheless, future work needs to take a broader look not only at the harbors but also at the onshore infrastructure, the control of that infrastructure, and the logistics optimizing supply in event of refinery closures or physical disasters.

2.6.5. Quantification of Uncertainties: Specific Scenarios

2.6.5.1. The Problem

Taking all variables into account, the future oil-shipping demand on KPBH could fall significantly, or in some scenarios, could rise substantially. Depending on the future of the refineries and whether they are converted to terminals, it is even possible for demand on KBPH to rise and then fall sharply. Here we can do little more than outline the range of possibilities.

Based on DOT data for FY 2012, a rough overview of the total demands on KBPH at present are given in the following table.

Figure 52: DOT Data On Use of KBPH for Fuels, FY 2012 (kb/d)

	Barge	"Overseas"*	TOTAL
LPG	-	0.5	**0.5**
Gasoline	6.5	0.2	**6.6**
Jet Fuel	5.0	0.1	**5.1**
Diesel	7.1	5.7	**12.8**
Fuel Oil/Other**	5.6	1.4	**6.9**
Ethanol	0.2	0.7	**0.9**
Asphalt	-	0.9	**0.9**
Bunkers	0.9	3.3	**4.1**
TOTAL	**25.2**	**12.7**	**37.8**

* All traffic apart from Interisland. Data does not distinguish between imports and exports.

The largest element in fuels-handling at the port is supply to Neighbor Islands. If the bunkering of the barges in included, this accounts for almost exactly two-thirds of the demand for throughput.

There are actually considerable uncertainties about the current utilization of the KBPH terminal for oil product movements. The DOT data system tracks movements by "Barge" and "Overseas" (the latter including both international shipping and shipping to and from the US Mainland), but it doesn't track directionality; we are told it is not able to distinguish between fuel shipped to the port and fuel shipped from the port. There is also believed to be some amount of double counting, since what is tracked is the volume handled, and cargoes or portions thereof may be handled multiple times.

There are six specific elements driving demand for oil movements through KBPH:

- Neighbor Island demand (including ethanol) through barge deliveries.
- Imports of products from US West Coast and international sources. (Some share of these may be then be re-exported by barge to Neighbor Islands.) This is included in "Overseas."
- Exports of excess products from the refineries.

- Bunkering
- Imports of LPG.
- Imports of asphalt.
- Imports of ethanol.

2.6.5.2. Neighbor Island Demand via Barge

Generally speaking, Neighbor Island demand is served by barge. (The two exceptions to this, LPG and asphalt, are discussed separately below.) There have at times in the past been deliveries of fuel on the Big Island by small tankers after the tanker dropped the bulk of its cargo on Oahu.

The barge traffic is effectively a one-way transaction, with loadings on Oahu and deliveries on Neighbor Islands. Although there are problems in interpreting the DOT data, the loading of barges is relatively straightforward. Based on FY 2012 data, the estimated balances for barge traffic are shown in the table below.

Figure 53: Barge Movements of Fuel to Neighbor Islands, FY 2012

	DOT Barge Movements KBPH		Neighbor Island Demand	Implied non-KBPH Movements*
	bbl	*kb/d*	*kb/d*	*kb/d*
Gasoline	2,356,358	6.5	10.7	4.3
Jet Fuel	1,811,293	5.0	6.4	1.5
Diesel	2,608,611	7.1	9.4	2.2
Fuel Oil	1,102,535	3.0	3.0	0.0
Other**	925,196	2.5	2.5	0.0
Ethanol	58,206	0.2	0.2	0.0
NI Total	**8,862,199**	**24.2**	**32.2**	**8.0**

* attributed to Chevron's Honolulu Marine Terminal

** excluding asphalt and LPG. Primarily naphtha. Included in "Fuel Oil" in DOT data system.

It appears that Chevron's Honolulu Marine Terminal (HMT) handles about 25% of the total interisland fuels traffic. (It is worth noting that HMT no longer handles black products; all supplies of fuel oil to Neighbor Islands now move through KBPH.) As a basic assumption, this proportion of Neighbor Island demand might be held constant. It should be kept in mind, however, that if Chevron chose to withdraw from the market entirely, that this volume of demand might be transferred to KBPH.

2.6.5.3. Overseas Imports and Exports of Products

At present, the majority of trade in oil products between Hawaii and other locations is carried out through KBPH. This is not a one-way trade; products are both imported and exported. Some of these are matters of temporary volumetric imbalances, but product specifications also play a major role.

As seen in Figure 52 previously, the largest trade volume is in diesel fuels. Chevron cannot produce EPA-certified, ultralow-sulfur diesel fuel, and the HIE refinery can produce only certain volumes. This means that the same refiner may find itself both importing and exporting different grades of diesel fuel.

Refiners may also find themselves producing an excess of some kinds of gasoline blending components, while still needing to import components mandated by law (e.g. ethanol). In this case, ethanol imports may cause some volume of unfinished gasoline to be sent to other markets where it can be used.

At present, virtually all of the overseas imports and exports of oil products (other than LPG, asphalt, and lube oils) move through KBPH. Were the volumes traded to change dramatically, however, this pattern could change dramatically.

The refineries are licensed for only small volumes of product imports and exports through their offshore pipelines and moorings. The licensing and practices could change; thus far, there has been little incentive to make these alterations. The essential reason is logistics. Receiving or sending out small cargoes of products through an offshore pipeline is complex, especially if the carrier is a small multiproducts bottom such as a barge. Keeping segregation of products in the pipeline for small volumes poses many challenges, and barges were not generally designed for open-water moorage. Therefore, to date the refiners have chosen to handle the majority of

their waterborne product movements through KBPH or HMT—and there will be an incentive to continue to do so for interisland barge traffic.

If exports or imports rise to high levels, however, then there will be an incentive to move overseas cargoes in or out of the Oahu through the refinery terminal and pipeline itself. This is a standard changeover in a Refinery-To-Terminal (RTT) conversion: the crude import line becomes a product import line. But it is also seen when a refinery run for local use suddenly becomes a substantial international exporter: the offshore line carries crude in, but carries products out.

What this means is that there is not a proportional correlation between trade needs and the demands that are likely to be placed on Oahu's oil harborage. If refinery imbalances increase (as is likely under most scenarios), the need for overseas imports and exports of products are likely to increase…until a tipping point is reached, and larger, more frequent cargoes are preferred. (This point may or may not be reached before an RTT seems like the most economic option.) At this point, the demand on facilities such as KBPH will fall, possibly sharply—although it will probably remain the dominant facility for serving the Neighbor Islands. The effects of a refinery closure on demand on KBPH thus depends on circumstance and business decisions, and can either raise or lower demand.

Under most scenarios, however, either refinery, if converted to an import terminal, could probably eliminate the role of KBPH in meeting import needs. Indeed, even with such a conversion, with a different operating strategy and some mechanical changes, it is probable that as demand declines, either refinery alone would be able to supply refined products and also meet product import needs at the margin.

2.6.5.4. Bunkering

As discussed earlier, IMO regulations will be causing a massive realignment in bunker-fuel specifications, and these will affect Hawaii beginning in 2015. It is unclear how this will affect bunkering volumes at KBPH. Hawaii is not a low-cost site for bunkering, but it is sometimes cost-competitive on high-sulfur fuel oil (HSFO) bunkers. Even if this cost advantage remains, ships electing to bunker with HSFO would have to load the fuel into segregated tanks and avoid

burning them until out of the North American ECA. Under the new standards, even Oahu-grade utility LSFO will not be allowed for burning in the ECA.

One effect will probably be to shift bunkering demand to more diesel. (On a volume basis, the effect is more than proportionate, since it can take nearly ten percent more diesel to provide the same energy as a barrel of fuel oil.)

Furthermore, if Hawaii's oil demand declines, there will be less need for oil to fuel oil deliveries. Deliveries of other goods, however, might expand. Bunkering is a small share of Hawaii's oil demand, but it is easy to construct plausible scenarios where it rises or falls. For our purposes here, it is probably most sensible to hold the KBPH volume constant, but it is equally easy to make arguments for increases or decreases.

Another uncertainty in the bunkering outlook is the trend toward bunkering with LNG to meet IMO regulations. There is presently a small amount of LNG bunkering in Europe, and there are many plans for supplying LNG bunkers to US mainland coastal trade. Whether international, high-seas transport will turn to LNG in the longer term is very much an open question.

If LNG becomes available in Hawaii, there is potential for interisland cargo bunkers to be displaced by LNG. According to a study done for HNEI, however, the volume of fuel potentially displaced is comparatively small (probably less than 1 k/bd).

What of the possibility of international bunkering of LNG in Hawaii? Physically it is certainly possible, but the economics lobby against it. It is true that if LNG bunkering for international marine transport becomes widespread, that many major bunkering centers will have to provide their LNG from imports. But hauling LNG to Hawaii from anywhere is quite expensive, and the competitiveness of Hawaii as an entrepot bunkering center for LNG is seriously reduced by the small scale of Hawaii's possible import facilities. In addition, there are serious questions about where such bunkering would take place; if at HMT or KBPH, there would have to be specialized storage, loading, and offloading facilities capable of handling cryogenic temperatures.

In summary, then, Hawaii as an international LNG bunkering center presently seems unlikely for economic, logistical, and infrastructural reasons.

That said, it is good to keep in mind that there are plausible reasons that bunkering in Hawaii might significantly rise or fall (or even rise and then fall thereafter). If Hawaii's overall demand

continues to decline and the refineries continue to operate at high throughput, then the refiners may be willing to provide bunkers at very competitive prices as an alternative to the lower returns from exporting. But at the other extreme, if one or both refineries close, all bunkering would have to be based on imported products, and this would make Hawaii a very high-cost source of bunkers. As with other aspects of the outlook for demand on KBPH, this could easily result in a situation where demand for bunkering first expands, and then later significantly contracts. LNG bunkering is just one more reason for uncertainty.

2.6.5.5. LPG

LPG (which, in the case of Hawaii is almost exclusively propane) is the only product other than jet fuel that seems likely to see increased demand in all scenarios.

Hawaii's LPG demand exceeds its refinery output by a considerable percentage. Since LPG requires specialized ships and specialized storage tanks, this results in a peculiar import pattern. Small LPG tankers perform long-haul voyages, and then deliver propane to the various import terminals on a "milk run." Unlike other products, where Oahu is the hub, for propane Oahu is just one of the stops—and only occasionally.

It would probably be more economical to establish a central "breakbulk" terminal at KBPH, so that propane could be imported on larger ships and then distributed to Neighbor Islands, instead of running small ships across thousands of sea miles. This has not yet occurred for a variety of reasons, including uncertainties in the market, infrastructure problems, and competitive strategies of the players.

Centralizing KBPH as an LPG hub has a highly leveraged effect on demand for throughput at KBPH. In 2012, about 0.5 kb/d of LPG was shipped from KBPH to Neighbor Islands, while another 2 kb/d of LPG was imported directly to Neighbor Islands. If imports were centralized, 2 kb/d of LPG would have been imported to Oahu, and 2.5 exported to Neighbor Islands. The increase in port demand for LPG at KPBH would be 800% ([2 in + 2.5 out – 0.5 base] / 0.5 = 8).

Although many parties in Hawaii are excited about the prospects for growth in LPG demand, it is important to keep it in perspective. While the growth in demand may be high, and the increase in KBPH port demand is a large percentage jump, LPG represents only 3% of Hawaii's

oil-product demand—and, even under the most extreme scenario examined, is unlikely to represent more than 6% of the State's demand in 2040.

2.6.5.6. Asphalt

Both of Hawaii's refineries were built with asphalt units, but the switch to low-sulfur waxy crudes means that there is not sufficient feedstock to support asphalt units. (The heavy components of waxy crudes are, in fact, waxes, rather than the tars found in crudes suitable for asphalt.)

For this reason, in recent years all asphalt in Hawaii has been imported, and KBPH is the import center. Unlike other products, however, asphalt is not moved to Neighbor Islands on tankers from KBPH. In general, it is moved onto suitable containers and the moved as freight (mostly out of Honolulu Harbor).

Thus, almost all asphalt demand typically arrives at KBPH, but its transshipment doesn't affect the fuel throughput at KBPH.

2.6.5.7. Ethanol

Virtually all of Hawaii's imports of ethanol end up blended into gasoline. The bulk of this is done on Oahu, but about 20% of imports arrive at KBPH and are transshipped to Neighbor Islands.

If the refineries were to close, it is possible that ethanol imports would cease, and all gasoline would be imported with ethanol already blended; US refiners can easily supply gasoline with ethanol already blended to meet Hawaii's standards. On the other hand, if the main sources of gasoline imports are countries other than the US, then Hawaii might need to import non-oxygenated (i.e. gasoline with no ethanol blended) and import ethanol separately for blending in the islands. Whether such blending would take place on Oahu or elsewhere is unclear. Once again, this is a case where the volumes involved are only a small fraction of the State's total oil product demand. In terms of total import volumes, there is no significant difference between the two situations. But even if the refineries convert to import terminals, any imports of ethanol (as opposed to gasoline that contains ethanol) will probably be handled at KBPH.

2.6.5.8. Representative Scenarios

The uncertainties in the present situation are so great that there are literally hundreds of plausible scenarios that could be provided, and those who wish to argue for higher or lower demand at KBPH can find plenty of "but what if" examples.

To get some perspective on the topic, we need to examine a reference case. It is easiest to start by bracketing the possibilities with the highest and lowest plausible cases.

It should be understood that the High Throughput Case is not a base case; it is closer to a ceiling.

The assumptions of the High Throughput Case are as follows:

- Business-as-Usual demand. In other words, this assumes that the HCEI and renewable portfolio standard both fail, and that state policies have no effect on demand growth beyond what has already been accomplished. We believe this is somewhere near the feasible demand ceiling.
- No LNG.
- Both refineries continue to operate. They ramp up to higher levels of runs to follow growing demand, and adopt a somewhat lighter crude slate. (As noted before, closure of one or both refineries does not necessarily increase demand on KBPH; indeed, with terminal conversions, some of the existing traffic might be rerouted to refinery-based terminals. In addition, without refineries, any exportable surpluses disappear.)
- Neighbor Island Fuel demand on KBPH (excluding asphalt, ethanol and LPG) at 75% of Neighbor Island demand; 25% covered by HMT.
- Overseas Baseline: Baseyear (2012) balancing volumes projected as percent of total demand.
- Supplemental jet: The lesser of 1) the total jet deficit, or 2) 10% of Oahu's jet demand imported at KBPH to avoid delays and congestion at HFFC's import pier.
- HEI direct fuel imports at KBPH = any volumes not available from the refineries.
- Additional imports: Volumes not met by refiners or other specified imports. (These are import needs above the assumed Baseline balancing.)

- Additional exports: Product surpluses from refiners. (These are import needs above the assumed Baseline balancing.)
- Asphalt/Ethanol: KBPH ethanol imports at constant share of total gasoline demand; re-exports by barge at constant share of Neighbor Island gasoline demand.
- Bunkering: Held constant.
- LPG: KBPH becomes import hub; demand on KBPH is two times imports (imports plus re-export) plus refinery supply to Neighbor Islands

Figure 54: High Throughput Case (kb/d)

	2012	2020	2030	2040
Neighbor Island Fuels	24.1	26.5	27.9	31.6
Overseas Baseline	7.3	7.9	8.0	8.6
Supplemental Jet	-	0.7	1.4	2.1
HEI Imports	-	-	2.1	5.7
Additional Imports	-	0.1	2.1	4.4
Additional Exports	-	4.9	8.8	7.2
Asphalt/Ethanol	1.8	1.8	1.6	1.7
Bunkers	4.1	4.1	4.1	4.1
LPG	0.5	4.0	4.7	5.5
TOTAL	**37.8**	**50.0**	**60.8**	**70.8**
Increase over 2012	***0%***	***32%***	***61%***	***87%***

The High Throughput Case sees massive growth in demand on facilities at KBPH. This is largely a result of growing refinery imbalances, though HECO imports and supplies of supplemental jet for HFFC also have a strong effect from 2030 onward.

This scenario is plausible, but how likely is it? In our estimation, it is rather improbable. Not only does it presume that most State policies on conservation and renewables fail, it also assumes that as demand growth for oil resumes that no major new sources of energy—such as LNG—are deployed. It also assumes high levels of refinery operations through the coming decades, which we consider exceedingly improbable unless large new investments are made.

Let us now consider the opposite end of the spectrum, the Low Throughput Case. In this case the assumptions are:

- Demand from the HCEI Succeeds (Mostly) Case. This assumes the RPS is met, and that most conservation goals succeed. It also assumes that some, but not all, of the goals for the use of renewables in transportation are met.
- Unconstrained imports of LNG (as in scenarios discussed earlier in the chapter).
- The refineries close and at least one converts to an import terminal. All major fuel imports arrive the new import terminals.
- Neighbor Island Fuel continues to be supplied through KBPH at 75% of Neighbor Island demand; 25% covered by HMT.
- Overseas Baseline: Without refineries, balancing volumes are no longer required.
- Supplemental jet: None.
- HEI direct fuel imports at KBPH: None.
- Additional imports: All arrive at the new import terminals.
- Additional exports: None.
- Asphalt/Ethanol: KBPH ethanol imports at constant share of total gasoline demand; re-exports by barge at constant share of Neighbor Island gasoline demand.
- Bunkering: Falls by half after new IMO regulations take effect.
- LPG: All imports served by small tankers on milk runs; deliveries to KBPH serve Oahu's import needs.

As the results show, in the Low Throughput Case the demands on KBPH decline steeply, falling by a quarter by 2020, and by nearly half in later years. This is a plausible scenario, and, in our view, more probable than the High Throughput Case.

Figure 55: Low Throughput Case (kb/d)

	2012	2020	2030	2040
Neighbor Island Fuels	24.1	23.1	16.1	15.1
Overseas Baseline	7.3	-	-	-
Supplemental Jet	-	-	-	-
HEI Imports	-	-	-	-
Additional Imports	-	-	-	-
Additional Exports	-	-	-	-
Asphalt/Ethanol	1.8	1.7	1.4	1.3
Bunkers	4.1	2.1	2.1	2.1
LPG	0.5	1.0	1.1	1.2
TOTAL	**37.8**	**27.8**	**20.6**	**19.6**
Increase over 2012	***0%***	***-26%***	***-45%***	***-48%***

Between these two scenarios there are a huge number of other possibilities. Some of them are more likely than others, and also seem more probable than either the High or Low Throughput cases.

The main variable is whether or not one of the refineries converts to an import terminal. If an import terminal is established at one of the refineries, then long-haul product imports (with the exceptions of jet, LPG, ethanol, and asphalt) will most likely arrive at the new import terminal. It is also worth noting that in any scenario where Hawaii's oil demand is declining, the conversion of one of the refineries to an import terminal will put serious competitive pressure on the remaining refinery, as one import terminal would easily be able to serve the whole state's import needs.

To give some an example of an intermediate case, however, let's consider a scenario where one of the refineries continues operating alongside an import terminal.

We consider the RPS Succeeds scenario to be a likely demand outlook; both the State and the utilities have made strong commitments to conservation and renewables. Under this scenario, if there is no import of LNG then there is no major surplus of products for export, and, with a

refinery converted to an import terminal, there is no new pressure on KBPH. If LNG is imported, however, the cuts in demand result in imbalances even with only one refinery in operation.

For this example, we will assume the smaller of the two refineries (Chevron) continues in operation, and uses KBPH to handle any surplus products. In addition, half the previous Overseas Baseline is maintained to support Chevron's needs to balance sulfur on diesel grades.

This scenario also assumes that KBPH becomes the LPG hub for the state. After Oahu's demand is satisfied by the refinery, excess is shipped out to Neighbor Islands; and the State's net deficit in LPG is received at KBPH and then transshipped to Neighbor Islands. Bunkers are held constant, and ethanol and asphalt are treated as in previous scenarios.

As the figure below shows, under this scenario there is a slight growth in demand for shipping of fuels at KBPH. The main increases are from exports of surpluses (mostly fuel oil) and the establishment of KBPH as the LPG hub for the State.

Figure 56: Intermediate Scenario I: One Refinery, RPS, LNG (kb/d)

	2012	2020	2030	2040
Neighbor Island Fuels	23.6	23.4	16.6	16.5
Overseas Baseline	7.3	3.7	3.7	3.7
Supplemental Jet	-	-	-	-
HEI Imports	-	-	-	-
Additional Imports	-	-	-	-
Additional Exports	-	-	6.5	6.3
Asphalt/Ethanol	1.8	1.7	1.5	1.4
Bunkers	4.1	4.1	4.1	4.1
LPG	0.5	5.2	5.9	6.7
TOTAL	**37.3**	**38.1**	**38.3**	**38.6**
Increase over 2012	***0%***	***2%***	***3%***	***4%***

It is worth exploring this from another angle. Suppose that both refineries close, and one or both convert to import terminals. But also hypothesize that a) the refiners stop using HMT to serve Neighbor Islands and convert these facilities to other uses; b) another party takes over the Neighbor Island jet market by imports at KPBH (perhaps by building jet tankage at the Aloha terminal); and, c) as before, KBPH becomes the State's LPG hub.

Figure 57: Intermediate Scenario II: No Refineries, RPS, LNG, New Jet Supplier (kb/d)

	2012	2020	2030	2040
Neighbor Island Fuels	23.6	31.2	22.2	22.0
Overseas Baseline	7.3	-	-	-
Neighbor Island Jet	-	7.7	8.0	8.3
HEI Imports	-	-	-	-
Additional Imports	-	-	-	-
Additional Exports	-	-		
Asphalt/Ethanol	1.8	1.7	1.5	1.4
Bunkers	4.1	4.1	4.1	4.1
LPG	0.5	6.4	7.1	7.9
TOTAL	**37.3**	**51.1**	**42.8**	**43.6**
Increase over 2012	***0%***	***37%***	***15%***	***17%***

In this case, demand on KBPH takes a large jump by 2020 (because of replacing HMT shipments and the new jet imports), but the gradual decline in oil demand erodes the throughput at KBPH in later years.

How likely is this scenario? As presented, none too likely; it is improbable that a new entrant could claw away the entire Neighbor Island jet market, and there aren't signs that Chevron plans to abandon shipping from HMT. Nonetheless, this shows that even some fairly dramatic changes may not have a game-changing impact.

Conclusions

- The two biggest variables affecting the required throughput KBPH are the level of oil demand in the State and the possible conversion of refineries to import terminals.
- Under most scenarios, Hawaii faces a declining demand for oil products, with the exception of LPG and jet fuel. The expected decline is largely the result of planned conservation and use of renewable energy, and may be greatly expanded if LNG is introduced.

- In the face of declining demand, overall there is more import and storage infrastructure already in place in the state than is likely to be needed. Much of this is presently devoted solely to crude oil, but it is capable of being converted to importing and storing finished products.
- Past 2020, in principle, if either refinery converts to an import terminal, it would be physically capable of meeting all of the State's oil-import needs. This would not be easy or convenient in the short run, but appears to be a possibility. Strictly speaking, in a volumetric sense, KPBH is not needed, and under most scenarios is needed even less with every passing year.
- In a practical sense, however, KBPH is needed for various purposes. Most transport of oil products to Neighbor Islands is by barge, and is it quite inconvenient to fill a multiproducts barge from a large offshore mooring buoy. The baseload on KBPH is therefore the Neighbor Island demand (less shipments via Honolulu Marine Terminal).
- In addition, KBPH is an important bunkering center. Furthermore, there may be strong economic incentives to create an LPG hub at KPBH so that larger cargoes may be brought to central storage and then distributed to Neighbor Islands.
- While the general trends in oil demand in Hawaii are downward, the demand in Neighbor Islands is somewhat more bullish. Therefore, all things held equal, the baseload on KBPH holds steadier, or falls less, than state demand.
- With only the information we have presented above, if anyone asked if a petroleum-oriented expansion of fuels capacity is needed at KBPH, the answer would almost certainly be, "Of course not—demand is dropping, not rising." The situation is more complicated than that, however.
- KBPH is used not only to transport products to Neighbor Islands, but also for imports of asphalt and ethanol. A more important use, in terms of volume and potential volume, are imports and exports of products by the refiners. At present, most excess products are "exported" (though many move to other US ports) through KBPH, while some shortages—once again, with the notable exception of jet fuel—come in through KBPH. A classic instance is Chevron exporting low-sulfur diesel through KBPH, while also importing ultralow-sulfur diesel through KBPH (since Chevron cannot manufacture ultralow-sulfur diesel).
- It might seem as if the higher Hawaii's oil-product import or export need, the higher the demand on KBPH. This idea is fallacious. In fact, when import and export needs from the

state are low or moderate, the refiners will be likely to use smaller ships and move product through KBPH. When the volumes become large—and especially when they become large enough to warrant closing a refinery and converting to an import terminal—they are more likely to use their own offshore moorings for both import and export (with the exception of loading interisland barges).

- *Ceteris paribus*, the probable demand on KBPH as a function of product movements in and out of the state is probably shaped something like a bell curve. At low levels of product imports and exports, the demand on KBPH is probably limited to Neighbor Island needs plus some overseas balancing.
- At higher levels of imports and exports, demand on KBPH begins to grow…until it reaches the point where the volumes are so large that a refiner closes and decides to operate as an import terminal. At this point, the demand on KBPH begins to fall rapidly back toward the level of baseline Neighbor Island imports.
- Even without the participation of the refiners, if the Aloha terminal were used as a transshipment point, then in event of a refinery closure, Aloha could become a link in the supply chain for gasoline and diesel to the Neighbor Islands. If Aloha were to add jet tankage, then KBPH could become a critical transshipment point for jet fuel—the most important fuel in Hawaii's future energy mix.
- The range of possible, plausible scenarios of required throughput is very large, reflecting the huge uncertainties about future demand and about the viability of refining on Oahu. The High Throughput case we show here, with oil demand rising and both refineries running near capacity, is certainly possible, and would require a large expansion in fuels throughput at KBPH. Nonetheless, we are skeptical both about the prospect for demand growth in Hawaii and about the long-term viability of two refineries on Oahu.
- The Low Throughput case is, in our view, more likely than the High Throughput case, but we suspect that it understates likely throughput at KBPH.
- Overall, we do not believe that there are powerful pressures for major capacity expansions of fuels facilities at KBPH, and feel it is most probable that the need for throughput will expand or contract slightly from current levels. It should be kept in mind that the near-term trajectory—which will have two refineries running, and will not include major cuts in demand—may be very different than the long-term trajectory. Pressure on KBPH may increase for a number of years, and then decline as the product balances and import options change.

- Ultimately, it is policymakers who must decide what assumptions to adopt about demand scenarios, future refinery operations, and the import of LNG. These are the factors that drive the need for throughput at KBPH, and the uncertainties about each of them are great.

3. Overall Energy Demand: Implications for the Environment

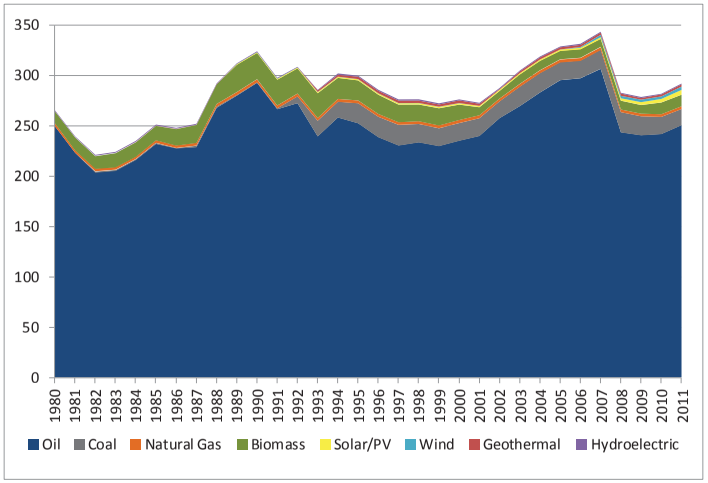
3.1. Outlook for Energy Demand of All Fuels by 2020 and 2030

This section builds upon Chapters 1 and 2, extending the energy demand outlook to all energy sources at a statewide level; other fossil fuels—coal and synthetic natural gas (SNG)—and renewables are included in addition to oil-products.

3.1.1. Current and Historical Energy Demand

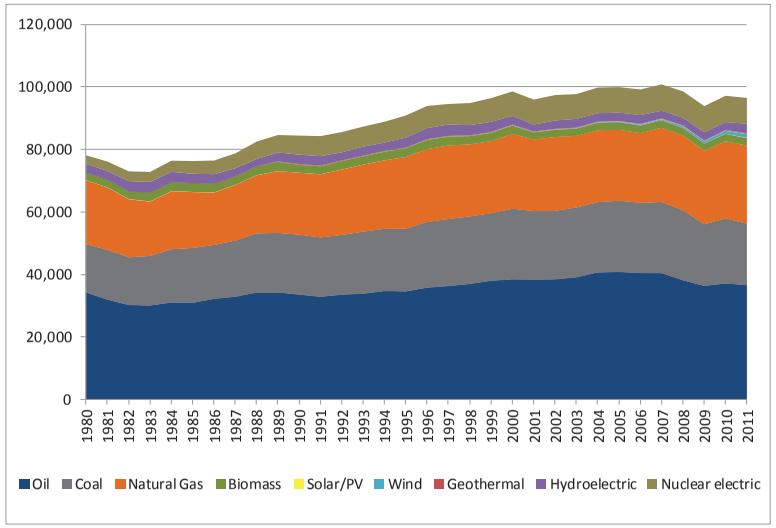
Aside from oil-products' long-standing majority share and the source of volatility in Hawaii's energy demand, as the figure shows, coal (since the 1990s) and biomass have steadily been the next two largest demand components, accounting for 5-7% and 3-4% in recent years respectively, followed by SNG and other renewables. Other renewables—solar thermal and photovoltaics (PV), geothermal, wind, and hydroelectric—comprise a minimal, yet slowly growing share of Hawaii's consumption portfolio.

Figure 58: **Hawaii Energy Demand, 1980 – 2011 (tbtu)**



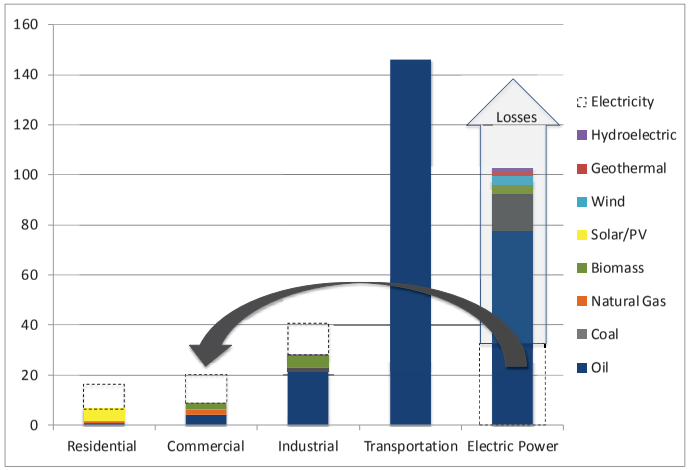
As previously mentioned, Hawaii's energy picture is very different from the US as a whole, where not only has demand remained relatively stable, but also there is no one source, namely petroleum, that clearly dominates demand. Instead, a mix of oil (38%), coal (20%), and natural gas (26%) somewhat proportionately forms the three pillars of US consumption, in addition to nuclear electric, which makes up roughly 9%. Biomass and other renewables similarly constitute a marginal share of energy consumption.

Figure 59: US Energy Demand, 1980 – 2011 (tbtu)



In terms of sectoral demand for energy sources, Hawaii also differs from the US, where natural gas is the dominant fuel of choice in residential, commercial, and industrial sectors, while coal is the main source for electric power generation, along with natural gas and nuclear power as the two other prime fuels. The only striking similarity (at least currently) to Hawaii, with the exception of a mere 3% of natural gas used in the transportation sector (for CNG vehicles and LNG trucking—this is growing with the expansion of America's Natural Gas Highway), is that petroleum products meets all of transportation demand.

Figure 60: Hawaii Energy Demand by Source by Sector, 2011 (tbtu)



As shown in the figure, the four end-use sectors are residential, commercial, industrial, and transportation. As explained in Chapter 1, the electric power sector is not an end-use sector since electricity is secondary energy (converted from primary energy by power plants) and is ultimately "used" in the residential, commercial, industrial, and transportation applications. As electricity is generated and then transmitted and distributed to end-users, loss occurs in the form of thermal conversion efficiency and heat, and consequently the amount of electric power actually used is less than the amount of energy consumed by the electric power sector.

Excluding electricity from the end-use sectors (i.e., treating electric power as a fifth sector), as anticipated, oil comprises a significant portion (nearly half) of Hawaii's commercial sector and is the majority fuel in the industrial and electric power sectors while solar/PV mainly powers the residential sector.

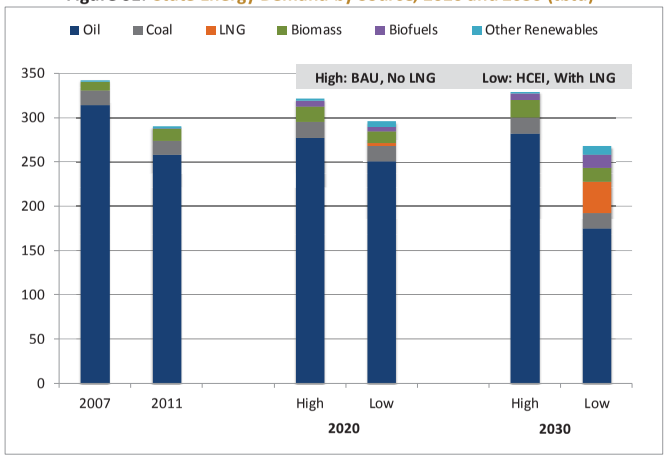
3.1.2. Energy Demand Outlook

In projecting demand for all fuels, two extreme scenarios are considered: "high" and "low." As described in Chapter 2, the scenarios are two-fold, the first of which is based on HCEI effectiveness, (i.e., diminishing oil demand), and the latter, which is adjusted for the availability

of LNG. "High" is a combination of Scenario 1: Business as Usual (BAU)—which is considered to be the effective ceiling on oil demand—and No LNG. Hence this is the high demand for energy case (specifically in terms of oil demand). "Low" merges Scenario 4: HCEI Mostly Succeeds and the subsidiary scenario, with LNG; this is therefore the low demand for energy situation (with respect to oil demand). As the remaining six scenarios fall somewhere in between (refer to Chapter 2), they are excluded from this portion of the analysis. The purpose here is to show the range of overall state energy demand.

The figure below shows demand by energy source for the two scenarios in the year 2020—when implementation of stricter environmental regulations are just around the corner and when LNG is not yet available—and 2030, the key target year of HCEI goals (RPS, EEPS/conservation, and transportation) and a year when LNG could be fully deployed, if imports in fact come. Biomass and biofuels are separated from the other renewables (geothermal, hydro, wind, and solar) to show the impact of ethanol blending and biodiesel blending—part of the renewable transportation goals—and they could be transshipped into/between islands.

Figure 61: State Energy Demand by Source, 2020 and 2030 (tbtu)



As illustrated, 2007 was a peak year for state energy demand, attributable primarily to increased demand for fuel oil and diesel in marine transportation; in contrast, 2011 is shown to represent a more typical year. Comparable to the oil product demand forecast in Chapter 2, future demand scenarios of all fuels, even under BAU with no LNG, is never expected to reach as high as 2007. In fact, total energy demand is projected to shrink 7% by 2020 and bounce back to 5% below 2007 by 2030 under the high scenario; considering the low scenario, however, total energy demand could fall considerably beyond 2007 levels (13% by 2020 and 22% by 2030). Again, the lower expected future demand in these scenarios with respect to 2007 is due to higher overall oil prices, conservation and renewable measures already implemented, and national measures like the CAFE mileage standards.

To put 2007 and Hawaii's progress in perspective, future energy demand should be compared to 2011; among the four forecasted figures, the only one in which total energy demand drops beyond the 2011 level is under the low scenario, as HCEI mostly succeeds and energy efficiency measures are almost fully achieved, by 2030 (only 7% though). In the other three cases, total energy demand is expected to top the 2011 level by 2% (2020 low), 9% (2020 high), and 12% (2030 high).

Also similar to the oil product demand forecast, the most impacted fuels are those in the power sector, followed by ground transportation. Air transportation and marine transportation fuels are unaltered, as there is neither any existing substitute fuel nor much or any local control on the activity levels and technologies.

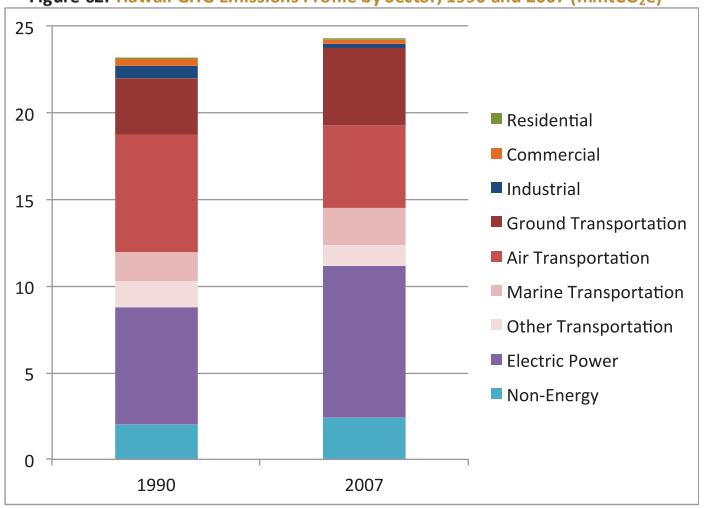
3.2. Implications for the Environment

3.2.1. GHG Emissions Reduction Goals

In addition to high prices and energy security concerns, human-induced climate change is another factor motivating the reduction of Hawaii's dependence on oil. While HCEI targets increased renewable energy and energy efficiency, Hawaii's Global Warming Solutions Act (Act 234) mandates that statewide greenhouse gas (GHG) emissions be reduced to 1990 levels by 2020 (excluding airplane emissions). Passed in 2007, Act 234 also created GHG Task Force, which prepared a work plan and regulatory scheme to achieve the statewide GHG limit. The

State Department of Health is still in the process of establishing these rules. The following six key GHGs are expected to be regulated: carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (N_2O), hydrofluorocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6).

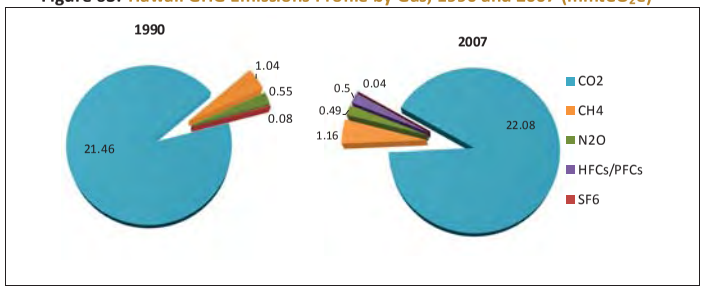
Figure 62: Hawaii GHG Emissions Profile by Sector, 1990 and 2007 ($mmtCO_2e$)[1]



As shown in the above figure, total GHG emissions grew by 5% overall between 1990 and 2007. While non-energy sources (industrial processes, waste, and agricultural, forestry, and other land use) are not major contributors of GHG emissions, ground transportation and the electric power are not only the largest emitters, but also the fastest growing (38% and 29%, respectively). Hawaii's sectoral emissions and trends are consistent with the US in that the electric power sector is the largest source of GHG emissions, followed by the transportation sector, where both have historically increased. For Hawaii, this is supported by the fact that oil overwhelmingly makes up the lion's share of Hawaii's energy demand in both sectors.

[1] ICF International, 2008. Hawaii Greenhouse Gas Inventory: 1990 and 2007.

Figure 63: Hawaii GHG Emissions Profile by Gas, 1990 and 2007 ($mmtCO_2e$)[2]

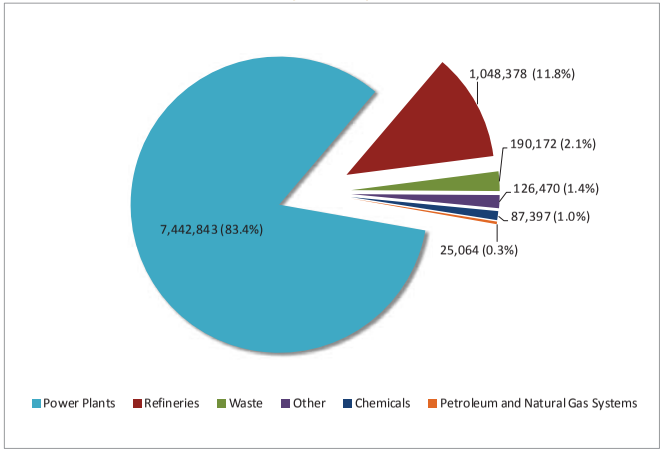


Separating emissions by GHG, carbon dioxide (CO_2) is by far the major GHG player. As the most well-known and prevalent GHG, CO_2 is emitted into the atmosphere mainly from burning fossil fuels (coal, natural gas, and oil) for power generation and transportation. On a smaller scale certain industrial processes and land-use changes (i.e., burning solid waste, trees and wood products) also release CO_2.

Of the total GHG emissions, less than half is monitored and regulated by the EPA; these include emissions of only large facilities. In 2011, from a total of 9,275,935 tCO_2e reported to the EPA, CO_2 accounted for 96%, 83% of which power plants were responsible for. As the figure shows, transportation (marine, ground, and air) is excluded along with small fuel volumes (i.e., from RCI).

[2] ICF International, 2008. Hawaii Greenhouse Gas Inventory: 1990 and 2007.

Figure 64: Hawaii Direct CO_2 Emissions by Sector from Large Facilities, 2011 ($mmtCO_2$)



Clearly for Hawaii, the majority of CO_2 emissions are attributable to using oil for 75% of power generation, and as a remote island, fuel for air transportation. Yet when compared per capita, Hawaii actually has lower CO_2 emissions—19 tCO_2e—than the national average of 23 tCO_2e in 2007. This is because coal forms half of the fuel burned for power generation in the US, combined with less electricity use per capita in Hawaii (due to no extreme space cooling/heating needs) as well as shorter commuting distances. Based on the energy demand forecast, a CO_2 emissions outlook will be presented in a later subsection.

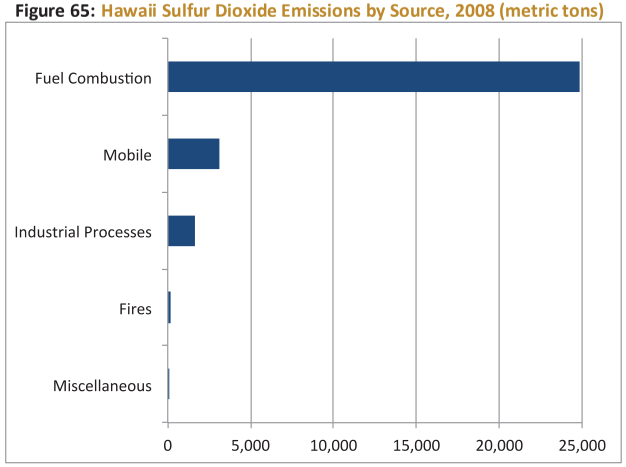
3.2.2. Other Environmental Regulations and Compliance

Two specific EPA standards, both of which fall under the CAA—National Ambient Air Quality Standards (NAAQS) and Mercury and Air Toxic Standards (MATS)—are of particular importance to Hawaii. Much of the chatter in the last year about the state's fuel strategy is centered on how to most reliably and cost-effectively comply with these upcoming tighter environmental regulations.

NAAQS. EPA has set national ambient air quality standards for six common air pollutants—carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particular matter (PM), and sulfur dioxide (SO_2)—considered harmful to public health and the environment. In practice, these standards are separated into primary (health-based) and secondary (welfare-based) standards, which protect against environmental damage. In the most recent five-year NAAQS review process in 2010, the EPA established stricter concentration levels for SO_2 and NO_2 as well as more stringent compliance requirements for PM.

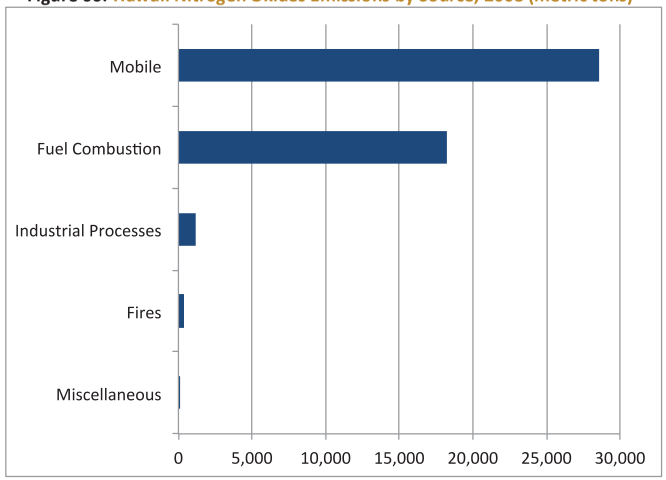
SO_2: Fossil fuel combustion at power plants and other industrial facilities is the main source of SO_2 emissions; to a lesser extent, industrial processes including extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, larger ships and non-road equipment are also contributing activities. The EPA first introduced SO_2 standards in 1971, with a primary standard of 140 ppb and a 30 ppb averaged annually, and a secondary standard of 500 ppb averaged over three hours. It was not until 2010 that the first revisions were made; with the establishment of a new 75 ppb 1-hour standard, the other two primary standards were no longer necessary. In 2012, the EPA ruled to keep the original (current) 3-hour average secondary standard at 500 ppb.

Figure 65: Hawaii Sulfur Dioxide Emissions by Source, 2008 (metric tons)



NO_2: NO_2 is a member of nitrogen oxides (NOx), a group of highly reactive gases. Originating from emissions from cars, trucks, buses, power plants, off-road equipment, and agriculture sources, NO_2 is a contributor to ground-level ozone and fine particle pollution. A primary standard and a secondary standard of 53 ppb, averaged over a year, was first set in 1971 and reviewed twice with no revisions prior to 2010, when in addition to the 53 ppb, a new primary standard of 100 ppb averaged over one hour, was established.

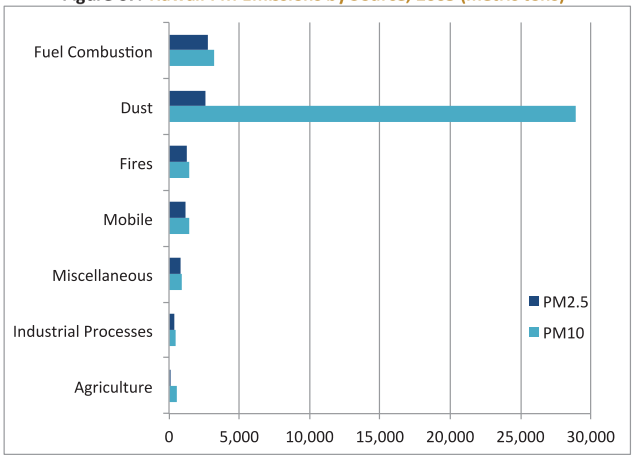
Figure 66: Hawaii Nitrogen Oxides Emissions by Source, 2008 (metric tons)



PM: Particulate matter is the combination of extremely small particles and liquid droplets, made up of acids, organic chemicals, metals and soil or dust particles. PM is grouped into two categories according to the size of the particles. PM_{10}, or "inhalable coarse particles," range from 2.5-10 micrometers and come from road dust, some agricultural operations, construction and demolition operations, industrial processes and biomass burning. $PM_{2.5}$ are considered "fine particles," 2.5 micrometers in diameter and smaller. Direct sources of $PM_{2.5}$ include vehicles, smokestacks, and fires, while secondary sources come from sulfur dioxides and nitrogen oxides emitted from power plants, industrial processes, and gasoline and diesel

engines, reacting in the atmosphere to form these particles. It is the later (those formed from emitted gases reacting in the atmosphere), which comprise most of $PM_{2.5}$.

Figure 67: Hawaii PM Emissions by Source, 2008 (metric tons)



Adopted from the EPA, the following table presents the current NAAQS for $PM_{2.5}$ and PM_{10}, as well as summarizes that of sulfur dioxide and nitrogen dioxide.

Figure 68: NAAQS Summary of Selected Pollutants

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Particle Pollution	$PM_{2.5}$	primary	Annual	12 µg/m^3	Annual mean, avged over 3 years
		secondary	Annual	15 µg/m^3	Annual mean, avged over 3 years
		primary & secondary	24-hour	35 µg/m^3	98th percentile, avged over 3 years
	PM_{10}	primary & secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on avg over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb	99th percentile of 1-hour daily max concent, avged over 3 years
		secondary	3-hour	500 ppb	Not to be exceeded more than once per year
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile, avged over 3 years
		primary & secondary	Annual	53 ppb	Annual Mean

Of the three air pollutants' standards revisions, reducing SO_2 emissions pose the greatest challenge, particularly for generation units running on fuel oil. The LSFO burned by HECO's power plants has a sulfur content of 0.5%, while HELCO and MECO use a variety of fuel from 0.4% sulfur (maximum) diesel to 2.0% sulfur (maximum) IFO; NAAQS, however, requires much lower sulfur contents. Adhering to the new SO_2 requirements means 1) either adding expensive backend controls to the power plant, 2) switching to lower emissions fuels, such as diesel and lower sulfur fuel oil, fuel-blending diesel and fuel oil (not yet well-studied), or 3) switching to LNG. The Hawaiian Electric Companies' understanding of the EPA rules is that State emitters are expected to be in complete compliance with the NAAQS standards by 2022 or 2025 (depending on the utilities' plan of action), which was recently extended from the 2017 deadline, much to their relief. Note however, as specific NAAQS compliance requirements and schedules at the statewide level have not been established yet, additional EPA rules and guidance may follow. In their July 2013 Fuels Master Plan, the Hawaiian Electric Companies stated that their preferred option to comply with NAAQS is to switch to LNG as it is the most cost effective NAAQS compliant fuel. To do so, they plan to develop bulk importation and the required infrastructure, and make the necessary generating unit modifications by 2020, two years ahead of the earliest possible NAAQS deadline.

MATS. A much sooner deadline of concern is complying with MATS by April 2015, with the possibility of two 1-year extensions—the Broadly Available One Year Extension for technology installation under the CAA and can be granted by the Department of Health, and the second, through the EPA Administrative Order which entails stricter criteria—bringing the compliance date to April 2017 at the latest. Aimed at reducing air pollution from coal and oil-fired power plants, the 2011 final rule sets standards for all hazardous air pollutants (HAPs) including mercury, heavy metals and acid gases, and PM from generating units with a capacity of 25 MW or greater. Based on the EPA list of power plants likely covered by the MATS, only the island of Oahu is affected—HECO's steam units (Honolulu, Kahe, and Waiau power plants) and AES Hawaii are the only plants listed.

As laid out in their master plan, HECO is exploring whether they can continue to consume the current grade of LSFO in their steam units in combination with the following alternatives: fuel

additive, increased air flow to improve combustion efficiency, increased frequency of boiler furnace and/or air-preheater washes, and by retrofitting boilers with steam atomization.

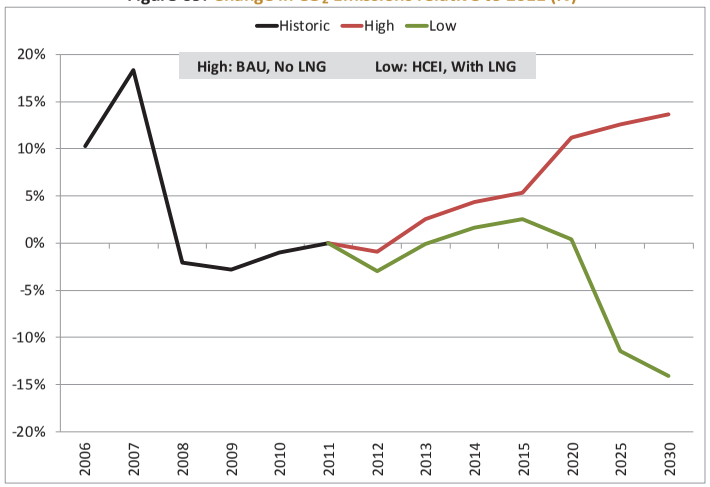
3.2.3. Emissions Outlook

The emissions outlook focuses on two gases: CO_2 and SO_2; CO_2 is the major GHG and SO_2 is a major concern of the new EPA regulations, as discussed above.

Carbon Dioxide.

Applying the same definition of "high" and "low" scenarios provided in Section 3.1.2 and using the same demand outlook for the two scenarios, the relative change in CO_2 emissions is calculated between 2011 and 2030. CO_2 emission factors—by source and by activity—are taken from the EPA's Emissions Factors Hub at the Center for Corporate Climate Leadership.

Figure 69: Change in CO_2 Emissions relative to 2011 (%)



CO_2 emissions in 2011 were around 21 mmtCO_2. From this historical data point, it should be observed that the divergence in the two forecasted scenario paths does not occur until 2015. Prior to then, both follow the same downward drop in 2012, falling below 2011 levels, and then steadily increases such that in both scenarios, emissions are higher relative to 2011. This is

mainly due to a first cut in power fuel between 2015 and 2020 to comply with MATS and then the power fuel switch (to LNG) between 2020 and 2025 in the low scenario. Another contributing factor is the difference in the amount of biofuels-based generation in the two scenarios.[3] It is worth mentioning that in line with both EPA's Mandatory Reporting Rule and Climate Leaders technical guidance, biofuels' CO_2 emission factors are non-zero and are very close to their petroleum-based counterparts (i.e., the emission factor used for biodiesel in power generation is nearly the same as the emission factor used for diesel in power generation). As expected in the years further out, under the high demand case (high demand for oil), emissions are higher by 11% in 2020 and 14% in 2030. On the other hand, under the low scenario, relative to 2011, emissions remain constant in 2020, and falls by 14% in 2030.

Sulfur.

Similarly, the relative change in sulfur emissions is calculated based on the energy demand forecast and respective two scenarios. In addition to using EPA's emission factors (by source and by activity), the below assumptions are made regarding the sulfur content on fuel oil and diesel in the power and marine transportation sectors. It should be noted that by looking at the change in fuel quality (in terms of sulfur content) in the power and marine transportation sectors, we are able to capture 95% of total SO_2 emissions in our emission trend analysis (as shown in Figure 8).

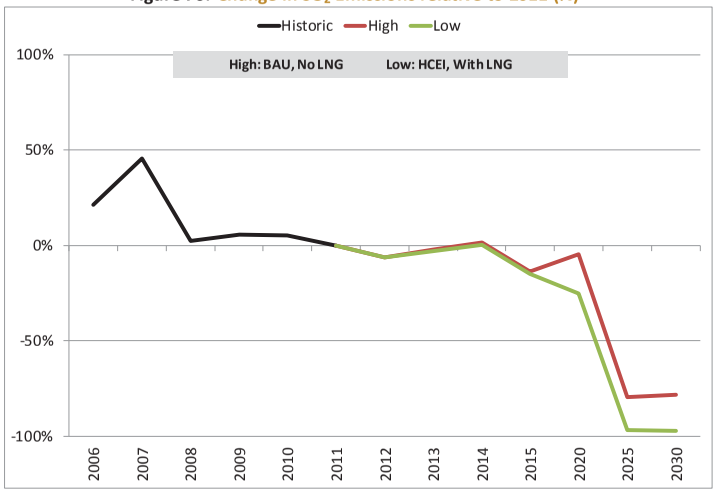
For power generation, following Hawaiian Electric Companies' Environmental Regulation Compliance Schedule, NAAQS imposes a sulfur content of 0.05% in 2022. In the meantime, to comply with MATS PM by 2015, power utilities could switch completely to diesel, or find a blending solution. Either way, we assume the sulfur content to remain at 0.5%. Beyond 2022, it is assumed that utilities comply with 0.05% sulfur content by switching entirely to diesel, installing back-end controls, or transitioning to LNG.

For marine transportation, the International Maritime Organization (IMO) will require all fuels burned in Emission Control Areas (ECAs)—which includes Hawaii as of 2015—emit no more

[3] In the High scenario, as no gas-fired generation is assumed on the grid, Oahu's RPS is assumed to be met by a larger share of biofuels (up to 43 MW of biofuel-based generation, equal to 3.6 kb/d or 55 mgpy of biofuels). In the Low scenario, however, assuming 85% of oil-based generation conversion to gas-fired generation, which allows for higher intermittent resource penetration on the grid, limited biofuel-based generation is assumed (up to 16 MW of generation, equivalent to 1.3 kb/d or 20 mgpy of biofuels).

than the equivalent of 0.1% sulfur bunker fuel. Since there is no real market in that grade for diesel, we assume that all marine diesel fuel will be low sulfur diesel (LSD), with 0.05% sulfur content. To meet the 0.1% sulfur bunker fuel regulation using fuel oil, onboard scrubbers would need to be installed since fuel oil of 0.1% is virtually nonexistent.

Figure 70: Change in SO_2 Emissions relative to 2011 (%)



Recall that 2007 was a peak year in energy demand, specifically, a unique year in marine fuel demand, with twice the average fuel oil use. This explains the spike in SO_2 emissions in 2007 as the figure shows. Moving forward from 2011 as a baseline year, both scenarios follow a distinctly similar path, with not much change in sulfur emissions until 2015, where both scenarios reflect 14-15% drop. This first cut is caused by expected IMO regulations in 2015. The anticipated NAAQS regulation in 2022 drives the second, more observable drop in emissions, bringing emissions close to zero (80-97% reduction from 2011) by 2025. The gap between the two scenarios beyond 2020 corresponds to the difference in fuel demand for power generation due to the combined impact of HCEI and LNG substitution.

3.3. Concluding Remarks

Hawaii's energy demand and implications for the environment are tightly linked. Despite the growing share of renewables in Hawaii's portfolio, fossil fuels—specifically oil—are the most prevalent energy source. Capturing the effects of HCEI and fuel switching due to environmental regulations yields the following key projections:

- State energy demand increases beyond 2011 levels under the high scenario in 2020 (9%) and even further by 2030 (12%). As a result, CO_2 emissions follow an increasing trend since power generation and transportation are the key sources of fossil fuel emissions. SO_2 emissions, however, despite increasing energy demand as a whole, remain relatively constant through 2020, and by 2030 are 75% lower than in 2011 because of mandatory sulfur reduction in petroleum product specifications. Early on, emissions remain stable as upcoming compliance standards are yet to be met; sulfur content fuel switching begins in 2015 with IMO regulations in the marine transportation sector, followed by NAAQS in the power generation sector.
- The low scenario only achieves an energy demand level lower than that of 2011 by 2030 (7%), as opposed to 2020. This is because 2030 is the ultimate target year of HCEI and efficiency targets are almost fully achieved by then. While demand is higher than 2011 levels in 2020, CO_2 emissions are roughly the same. By 2030, however, emissions fall considerably to 15% below, as LNG forms 13% of the overall energy demand. Likewise, the drop in sulfur emissions by 100% from 2011 reflects the use of LNG in marine transportation and power generation sectors.

Fuels Market in Hawaii:

Data Appendices

Submitted to

Department of Transportation, State of Hawaii

March 2014

TABLE OF CONTENTS

Appendix A: Assumptions for Demand Scenarios 3

Appendix B: Detailed Oil-Product Demand Scenarios 10

Appendix C: Detailed Import and Export Scenarios 19

APPENDIX A:
Assumptions for Demand Scenarios

The overarching assumptions are explained in the main report, but there are a large number of subsidiary assumptions. This section provides details on those inputs, as well as information on conversion factors and other important variables.

TABLE A.1.(a) Demand Scenario Assumptions

	Unit	2015	2020	2025	2030	2035	2040
Business As Usual							
Electricity Conservation	%	14%	15%	15%	15%	15%	15%
Oahu	%	15%	16%	16%	17%	17%	17%
Non-oahu	%	12%	12%	12%	11%	11%	11%
Renewable Electricity - State	%	15%	15%	15%	15%	15%	15%
Oahu	%	8%	8%	9%	9%	9%	9%
Non-oahu	%	33%	32%	31%	30%	29%	28%
Ground Transp Fuel Conservation	%						
VMT reduction	%	0%	0%	0%	0%	0%	0%
MPG improvement	%	5%	10%	25%	33%	33%	33%
EV penetration	%	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%
Renewable Transportation Fuel	kb/d	-	-	-	-	-	-
Ethanol blending	%	10%	10%	10%	10%	10%	10%
Biodiesel blending	%	1%	1%	1%	1%	1%	1%
RPS Falls Short							
Electricity Conservation	%	15%	20%	25%	30%	30%	30%
Oahu	%	16%	21%	27%	33%	34%	34%
Non-oahu	%	13%	16%	20%	23%	22%	21%
Renewable Electricity - State	%	15%	17%	19%	21%	23%	25%
Oahu	%	8%	9%	11%	12%	13%	15%
Non-oahu	%	33%	36%	39%	41%	44%	46%
Ground Transp Fuel Conservation	%						
VMT reduction	%	0.25%	0.50%	0.75%	1.00%	1.00%	1.00%
MPG improvement	%	5%	10%	25%	33%	33%	33%
EV penetration	%	1%	3%	6%	12%	18%	24%
Renewable Transportation Fuel	kb/d	-	-	-	-	-	-
Ethanol blending	%	10%	10%	10%	10%	10%	10%
Biodiesel blending	%	3%	20%	20%	20%	20%	20%

TABLE A.1.(b) Demand Scenario Assumptions (continued)							
	Unit	2015	2020	2025	2030	2035	2040
RPS Succeeds							
Electricity Conservation	%	15%	20%	25%	30%	30%	30%
Oahu	%	16%	21%	27%	33%	34%	34%
Non-oahu	%	13%	16%	20%	23%	22%	21%
Renewable Electricity - State	%	15%	25%	30%	40%	40%	40%
Oahu	%	8%	14%	17%	23%	23%	24%
Non-oahu	%	33%	53%	61%	79%	76%	74%
Ground Transp Fuel Conservation	%						
VMT reduction	%	0.25%	0.50%	0.75%	1.00%	1.00%	1.00%
MPG improvement	%	5%	10%	25%	33%	33%	33%
EV penetration	%	1%	3%	6%	12%	18%	24%
Renewable Transportation Fuel	kb/d	-	-	-	-	-	-
Ethanol blending	%	10%	10%	10%	10%	10%	10%
Biodiesel blending	%	3%	20%	20%	20%	20%	20%
HCEI Mostly Succeeds							
Electricity Conservation	%	15%	20%	25%	30%	30%	30%
Oahu	%	16%	21%	27%	33%	34%	34%
Non-oahu	%	13%	16%	20%	23%	22%	21%
Renewable Electricity - State	%	15%	25%	30%	40%	40%	40%
Oahu	%	8%	14%	17%	23%	23%	24%
Non-oahu	%	33%	53%	61%	79%	76%	74%
Ground Transp Fuel Conservation	%						
VMT reduction	%	2%	4%	6%	8%	8%	8%
MPG improvement	%	5%	10%	25%	33%	33%	33%
EV penetration	%	1%	4%	9%	15%	25%	40%
Renewable Transportation Fuel	kb/d	3.26	4.89	6.52	9.78	9.78	9.78
Ethanol blending	%	10%	10%	10%	10%	10%	10%
Biodiesel blending	%	3%	20%	20%	20%	20%	20%

TABLE A.2. LNG Scenario Assumptions							
	Unit	2015	2020	2025	2030	2035	2040
No LNG							
LNG for SNG substitution on Oahu	%	0%	0%	0%	0%	0%	0%
LNG for HDV Transportation	%	0%	0%	0%	0%	0%	0%
CNG for LDV Transportation	%	0%	0%	0%	0%	0%	0%
LNG for Power on Oahu	%	0%	0%	0%	0%	0%	0%
LNG for Power on Neighbor Islands	%	0%	0%	0%	0%	0%	0%
FO share of oil-based gen							
Oahu	%	98%	98%	98%	98%	98%	98%
Non-Oahu	%	30%	30%	30%	30%	30%	30%
Diesel share of oil-based gen							
Oahu	%	1%	1%	1%	1%	1%	1%
Non-Oahu	%	55%	55%	55%	55%	55%	55%
Biomass Capacity (RE)							
Oahu	MW	40	60	80	80	80	80
Non-Oahu	MW	16	15	15	15	15	15
Ohshore/Nearshore LNG							
LNG for SNG substitution on Oahu	%	15%	100%	100%	100%	100%	100%
LNG for HDV Transportation	%	0%	0.01%	10%	20%	35%	50%
CNG for LDV Transportation	%	0%	0.01%	1.5%	3%	5%	10%
LNG for Power on Oahu	%	0%	0%	85%	85%	85%	85%
LNG for Power on Neighbor Islands	%	0%	0%	85%	85%	85%	85%
FO share of oil-based gen							
Oahu	%	98%	98%	98%	98%	98%	98%
Non-Oahu	%	30%	30%	30%	30%	30%	30%
Diesel share of oil-based gen							
Oahu	%	1%	1%	1%	1%	1%	1%
Non-Oahu	%	55%	55%	55%	55%	55%	55%
Biomass Capacity (RE)							
Oahu	MW	40	60	80	80	80	80
Non-Oahu	MW	16	15	15	15	15	15

TABLE A.3. Other Assumptions and Derived Variables							
	Unit	2015	2020	2025	2030	2035	2040
AES/Coal Power	MWh	1,550,000	1,550,000	1,550,000	1,550,000	1,550,000	1,550,000
T&D Losses	%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%
Oahu	%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%
Non-Oahu	%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Demand breakdown							
Oahu Shares of Totals		2015	2020	2025	2030	2035	2040
Gasoline	%	63%	62%	61%	60%	59%	58%
Electricity	%	73%	72%	71%	70%	69%	67%
Road Diesel	%	55%	54%	53%	52%	52%	51%
LPG	%	28%	28%	27%	27%	26%	26%
Jet fuel	%	78.5%	78.0%	77.5%	77.0%	76.5%	76.0%
Marine Diesel	%	75%	74%	73%	72%	70%	69%
Marine Fuel Oil	%	100%	100%	100%	100%	100%	100%

TABLE A.4. Key Factors		
	Unit	
Conversion Factors		
LNG	[mmbtu/tonne]	51.32
LPG	[Therms/gal]	0.91
Coal	[mmbtu/tonne]	20.47
Fuel Oil	[mmbtu/bbl]	6.26
Diesel	[mmbtu/bbl]	5.73
Other oil (waste oil)	[mmbtu/bbl]	5.54
Biofuels	[mmbtu/bbl]	5.43
Biomass	[mmbtu/short tons]	11.63
Gasoline	[btu/gal]	112,000
Diesel	[btu/gal]	127,500
CNG	[btu/therm]	93,000
LNG	[btu/gal]	71,100
CNG	[therm/gge]	0.83
LNG	[gal/dge]	0.56
Avg Heat Rates		
Oil-fired	[Btu/kWh]	10,395
Coal	[Btu/kWh]	10,105
Gas	[Btu/kWh]	7,518
GT	[Btu/kWh]	8,421
CCGT	[Btu/kWh]	6,614
Biofuels	[Btu/kWh]	18,627
Biomass	[Btu/kWh]	14,216

TABLE A.5. Key Drivers (adopted from DBEDT and UHERO forecasts)							
	Unit						
Population		2015	2020	2025	2030	2035	2040
Oahu share	%	69%	68%	67%	66%	65%	64%
Oahu	#	976,190	1,003,710	1,029,410	1,052,130	1,071,220	1,086,710
Non-Oahu	#	442,060	477,540	513,840	550,200	586,280	622,200
Maui	#	168,010	181,020	194,200	207,310	220,210	232,860
Hawai'i	#	202,670	220,880	239,640	258,510	277,340	296,320
Kauai	#	71,380	75,640	80,000	84,380	88,730	93,020
Tourism forecast		2015	2020	2025	2030	2035	2040
(Visitor Arrival) growth	%	2.2	0.9	0.9	0.9	0.9	0.9
Oahu	%	1.2	0.4	0.4	0.4	0.4	0.4
Non-Oahu	%	2.5	1.7	1.7	1.7	1.7	1.7

APPENDIX B:
Detailed Oil-Product Demand Scenarios

The demand outlook in Hawaii could hardly be less clear. In addition to the uncertainties about the effects of international prices, renewable energy sources, LNG, and the HCEI, the effects of new nationwide environmental regulations could have a major effect on the composition of oil demand—especially the demand for fuel oil as opposed to diesel in the power sector.

To be specific, if oil continues to be a major fuel in the power sector (which it no longer is in the rest of the United States), environmental compliance may make it necessary to substitute diesel for fuel oil. This may not mean the wholesale displacement of fuel oil by diesel; 80/20, or even 90/10 fuel-oil/diesel blends might be able to meet specifications, and some analysts feel that even low-sulfur fuel oil could be made compliant in the majority of applications. (Furthermore, if LNG displaces oil in the power sector, much of the debate might become moot.)

Any continued power-sector demand for fuel oil thus might be actual fuel oil; or, alternatively, it might be demand for a specialized blend (or, in an extreme case, might be transferred entirely to diesel). Since diesel has a heat content lower than fuel oil, to the extent that diesel replaces fuel oil, the volumes of diesel required will be about 7% greater than the fuel oil they replace.

TABLE B.1. Business-As-Usual with No LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.5	37.7	8.3	**139.5**
2007	2.9	2.4	31.3	37.3	25.7	42.2	7.9	**149.7**
2008	2.9	2.3	29.5	32.7	15.2	31.5	7.0	**121.1**
2009	2.6	2.2	29.7	30.9	16.8	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.9	30.2	7.7	**121.7**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.3	27.6	6.4	**122.2**
2013	3.4	2.3	27.7	37.3	17.0	30.2	6.9	**124.8**
2014	3.5	2.3	27.9	38.2	17.4	31.0	7.0	**127.3**
2015	3.5	2.3	28.1	39.1	19.5	29.7	7.0	**129.3**
2020	3.7	2.3	27.7	39.4	20.3	32.2	7.3	**132.9**
2025	3.9	2.3	24.0	39.8	21.4	34.2	7.5	**133.1**
2030	4.1	2.3	22.2	40.1	22.3	35.9	7.8	**134.8**
2035	4.3	2.3	23.0	40.5	23.5	37.7	8.0	**139.2**
2040	4.5	2.3	23.8	40.8	24.6	39.5	8.3	**143.8**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.7	38.3	3.8	**109.1**
2008	0.8	2.3	18.8	26.9	6.3	27.8	3.1	**86.0**
2009	0.7	2.2	18.9	25.4	7.5	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.9	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.1	24.7	4.0	**88.1**
2013	1.0	2.3	17.5	30.2	8.3	27.3	3.8	**90.4**
2014	1.0	2.3	17.6	30.9	8.3	27.9	3.9	**91.9**
2015	1.0	2.3	17.8	31.5	9.8	26.6	3.9	**92.8**
2020	1.0	2.3	17.2	31.7	9.9	28.7	3.9	**94.7**
2025	1.1	2.3	14.7	31.9	9.9	30.3	3.9	**94.1**
2030	1.1	2.3	13.4	32.1	9.9	31.6	3.9	**94.4**
2035	1.1	2.3	13.7	32.3	9.9	33.0	3.9	**96.2**
2040	1.2	2.3	13.9	32.5	9.9	34.3	4.0	**98.1**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.2	7.1	8.7	2.9	3.0	**34.4**
2014	2.5	-	10.3	7.4	9.1	3.0	3.1	**35.4**
2015	2.5	-	10.4	7.6	9.7	3.1	3.2	**36.4**
2020	2.7	-	10.5	7.7	10.5	3.5	3.4	**38.2**
2025	2.8	-	9.3	7.8	11.5	3.9	3.6	**39.0**
2030	3.0	-	8.8	8.0	12.5	4.3	3.8	**40.4**
2035	3.2	-	9.4	8.1	13.5	4.7	4.1	**43.0**
2040	3.3	-	9.9	8.3	14.7	5.2	4.3	**45.7**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.2. RPS Falls Short with No LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.5	37.3	16.8	29.8	6.9	**124.0**
2014	3.5	2.3	27.7	38.2	17.2	30.6	7.0	**126.5**
2015	3.5	2.3	27.9	39.1	19.4	29.3	7.0	**128.5**
2020	3.7	2.3	27.1	39.4	19.0	29.3	7.0	**127.8**
2025	3.9	2.3	22.8	39.8	19.1	28.0	7.0	**122.8**
2030	4.1	2.3	19.8	40.1	19.0	26.2	6.9	**118.5**
2035	4.3	2.3	19.2	40.5	19.6	26.9	7.0	**119.8**
2040	4.5	2.3	18.6	40.8	19.9	27.4	7.1	**120.6**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.4	30.2	8.2	26.9	3.8	**89.9**
2014	1.0	2.3	17.5	30.9	8.3	27.6	3.9	**91.3**
2015	1.0	2.3	17.6	31.5	9.8	26.2	3.9	**92.3**
2020	1.0	2.3	16.8	31.7	9.5	26.1	3.9	**91.3**
2025	1.1	2.3	13.9	31.9	9.5	24.9	3.8	**87.4**
2030	1.1	2.3	12.0	32.1	9.4	23.2	3.8	**83.9**
2035	1.1	2.3	11.4	32.3	9.4	23.7	3.8	**84.1**
2040	1.2	2.3	10.9	32.5	9.4	24.1	3.8	**84.2**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.1	7.1	8.6	2.8	3.0	**34.1**
2014	2.5	-	10.2	7.4	9.0	3.0	3.1	**35.2**
2015	2.5	-	10.3	7.6	9.6	3.1	3.1	**36.2**
2020	2.7	-	10.2	7.7	9.5	3.1	3.2	**36.4**
2025	2.8	-	8.8	7.8	9.6	3.1	3.2	**35.4**
2030	3.0	-	7.9	8.0	9.6	3.0	3.1	**34.6**
2035	3.2	-	7.8	8.1	10.1	3.2	3.2	**35.6**
2040	3.3	-	7.7	8.3	10.6	3.3	3.3	**36.5**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.3. RPS Succeeds with No LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.5	37.3	16.8	29.8	6.9	**124.0**
2014	3.5	2.3	27.7	38.2	17.2	30.6	7.0	**126.5**
2015	3.5	2.3	27.9	39.1	19.4	29.3	7.0	**128.5**
2020	3.7	2.3	27.1	39.4	17.6	27.1	6.7	**123.8**
2025	3.9	2.3	22.8	39.8	17.3	25.1	6.5	**117.6**
2030	4.1	2.3	19.8	40.1	16.0	21.2	6.1	**109.6**
2035	4.3	2.3	19.2	40.5	16.7	22.2	6.2	**111.4**
2040	4.5	2.3	18.6	40.8	17.3	23.1	6.4	**113.0**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.4	30.2	8.2	26.9	3.8	**89.9**
2014	1.0	2.3	17.5	30.9	8.3	27.6	3.9	**91.3**
2015	1.0	2.3	17.6	31.5	9.8	26.2	3.9	**92.3**
2020	1.0	2.3	16.8	31.7	9.5	24.6	3.8	**89.7**
2025	1.1	2.3	13.9	31.9	9.5	22.8	3.8	**85.3**
2030	1.1	2.3	12.0	32.1	9.4	19.7	3.8	**80.3**
2035	1.1	2.3	11.4	32.3	9.4	20.4	3.8	**80.8**
2040	1.2	2.3	10.9	32.5	9.3	21.1	3.8	**81.1**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.1	7.1	8.6	2.8	3.0	**34.1**
2014	2.5	-	10.2	7.4	9.0	3.0	3.1	**35.2**
2015	2.5	-	10.3	7.6	9.6	3.1	3.1	**36.2**
2020	2.7	-	10.2	7.7	8.2	2.5	2.8	**34.1**
2025	2.8	-	8.8	7.8	7.8	2.2	2.7	**32.2**
2030	3.0	-	7.9	8.0	6.7	1.5	2.3	**29.3**
2035	3.2	-	7.8	8.1	7.3	1.8	2.4	**30.6**
2040	3.3	-	7.7	8.3	8.0	2.0	2.6	**31.9**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.4. HCEI Generally Succeeds with No LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.0	37.3	16.8	29.8	6.9	**123.5**
2014	3.5	2.3	27.2	38.2	17.2	30.6	7.0	**126.0**
2015	3.5	2.3	27.5	39.1	19.4	29.3	7.0	**128.0**
2020	3.7	2.3	25.9	39.4	17.6	27.1	6.7	**122.6**
2025	3.9	2.3	20.9	39.8	17.3	25.1	6.5	**115.7**
2030	4.1	2.3	17.9	40.1	16.0	21.2	6.1	**107.7**
2035	4.3	2.3	16.4	40.5	16.7	22.2	6.2	**108.5**
2040	4.5	2.3	13.8	40.8	17.3	23.1	6.4	**108.2**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.1	30.2	8.2	26.9	3.8	**89.6**
2014	1.0	2.3	17.2	30.9	8.3	27.6	3.9	**91.0**
2015	1.0	2.3	17.3	31.5	9.8	26.2	3.9	**92.0**
2020	1.0	2.3	16.1	31.7	9.5	24.6	3.8	**89.0**
2025	1.1	2.3	12.8	31.9	9.5	22.8	3.8	**84.2**
2030	1.1	2.3	10.8	32.1	9.4	19.7	3.8	**79.1**
2035	1.1	2.3	9.8	32.3	9.4	20.4	3.8	**79.1**
2040	1.2	2.3	8.1	32.5	9.3	21.1	3.8	**78.3**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.0	7.1	8.6	2.8	3.0	**34.0**
2014	2.5	-	10.0	7.4	9.0	3.0	3.1	**35.0**
2015	2.5	-	10.1	7.6	9.6	3.1	3.1	**36.0**
2020	2.7	-	9.8	7.7	8.2	2.5	2.8	**33.6**
2025	2.8	-	8.1	7.8	7.8	2.2	2.7	**31.5**
2030	3.0	-	7.1	8.0	6.7	1.5	2.3	**28.5**
2035	3.2	-	6.7	8.1	7.3	1.8	2.4	**29.5**
2040	3.3	-	5.7	8.3	8.0	2.0	2.6	**29.9**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.5. Business-As-Usual with LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.5	37.7	8.3	**139.5**
2007	2.9	2.4	31.3	37.3	25.7	42.2	7.9	**149.7**
2008	2.9	2.3	29.5	32.7	15.2	31.5	7.0	**121.1**
2009	2.6	2.2	29.7	30.9	16.8	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.9	30.2	7.7	**121.7**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.3	27.6	6.4	**122.2**
2013	3.4	2.3	27.7	37.3	17.0	30.2	6.9	**124.8**
2014	3.5	2.1	27.9	38.2	17.4	31.0	7.0	**127.1**
2015	3.5	2.0	28.1	39.1	19.5	29.7	7.0	**128.9**
2020	3.7	-	27.7	39.4	20.3	32.2	7.3	**130.6**
2025	3.9	-	23.7	39.8	14.8	7.0	5.5	**94.6**
2030	4.1	-	21.6	40.1	14.7	7.3	5.6	**93.3**
2035	4.3	-	21.9	40.5	14.5	7.5	5.6	**94.2**
2040	4.5	-	21.5	40.8	14.1	7.8	5.7	**94.4**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.7	38.3	3.8	**109.1**
2008	0.8	2.3	18.8	26.9	6.3	27.8	3.1	**86.0**
2009	0.7	2.2	18.9	25.4	7.5	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.9	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.1	24.7	4.0	**88.1**
2013	1.0	2.3	17.5	30.2	8.3	27.3	3.8	**90.4**
2014	1.0	2.1	17.6	30.9	8.3	27.9	3.9	**91.7**
2015	1.0	2.0	17.8	31.5	9.8	26.6	3.9	**92.5**
2020	1.0	-	17.2	31.7	9.9	28.7	3.9	**92.4**
2025	1.1	-	14.5	31.9	9.5	6.1	3.6	**66.6**
2030	1.1	-	13.0	32.1	9.2	6.3	3.6	**65.4**
2035	1.1	-	13.0	32.3	8.9	6.5	3.6	**65.5**
2040	1.2	-	12.6	32.5	8.5	6.7	3.6	**65.1**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.2	7.1	8.7	2.9	3.0	**34.4**
2014	2.5	-	10.3	7.4	9.1	3.0	3.1	**35.4**
2015	2.5	-	10.4	7.6	9.7	3.1	3.2	**36.4**
2020	2.7	-	10.5	7.7	10.5	3.5	3.4	**38.2**
2025	2.8	-	9.2	7.8	5.3	0.9	1.9	**28.0**
2030	3.0	-	8.6	8.0	5.5	1.0	2.0	**27.9**
2035	3.2	-	8.9	8.1	5.6	1.0	2.0	**28.8**
2040	3.3	-	8.9	8.3	5.6	1.1	2.0	**29.3**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.6. RPS Falls Short with LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.5	37.3	16.8	29.8	6.9	**124.0**
2014	3.5	2.1	27.7	38.2	17.2	30.6	7.0	**126.3**
2015	3.5	2.0	27.9	39.1	19.4	29.3	7.0	**128.1**
2020	3.7	-	27.1	39.4	19.0	29.3	7.0	**125.5**
2025	3.9	-	22.4	39.8	13.9	6.1	5.5	**91.6**
2030	4.1	-	19.3	40.1	13.7	5.8	5.5	**88.4**
2035	4.3	-	18.3	40.5	13.5	5.9	5.5	**88.0**
2040	4.5	-	16.8	40.8	13.2	6.0	5.5	**86.7**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.4	30.2	8.2	26.9	3.8	**89.9**
2014	1.0	2.1	17.5	30.9	8.3	27.6	3.9	**91.1**
2015	1.0	2.0	17.6	31.5	9.8	26.2	3.9	**91.9**
2020	1.0	-	16.8	31.7	9.5	26.1	3.9	**89.0**
2025	1.1	-	13.7	31.9	9.1	5.3	3.6	**64.7**
2030	1.1	-	11.6	32.1	8.9	5.0	3.6	**62.4**
2035	1.1	-	10.9	32.3	8.6	5.1	3.6	**61.7**
2040	1.2	-	9.8	32.5	8.3	5.2	3.6	**60.6**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.1	7.1	8.6	2.8	3.0	**34.1**
2014	2.5	-	10.2	7.4	9.0	3.0	3.1	**35.2**
2015	2.5	-	10.3	7.6	9.6	3.1	3.1	**36.2**
2020	2.7	-	10.2	7.7	9.5	3.1	3.2	**36.4**
2025	2.8	-	8.7	7.8	4.8	0.8	1.9	**26.8**
2030	3.0	-	7.6	8.0	4.9	0.8	1.8	**26.1**
2035	3.2	-	7.4	8.1	4.9	0.8	1.9	**26.3**
2040	3.3	-	7.0	8.3	4.9	0.8	1.9	**26.1**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.7. RPS Succeeds with LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.5	37.3	16.8	29.8	6.9	**124.0**
2014	3.5	2.1	27.7	38.2	17.2	30.6	7.0	**126.3**
2015	3.5	2.0	27.9	39.1	19.4	29.3	7.0	**128.1**
2020	3.7	-	27.1	39.4	17.6	27.1	6.7	**121.5**
2025	3.9	-	22.4	39.8	13.7	5.6	5.4	**90.8**
2030	4.1	-	19.3	40.1	13.3	5.1	5.3	**87.1**
2035	4.3	-	18.3	40.5	13.1	5.2	5.4	**86.7**
2040	4.5	-	16.8	40.8	12.8	5.3	5.4	**85.6**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.4	30.2	8.2	26.9	3.8	**89.9**
2014	1.0	2.1	17.5	30.9	8.3	27.6	3.9	**91.1**
2015	1.0	2.0	17.6	31.5	9.8	26.2	3.9	**91.9**
2020	1.0	-	16.8	31.7	9.5	24.6	3.8	**87.4**
2025	1.1	-	13.7	31.9	9.1	5.0	3.6	**64.4**
2030	1.1	-	11.6	32.1	8.9	4.5	3.6	**61.8**
2035	1.1	-	10.9	32.3	8.6	4.6	3.6	**61.2**
2040	1.2	-	9.8	32.5	8.3	4.7	3.6	**60.1**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.1	7.1	8.6	2.8	3.0	**34.1**
2014	2.5	-	10.2	7.4	9.0	3.0	3.1	**35.2**
2015	2.5	-	10.3	7.6	9.6	3.1	3.1	**36.2**
2020	2.7	-	10.2	7.7	8.2	2.5	2.8	**34.1**
2025	2.8	-	8.7	7.8	4.6	0.7	1.8	**26.4**
2030	3.0	-	7.6	8.0	4.4	0.6	1.7	**25.3**
2035	3.2	-	7.4	8.1	4.5	0.6	1.7	**25.5**
2040	3.3	-	7.0	8.3	4.5	0.6	1.8	**25.4**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

TABLE B.8. HCEI Generally Succeeds with LNG Imports (kb/d)								
STATE	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	3.1	2.4	31.6	38.0	18.4	37.7	8.3	**139.4**
2007	2.9	2.4	31.3	37.3	25.6	42.2	7.9	**149.6**
2008	2.9	2.3	29.5	32.7	15.1	31.5	7.0	**121.0**
2009	2.6	2.2	29.7	30.9	16.7	31.5	7.1	**120.8**
2010	3.3	2.2	27.5	32.0	18.8	30.2	7.7	**121.6**
2011	3.5	2.2	30.8	33.5	17.2	29.5	7.4	**124.2**
2012	3.4	2.3	29.5	35.8	17.2	27.6	6.4	**122.2**
2013	3.4	2.3	27.0	37.3	16.8	29.8	6.9	**123.5**
2014	3.5	2.1	27.2	38.2	17.2	30.6	7.0	**125.8**
2015	3.5	2.0	27.5	39.1	19.4	29.3	7.0	**127.6**
2020	3.7	-	25.9	39.4	17.6	27.1	6.7	**120.3**
2025	3.9	-	20.6	39.8	13.7	5.6	5.4	**89.0**
2030	4.1	-	17.3	40.1	13.3	5.1	5.3	**85.2**
2035	4.3	-	15.6	40.5	13.1	5.2	5.4	**84.0**
2040	4.5	-	12.4	40.8	12.8	5.3	5.4	**81.2**
OAHU	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	0.9	2.4	19.6	30.8	8.1	33.3	4.0	**99.1**
2007	0.8	2.4	19.2	30.8	13.6	38.3	3.8	**109.0**
2008	0.8	2.3	18.8	26.9	6.2	27.8	3.1	**85.9**
2009	0.7	2.2	18.9	25.4	7.4	27.8	3.4	**85.8**
2010	0.9	2.2	17.7	25.9	8.8	26.8	4.0	**86.4**
2011	1.0	2.2	19.7	27.1	7.7	26.3	4.0	**88.0**
2012	1.0	2.3	18.8	29.2	8.0	24.7	4.0	**88.1**
2013	1.0	2.3	17.1	30.2	8.2	26.9	3.8	**89.6**
2014	1.0	2.1	17.2	30.9	8.3	27.6	3.9	**90.8**
2015	1.0	2.0	17.3	31.5	9.8	26.2	3.9	**91.6**
2020	1.0	-	16.1	31.7	9.5	24.6	3.8	**86.7**
2025	1.1	-	12.6	31.9	9.1	5.0	3.6	**63.3**
2030	1.1	-	10.5	32.1	8.9	4.5	3.6	**60.7**
2035	1.1	-	9.3	32.3	8.6	4.6	3.6	**59.6**
2040	1.2	-	7.3	32.5	8.3	4.7	3.6	**57.6**
NEIGHBOR	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2006	2.2	-	12.0	7.2	10.4	4.5	4.2	**40.4**
2007	2.1	-	12.1	6.5	12.0	3.8	4.1	**40.6**
2008	2.1	-	10.7	5.8	8.9	3.7	3.9	**35.1**
2009	1.9	-	10.8	5.5	9.3	3.7	3.8	**35.0**
2010	2.3	-	9.8	6.1	10.0	3.3	3.7	**35.2**
2011	2.5	-	11.1	6.4	9.5	3.2	3.5	**36.2**
2012	2.5	-	10.7	6.5	9.2	2.9	2.4	**34.1**
2013	2.5	-	10.0	7.1	8.6	2.8	3.0	**34.0**
2014	2.5	-	10.0	7.4	9.0	3.0	3.1	**35.0**
2015	2.5	-	10.1	7.6	9.6	3.1	3.1	**36.0**
2020	2.7	-	9.8	7.7	8.2	2.5	2.8	**33.6**
2025	2.8	-	8.0	7.8	4.6	0.7	1.8	**25.7**
2030	3.0	-	6.9	8.0	4.4	0.6	1.7	**24.5**
2035	3.2	-	6.3	8.1	4.5	0.6	1.7	**24.4**
2040	3.3	-	5.1	8.3	4.5	0.6	1.8	**23.6**

Note: Naphtha/Unfinished Oils in power sector included in "Other"

APPENDIX C:
Detailed Import and Export Scenarios

These 48 scenario tables detail the range of product import and export results determined by

- The four Demand Scenarios
- The two LNG Scenarios
- The three Refinery Scenarios (Both Refineries, Chevron Only, HIE Only)
- The two Refinery Feed Scenarios (Standard Operations vs. Lighter Feedstock)

In principle, there are four Refinery Scenarios, since one obvious possibility is that neither refinery continues to operate in the longer term. These scenarios are not included, however, because they are already covered by the tabulation of demand scenarios in Appendix B. If no refineries are operating, then for all products, Imports = Demand, and Exports = 0.

	TABLE C.1. Business As Usual Demand, Both Refineries, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	0.1	-	-	2.1
2025	1.5	-	-	1.0	1.2	0.4	-	4.1
2030	1.7	-	-	1.4	2.1	2.1	-	7.3
2035	1.9	-	-	1.7	3.3	3.9	-	10.7
2040	2.1	-	-	2.1	4.4	5.7	-	14.2
Exports								
2015	-	0.1	2.8	-	0.7	4.1	1.6	9.3
2020	-	0.1	3.2	-	-	1.6	1.4	6.3
2025	-	0.1	6.9	-	-	-	1.1	8.2
2030	-	0.1	8.7	-	-	-	0.9	9.7
2035	-	0.1	7.9	-	-	-	0.6	8.7
2040	-	0.1	7.1	-	-	-	0.4	7.6

	TABLE C.2. Business As Usual Demand, Chevron Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.3	11.3	29.1	11.7	18.1	2.0	76.9
2020	2.5	2.3	10.9	29.4	12.5	20.6	2.2	80.5
2025	2.7	2.3	7.2	29.8	13.6	22.6	2.5	80.7
2030	2.9	2.3	5.4	30.1	14.6	24.3	2.7	82.4
2035	3.1	2.3	6.2	30.5	15.7	26.1	3.0	86.8
2040	3.3	2.3	7.0	30.8	16.8	28.0	3.2	91.4
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.3. Business As Usual Demand, HIE Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	14.0	10.3	7.1	7.5	0.1	41.3
2020	2.4	-	13.6	10.7	7.9	9.9	0.4	45.0
2025	2.6	-	9.9	11.0	9.0	12.0	0.6	45.2
2030	2.8	-	8.1	11.4	9.9	13.7	0.9	46.8
2035	3.0	-	8.9	11.7	11.1	15.5	1.1	51.3
2040	3.3	-	9.7	12.1	12.1	17.3	1.4	55.9
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.4. Business As Usual Demand, Both Refineries, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	9.1	-	9.2
2020	0.3	-	-	-	-	11.6	-	11.8
2025	0.4	-	-	-	-	13.6	-	14.1
2030	0.6	-	-	-	-	15.3	-	16.0
2035	0.9	-	-	-	-	17.1	-	18.0
2040	1.1	-	-	-	-	18.9	-	20.0
Exports								
2015	-	0.1	7.3	2.6	6.8	-	3.0	19.8
2020	-	0.1	7.7	2.2	6.0	-	2.7	18.8
2025	-	0.1	11.4	1.9	4.9	-	2.5	20.9
2030	-	0.1	13.2	1.6	4.0	-	2.2	21.1
2035	-	0.1	12.4	1.2	2.9	-	2.0	18.6
2040	-	0.1	11.6	0.9	1.8	-	1.7	16.1

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.5. Business As Usual Demand, Chevron Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.3	9.7	27.3	11.2	22.6	1.6	76.9
2020	2.3	2.3	9.3	27.7	12.0	25.1	1.9	80.5
2025	2.5	2.3	5.6	28.0	13.1	27.1	2.1	80.7
2030	2.7	2.3	3.8	28.4	14.0	28.8	2.4	82.4
2035	2.9	2.3	4.6	28.7	15.1	30.6	2.6	86.8
2040	3.1	2.3	5.4	29.1	16.2	32.4	2.9	91.4
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.6. Business As Usual Demand, HIE Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	11.1	9.2	1.5	16.2	-	39.4
2020	1.6	-	10.7	9.5	2.3	18.6	-	42.8
2025	1.8	-	7.0	9.8	3.4	20.7	-	42.8
2030	2.0	-	5.2	10.2	4.3	22.4	-	44.2
2035	2.2	-	6.0	10.5	5.5	24.2	0.1	48.5
2040	2.4	-	6.8	10.9	6.6	26.0	0.4	53.1
Exports								
2015	-	0.1	-	-	-	-	0.9	1.0
2020	-	0.1	-	-	-	-	0.6	0.7
2025	-	0.1	-	-	-	-	0.4	0.5
2030	-	0.1	-	-	-	-	0.1	0.2
2035	-	0.1	-	-	-	-	-	0.1
2040	-	0.1	-	-	-	-	-	0.1

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.7. RPS Falls Short Demand, Both Refineries, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.1	3.0	-	0.8	4.5	1.7	10.1
2020	-	0.1	3.9	-	1.2	4.5	1.6	11.3
2025	-	0.1	8.2	-	1.1	5.8	1.6	16.8
2030	-	0.1	11.1	-	1.2	7.6	1.7	21.6
2035	-	0.1	11.7	-	0.6	6.9	1.6	21.0
2040	-	0.1	12.4	-	0.3	6.4	1.5	20.7

	TABLE C.8. RPS Falls Short Demand, Chevron Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.3	11.1	29.1	11.6	17.7	4.3	78.5
2020	2.5	2.3	10.2	29.4	11.2	17.7	4.4	77.8
2025	2.7	2.3	5.9	29.8	11.3	16.4	4.4	72.8
2030	2.9	2.3	3.0	30.1	11.2	14.7	4.3	68.5
2035	3.1	2.3	2.4	30.5	11.8	15.3	4.4	69.8
2040	3.3	2.3	1.7	30.8	12.1	15.8	4.5	70.6
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.9. RPS Falls Short Demand, HIE Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.8	10.3	7.0	7.0	1.0	41.4
2020	2.4	-	13.0	10.7	6.5	7.0	1.0	40.7
2025	2.6	-	8.7	11.0	6.7	5.8	1.0	35.8
2030	2.8	-	5.7	11.4	6.6	4.0	0.9	31.5
2035	3.0	-	5.1	11.7	7.1	4.6	1.0	32.7
2040	3.3	-	4.5	12.1	7.5	5.2	1.1	33.6
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.10. RPS Falls Short Demand, Both Refineries, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	8.7	-	8.9
2025	0.4	-	-	-	-	7.4	-	7.9
2030	0.6	-	-	-	-	5.6	-	6.3
2035	0.9	-	-	-	-	6.3	-	7.1
2040	1.1	-	-	-	-	6.8	-	7.9
Exports								
2015	-	0.1	7.5	2.6	7.0	-	3.0	20.2
2020	-	0.1	8.4	2.2	7.4	-	2.9	21.1
2025	-	0.1	12.7	1.9	7.3	-	3.0	24.9
2030	-	0.1	15.6	1.6	7.3	-	3.0	27.6
2035	-	0.1	16.2	1.2	6.8	-	2.9	27.3
2040	-	0.1	16.9	0.9	6.4	-	2.9	27.1

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.11. RPS Falls Short Demand, Chevron Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.3	9.5	27.3	11.0	22.2	4.0	78.5
2020	2.3	2.3	8.6	27.7	10.6	22.2	4.0	77.8
2025	2.5	2.3	4.3	28.0	10.7	20.9	4.0	72.8
2030	2.7	2.3	1.4	28.4	10.7	19.2	3.9	68.5
2035	2.9	2.3	0.8	28.7	11.2	19.8	4.0	69.8
2040	3.1	2.3	0.1	29.1	11.6	20.3	4.1	70.6
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.12. RPS Falls Short Demand, HIE Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.9	9.2	1.4	15.7	0.0	38.7
2020	1.6	-	10.1	9.5	1.0	15.8	0.1	38.0
2025	1.8	-	5.8	9.8	1.1	14.5	0.0	33.0
2030	2.0	-	2.8	10.2	1.0	12.7	-	28.8
2035	2.2	-	2.2	10.5	1.6	13.4	0.1	30.0
2040	2.4	-	1.6	10.9	1.9	13.9	0.1	30.9
Exports								
2015	-	0.1	-	-	-	-	-	0.1
2020	-	0.1	-	-	-	-	-	0.1
2025	-	0.1	-	-	-	-	-	0.1
2030	-	0.1	-	-	-	-	0.0	0.1
2035	-	0.1	-	-	-	-	-	0.1
2040	-	0.1	-	-	-	-	-	0.1

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.13. RPS Succeeds Demand, Both Refineries, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.1	3.0	-	0.8	4.5	1.7	10.1
2020	-	0.1	3.9	-	2.6	6.7	2.0	15.3
2025	-	0.1	8.2	-	2.9	8.7	2.2	22.1
2030	-	0.1	11.1	-	4.2	12.6	2.6	30.5
2035	-	0.1	11.7	-	3.5	11.6	2.4	29.4
2040	-	0.1	12.4	-	2.9	10.7	2.3	28.3

	TABLE C.14. RPS Succeeds Demand, Chevron Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.3	11.1	29.1	11.6	17.7	4.3	78.5
2020	2.5	2.3	10.2	29.4	9.8	15.5	4.0	73.8
2025	2.7	2.3	5.9	29.8	9.5	13.5	3.8	67.6
2030	2.9	2.3	3.0	30.1	8.2	9.7	3.4	59.6
2035	3.1	2.3	2.4	30.5	8.9	10.6	3.6	61.4
2040	3.3	2.3	1.7	30.8	9.5	11.5	3.7	63.0
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.15. RPS Succeeds Demand, HIE Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.8	10.3	7.0	7.0	1.0	41.4
2020	2.4	-	13.0	10.7	5.2	4.8	0.7	36.8
2025	2.6	-	8.7	11.0	4.9	2.8	0.5	30.5
2030	2.8	-	5.7	11.4	3.6	-	0.1	23.6
2035	3.0	-	5.1	11.7	4.3	-	0.2	24.4
2040	3.3	-	4.5	12.1	4.9	0.9	0.4	25.9
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.16. RPS Succeeds Demand, Both Refineries, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	6.5	-	6.7
2025	0.4	-	-	-	-	4.5	-	4.9
2030	0.6	-	-	-	-	0.6	-	1.3
2035	0.9	-	-	-	-	1.6	-	2.4
2040	1.1	-	-	-	-	2.5	-	3.6
Exports								
2015	-	0.1	7.5	2.6	7.0	-	3.0	20.2
2020	-	0.1	8.4	2.2	8.7	-	3.3	22.8
2025	-	0.1	12.7	1.9	9.0	-	3.5	27.2
2030	-	0.1	15.6	1.6	10.3	-	3.9	31.5
2035	-	0.1	16.2	1.2	9.6	-	3.8	30.9
2040	-	0.1	16.9	0.9	9.0	-	3.6	30.5

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.17. RPS Succeeds Demand, Chevron Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.3	9.5	27.3	11.0	22.2	4.0	78.5
2020	2.3	2.3	8.6	27.7	9.3	20.0	3.6	73.8
2025	2.5	2.3	4.3	28.0	9.0	18.0	3.5	67.6
2030	2.7	2.3	1.4	28.4	7.7	14.2	3.1	59.7
2035	2.9	2.3	0.8	28.7	8.4	15.1	3.2	61.4
2040	3.1	2.3	0.1	29.1	9.0	16.0	3.3	63.0
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.18. RPS Succeeds Demand, HIE Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.9	9.2	1.4	15.7	0.0	38.7
2020	1.6	-	10.1	9.5	-	13.5	-	34.7
2025	1.8	-	5.8	9.8	-	11.6	-	29.0
2030	2.0	-	2.8	10.2	-	7.7	-	22.7
2035	2.2	-	2.2	10.5	-	8.6	-	23.6
2040	2.4	-	1.6	10.9	-	9.6	-	24.5
Exports								
2015	-	0.1	-	-	-	-	-	0.1
2020	-	0.1	-	-	0.4	-	0.3	0.8
2025	-	0.1	-	-	0.7	-	0.5	1.3
2030	-	0.1	-	-	2.0	-	0.9	3.0
2035	-	0.1	-	-	1.3	-	0.8	2.2
2040	-	0.1	-	-	0.7	-	0.6	1.4

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.19. HCEI Mostly Succeeds Demand, Both Refineries, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.1	3.5	-	0.8	4.5	1.7	10.6
2020	-	0.1	5.1	-	2.6	6.7	2.0	16.5
2025	-	0.1	10.0	-	2.9	8.7	2.2	23.9
2030	-	0.1	13.1	-	4.2	12.6	2.6	32.5
2035	-	0.1	14.5	-	3.5	11.6	2.4	32.2
2040	-	0.1	17.2	-	2.9	10.7	2.3	33.1

	TABLE C.20. HCEI Mostly Succeeds Demand, Chevron Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.3	10.6	29.1	11.6	17.7	4.3	78.0
2020	2.5	2.3	9.0	29.4	9.8	15.5	4.0	72.6
2025	2.7	2.3	4.1	29.8	9.5	13.5	3.8	65.7
2030	2.9	2.3	1.0	30.1	8.2	9.7	3.4	57.7
2035	3.1	2.3	-	30.5	8.9	10.6	3.6	59.0
2040	3.3	2.3	-	30.8	9.5	11.5	3.7	61.2
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	0.4	-	-	-	-	0.4
2040	-	-	3.1	-	-	-	-	3.1

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.21. HCEI Mostly Succeeds Demand, HIE Only, StanOps, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.4	10.3	7.0	7.0	1.0	40.9
2020	2.4	-	11.8	10.7	5.2	4.8	0.7	35.6
2025	2.6	-	6.8	11.0	4.9	2.8	0.5	28.7
2030	2.8	-	3.8	11.4	3.6	-	0.1	21.6
2035	3.0	-	2.3	11.7	4.3	-	0.2	21.6
2040	3.3	-	-	12.1	4.9	0.9	0.4	21.5
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.22. HCEI Mostly Succeeds Demand, Both Refineries, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	6.5	-	6.7
2025	0.4	-	-	-	-	4.5	-	4.9
2030	0.6	-	-	-	-	0.6	-	1.3
2035	0.9	-	-	-	-	1.6	-	2.4
2040	1.1	-	-	-	-	2.5	-	3.6
Exports								
2015	-	0.1	8.0	2.6	7.0	-	3.0	20.7
2020	-	0.1	9.6	2.2	8.7	-	3.3	24.0
2025	-	0.1	14.5	1.9	9.0	-	3.5	29.1
2030	-	0.1	17.6	1.6	10.3	-	3.9	33.5
2035	-	0.1	19.0	1.2	9.6	-	3.8	33.8
2040	-	0.1	21.7	0.9	9.0	-	3.6	35.3

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.23. HCEI Mostly Succeeds Demand, Chevron Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.3	9.0	27.3	11.0	22.2	4.0	78.0
2020	2.3	2.3	7.4	27.7	9.3	20.0	3.6	72.6
2025	2.5	2.3	2.5	28.0	9.0	18.0	3.5	65.7
2030	2.7	2.3	-	28.4	7.7	14.2	3.1	58.3
2035	2.9	2.3	-	28.7	8.4	15.1	3.2	60.6
2040	3.1	2.3	-	29.1	9.0	16.0	3.3	62.9
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	0.6	-	-	-	-	0.6
2035	-	-	2.0	-	-	-	-	2.0
2040	-	-	4.7	-	-	-	-	4.7

	TABLE C.24. HCEI Mostly Succeeds Demand, HIE Only, Lite, No LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.5	9.2	1.4	15.7	0.0	38.2
2020	1.6	-	8.9	9.5	-	13.5	-	33.5
2025	1.8	-	3.9	9.8	-	11.6	-	27.1
2030	2.0	-	0.9	10.2	-	7.7	-	20.8
2035	2.2	-	-	10.5	-	8.6	-	21.4
2040	2.4	-	-	10.9	-	9.6	-	22.9
Exports								
2015	-	0.1	-	-	-	-	-	0.1
2020	-	0.1	-	-	0.4	-	0.3	0.8
2025	-	0.1	-	-	0.7	-	0.5	1.3
2030	-	0.1	-	-	2.0	-	0.9	3.0
2035	-	0.1	0.6	-	1.3	-	0.8	2.7
2040	-	0.1	3.2	-	0.7	-	0.6	4.6

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.25. Business As Usual Demand, Both Refineries, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	0.1	-	-	2.1
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.4	2.8	-	0.7	4.1	1.6	9.7
2020	-	2.4	3.2	-	-	1.6	1.4	8.6
2025	-	2.4	7.3	-	5.4	26.8	3.1	45.0
2030	-	2.4	9.4	-	5.5	26.5	3.1	46.9
2035	-	2.4	9.1	-	5.7	26.3	3.0	46.5
2040	-	2.4	9.5	-	6.1	26.0	3.0	46.9

	TABLE C.26. Business As Usual Demand, Chevron Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.0	11.3	29.1	11.7	18.1	2.0	76.5
2020	2.5	-	10.9	29.4	12.5	20.6	2.2	78.2
2025	2.7	-	6.8	29.8	7.0	-	0.5	46.8
2030	2.9	-	4.7	30.1	6.9	-	0.5	45.2
2035	3.1	-	5.0	30.5	6.7	-	0.6	45.9
2040	3.3	-	4.6	30.8	6.3	-	0.6	45.8
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	4.6	-	4.6
2030	-	-	-	-	-	4.3	-	4.3
2035	-	-	-	-	-	4.0	-	4.0
2040	-	-	-	-	-	3.8	-	3.8

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.27. Business As Usual Demand, HIE Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	14.0	10.3	7.1	7.5	0.1	41.3
2020	2.4	-	13.6	10.7	7.9	9.9	0.4	45.0
2025	2.6	-	9.6	11.0	2.4	-	-	25.6
2030	2.8	-	7.5	11.4	2.3	-	-	23.9
2035	3.0	-	7.8	11.7	2.1	-	-	24.6
2040	3.3	-	7.4	12.1	1.7	-	-	24.4
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.28. Business As Usual Demand, Both Refineries, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	9.1	-	9.2
2020	0.3	-	-	-	-	11.6	-	11.8
2025	0.4	-	-	-	-	-	-	0.4
2030	0.6	-	-	-	-	-	-	0.6
2035	0.9	-	-	-	-	-	-	0.9
2040	1.1	-	-	-	-	-	-	1.1
Exports								
2015	-	0.4	7.3	2.6	6.8	-	3.0	20.1
2020	-	2.4	7.7	2.2	6.0	-	2.7	21.1
2025	-	2.4	11.8	1.9	11.6	13.6	4.4	45.7
2030	-	2.4	13.9	1.6	11.7	13.3	4.4	47.2
2035	-	2.4	13.6	1.2	11.9	13.1	4.4	46.5
2040	-	2.4	14.0	0.9	12.2	12.8	4.3	46.6

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.29. Business As Usual Demand, Chevron Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.0	9.7	27.3	11.2	22.6	1.6	76.5
2020	2.3	-	9.3	27.7	12.0	25.1	1.9	78.2
2025	2.5	-	5.2	28.0	6.4	-	0.1	42.3
2030	2.7	-	3.1	28.4	6.3	0.2	0.2	40.9
2035	2.9	-	3.4	28.7	6.1	0.5	0.2	41.9
2040	3.1	-	3.0	29.1	5.8	0.7	0.3	42.0
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	0.1	-	0.1
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.30. Business As Usual Demand, HIE Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	11.1	9.2	1.5	16.2	-	39.4
2020	1.6	-	10.7	9.5	2.3	18.6	-	42.8
2025	1.8	-	6.7	9.8	-	-	-	18.3
2030	2.0	-	4.6	10.2	-	-	-	16.8
2035	2.2	-	4.9	10.5	-	-	-	17.6
2040	2.4	-	4.5	10.9	-	-	-	17.8
Exports								
2015	-	0.4	-	-	-	-	0.9	1.3
2020	-	2.4	-	-	-	-	0.6	3.0
2025	-	2.4	-	-	3.2	6.5	2.3	14.5
2030	-	2.4	-	-	3.3	6.3	2.3	14.3
2035	-	2.4	-	-	3.5	6.0	2.3	14.2
2040	-	2.4	-	-	3.9	5.7	2.2	14.2

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.31. RPS Falls Short Demand, Both Refineries, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.4	3.0	-	0.8	4.5	1.7	10.5
2020	-	2.4	3.9	-	1.2	4.5	1.6	13.6
2025	-	2.4	8.5	-	6.3	27.7	3.2	48.1
2030	-	2.4	11.7	-	6.5	28.0	3.2	51.7
2035	-	2.4	12.6	-	6.7	27.9	3.2	52.8
2040	-	2.4	14.2	-	7.0	27.8	3.2	54.6

	TABLE C.32. RPS Falls Short Demand, Chevron Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.0	11.1	29.1	11.6	17.7	4.3	78.1
2020	2.5	-	10.2	29.4	11.2	17.7	4.4	75.5
2025	2.7	-	5.6	29.8	6.1	-	2.8	47.1
2030	2.9	-	2.4	30.1	5.9	-	2.8	44.2
2035	3.1	-	1.5	30.5	5.7	-	2.8	43.6
2040	3.3	-	-	30.8	5.4	-	2.8	42.4
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	5.5	-	5.5
2030	-	-	-	-	-	5.8	-	5.8
2035	-	-	-	-	-	5.7	-	5.7
2040	-	-	0.1	-	-	5.6	-	5.7

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.33. RPS Falls Short Demand, HIE Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.8	10.3	7.0	7.0	1.0	41.4
2020	2.4	-	13.0	10.7	6.5	7.0	1.0	40.7
2025	2.6	-	8.3	11.0	1.5	-	-	23.5
2030	2.8	-	5.2	11.4	1.3	-	-	20.7
2035	3.0	-	4.2	11.7	1.1	-	-	20.1
2040	3.3	-	2.7	12.1	0.8	-	-	18.8
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.34. RPS Falls Short Demand, Both Refineries, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	8.7	-	8.9
2025	0.4	-	-	-	-	-	-	0.4
2030	0.6	-	-	-	-	-	-	0.6
2035	0.9	-	-	-	-	-	-	0.9
2040	1.1	-	-	-	-	-	-	1.1
Exports								
2015	-	0.4	7.5	2.6	7.0	-	3.0	20.5
2020	-	2.4	8.4	2.2	7.4	-	2.9	23.4
2025	-	2.4	13.0	1.9	12.4	14.5	4.5	48.8
2030	-	2.4	16.2	1.6	12.6	14.8	4.5	52.1
2035	-	2.4	17.1	1.2	12.8	14.7	4.5	52.8
2040	-	2.4	18.7	0.9	13.2	14.6	4.5	54.2

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.35. RPS Falls Short Demand, Chevron Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.0	9.5	27.3	11.0	22.2	4.0	78.1
2020	2.3	-	8.6	27.7	10.6	22.2	4.0	75.5
2025	2.5	-	4.0	28.0	5.6	-	2.5	42.6
2030	2.7	-	0.8	28.4	5.4	-	2.5	39.7
2035	2.9	-	-	28.7	5.2	-	2.5	39.3
2040	3.1	-	-	29.1	4.8	-	2.5	39.5
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	1.0	-	1.0
2030	-	-	-	-	-	1.3	-	1.3
2035	-	-	0.1	-	-	1.2	-	1.3
2040	-	-	1.7	-	-	1.1	-	2.8

	TABLE C.36. RPS Falls Short Demand, HIE Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.9	9.2	1.4	15.7	0.0	38.7
2020	1.6	-	10.1	9.5	1.0	15.8	0.1	38.0
2025	1.8	-	5.4	9.8	-	-	-	17.1
2030	2.0	-	2.3	10.2	-	-	-	14.4
2035	2.2	-	1.3	10.5	-	-	-	14.1
2040	2.4	-	-	10.9	-	-	-	13.3
Exports								
2015	-	0.4	-	-	-	-	-	0.4
2020	-	2.4	-	-	-	-	-	2.4
2025	-	2.4	-	-	4.1	7.4	1.5	15.4
2030	-	2.4	-	-	4.3	7.7	1.5	15.9
2035	-	2.4	-	-	4.5	7.6	1.5	16.0
2040	-	2.4	0.2	-	4.8	7.5	1.5	16.5

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.37. RPS Succeeds Demand, Both Refineries, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.4	3.0	-	0.8	4.5	1.7	10.5
2020	-	2.4	3.9	-	2.6	6.7	2.0	17.6
2025	-	2.4	8.5	-	6.5	28.2	3.3	48.9
2030	-	2.4	11.7	-	6.9	28.7	3.3	53.1
2035	-	2.4	12.6	-	7.1	28.6	3.3	54.0
2040	-	2.4	14.2	-	7.4	28.5	3.3	55.7

	TABLE C.38. RPS Succeeds Demand, Chevron Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.0	11.1	29.1	11.6	17.7	4.3	78.1
2020	2.5	-	10.2	29.4	9.8	15.5	4.0	71.5
2025	2.7	-	5.6	29.8	5.9	-	2.7	46.7
2030	2.9	-	2.4	30.1	5.5	-	2.7	43.6
2035	3.1	-	1.5	30.5	5.3	-	2.7	43.1
2040	3.3	-	-	30.8	5.0	-	2.7	41.9
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	5.9	-	5.9
2030	-	-	-	-	-	6.5	-	6.5
2035	-	-	-	-	-	6.4	-	6.4
2040	-	-	0.1	-	-	6.2	-	6.3

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.39. RPS Succeeds Demand, HIE Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.8	10.3	7.0	7.0	1.0	41.4
2020	2.4	-	13.0	10.7	5.2	4.8	0.7	36.8
2025	2.6	-	8.3	11.0	1.3	-	-	23.2
2030	2.8	-	5.2	11.4	0.9	-	-	20.2
2035	3.0	-	4.2	11.7	0.7	-	-	19.6
2040	3.3	-	2.7	12.1	0.4	-	-	18.4
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.40. RPS Succeeds Demand, Both Refineries, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	6.5	-	6.7
2025	0.4	-	-	-	-	-	-	0.4
2030	0.6	-	-	-	-	-	-	0.6
2035	0.9	-	-	-	-	-	-	0.9
2040	1.1	-	-	-	-	-	-	1.1
Exports								
2015	-	0.4	7.5	2.6	7.0	-	3.0	20.5
2020	-	2.4	8.4	2.2	8.7	-	3.3	25.1
2025	-	2.4	13.0	1.9	12.7	15.0	4.6	49.5
2030	-	2.4	16.2	1.6	13.1	15.5	4.6	53.4
2035	-	2.4	17.1	1.2	13.2	15.4	4.6	54.0
2040	-	2.4	18.7	0.9	13.6	15.3	4.6	55.4

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.41. RPS Succeeds Demand, Chevron Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.0	9.5	27.3	11.0	22.2	4.0	78.1
2020	2.3	-	8.6	27.7	9.3	20.0	3.6	71.5
2025	2.5	-	4.0	28.0	5.3	-	2.4	42.2
2030	2.7	-	0.8	28.4	4.9	-	2.3	39.1
2035	2.9	-	-	28.7	4.8	-	2.3	38.7
2040	3.1	-	-	29.1	4.4	-	2.4	39.0
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	1.4	-	1.4
2030	-	-	-	-	-	2.0	-	2.0
2035	-	-	0.1	-	-	1.9	-	2.0
2040	-	-	1.7	-	-	1.7	-	3.4

	TABLE C.42. RPS Succeeds Demand, HIE Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.9	9.2	1.4	15.7	0.0	38.7
2020	1.6	-	10.1	9.5	-	13.5	-	34.7
2025	1.8	-	5.4	9.8	-	-	-	17.1
2030	2.0	-	2.3	10.2	-	-	-	14.4
2035	2.2	-	1.3	10.5	-	-	-	14.1
2040	2.4	-	-	10.9	-	-	-	13.3
Exports								
2015	-	0.4	-	-	-	-	-	0.4
2020	-	2.4	-	-	0.4	-	0.3	3.1
2025	-	2.4	-	-	4.3	7.9	1.6	16.2
2030	-	2.4	-	-	4.7	8.5	1.6	17.2
2035	-	2.4	-	-	4.9	8.3	1.6	17.3
2040	-	2.4	0.2	-	5.2	8.2	1.6	17.6

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.43. HCEI Mostly Succeeds Demand, Both Refineries, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.1	-	-	0.4	-	-	-	1.5
2020	1.3	-	-	0.7	-	-	-	2.0
2025	1.5	-	-	1.0	-	-	-	2.5
2030	1.7	-	-	1.4	-	-	-	3.0
2035	1.9	-	-	1.7	-	-	-	3.6
2040	2.1	-	-	2.1	-	-	-	4.2
Exports								
2015	-	0.4	3.5	-	0.8	4.5	1.7	11.0
2020	-	2.4	5.1	-	2.6	6.7	2.0	18.8
2025	-	2.4	10.3	-	6.5	28.2	3.3	50.7
2030	-	2.4	13.6	-	6.9	28.7	3.3	55.0
2035	-	2.4	15.3	-	7.1	28.6	3.3	56.7
2040	-	2.4	18.5	-	7.4	28.5	3.3	60.1

	TABLE C.44. HCEI Mostly Succeeds Demand, Chevron Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.4	2.0	10.6	29.1	11.6	17.7	4.3	77.6
2020	2.5	-	9.0	29.4	9.8	15.5	4.0	70.3
2025	2.7	-	3.8	29.8	5.9	-	2.7	44.9
2030	2.9	-	0.5	30.1	5.5	-	2.7	41.7
2035	3.1	-	-	30.5	5.3	-	2.7	41.6
2040	3.3	-	-	30.8	5.0	-	2.7	41.9
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	5.9	-	5.9
2030	-	-	-	-	-	6.5	-	6.5
2035	-	-	1.2	-	-	6.4	-	7.6
2040	-	-	4.4	-	-	6.2	-	10.6

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.45. HCEI Mostly Succeeds Demand, HIE Only, StanOps, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.3	-	13.4	10.3	7.0	7.0	1.0	40.9
2020	2.4	-	11.8	10.7	5.2	4.8	0.7	35.6
2025	2.6	-	6.5	11.0	1.3	-	-	21.4
2030	2.8	-	3.2	11.4	0.9	-	-	18.3
2035	3.0	-	1.5	11.7	0.7	-	-	17.0
2040	3.3	-	-	12.1	0.4	-	-	15.7
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-
2030	-	-	-	-	-	-	-	-
2035	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-

	TABLE C.46. HCEI Mostly Succeeds Demand, Both Refineries, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	0.1	-	-	-	-	8.7	-	8.7
2020	0.3	-	-	-	-	6.5	-	6.7
2025	0.4	-	-	-	-	-	-	0.4
2030	0.6	-	-	-	-	-	-	0.6
2035	0.9	-	-	-	-	-	-	0.9
2040	1.1	-	-	-	-	-	-	1.1
Exports								
2015	-	0.4	8.0	2.6	7.0	-	3.0	21.0
2020	-	2.4	9.6	2.2	8.7	-	3.3	26.3
2025	-	2.4	14.8	1.9	12.7	15.0	4.6	51.4
2030	-	2.4	18.1	1.6	13.1	15.5	4.6	55.3
2035	-	2.4	19.8	1.2	13.2	15.4	4.6	56.7
2040	-	2.4	23.0	0.9	13.6	15.3	4.6	59.7

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

	TABLE C.47. HCEI Mostly Succeeds Demand, Chevron Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	2.1	2.0	9.0	27.3	11.0	22.2	4.0	77.6
2020	2.3	-	7.4	27.7	9.3	20.0	3.6	70.3
2025	2.5	-	2.2	28.0	5.3	-	2.4	40.4
2030	2.7	-	-	28.4	4.9	-	2.3	38.3
2035	2.9	-	-	28.7	4.8	-	2.3	38.7
2040	3.1	-	-	29.1	4.4	-	2.4	39.0
Exports								
2015	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	1.4	-	1.4
2030	-	-	1.1	-	-	2.0	-	3.1
2035	-	-	2.8	-	-	1.9	-	4.7
2040	-	-	6.0	-	-	1.7	-	7.8

	TABLE C.48. HCEI Mostly Succeeds Demand, HIE Only, Lite, LNG (kb/d)							
Imports	**LPG**	**Naphtha**	**Gasoline**	**Jet**	**Diesel**	**Fuel Oil**	**Other**	**TOTAL**
2015	1.4	-	10.5	9.2	1.4	15.7	0.0	38.2
2020	1.6	-	8.9	9.5	-	13.5	-	33.5
2025	1.8	-	3.6	9.8	-	-	-	15.3
2030	2.0	-	0.3	10.2	-	-	-	12.5
2035	2.2	-	-	10.5	-	-	-	12.8
2040	2.4	-	-	10.9	-	-	-	13.3
Exports								
2015	-	0.4	-	-	-	-	-	0.4
2020	-	2.4	-	-	0.4	-	0.3	3.1
2025	-	2.4	-	-	4.3	7.9	1.6	16.2
2030	-	2.4	-	-	4.7	8.5	1.6	17.2
2035	-	2.4	1.4	-	4.9	8.3	1.6	18.6
2040	-	2.4	4.6	-	5.2	8.2	1.6	22.0

Note: StanOps = Standard Operation; Lite = Lighter Crude Slate

Appendix C

Berth Occupancy – Berthing Utilization
(Amergent Techs)

BERTH OCCUPANCY - BERTHING UTILIZATION

For the purposes of this evaluation, the berthing utilization was measured in berth foot days (BFD) which is tabulated to determine a vessel's linear berthing used with corresponding mooring allowances and the vessel 's port call duration, in relation to the maximum linear berth that is available for the specific berth. Calculations derived from State of Hawaii DOT-Harbors Divisions' vessel movement data base, covering a period from July 1, 2011 to June 30, 2012 (FY-2012).

Berth Occupancy Considerations

40% occupancy and lower are considered to be operationally acceptable and creates minimal delays.
40%-60% occupancy creates conflicts that may sub-optimize berthing availability and vessel utilization, creating operational inefficiencies.
60%-80% occupancy customary results in periodic conflicts and delays, reflecting subpar optimization
80% and higher occupancy results in regular conflicts and consistent delays.

PIER 1 (Barge Basin) Length 255 ft.	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 93,075***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Fuel Barges (LPG)	50	0	32.5	15.6 hrs.	10,628.7	11.42 %	***76.87 %***
Tugs/Workboats	123	0	21.1	4.1 hrs.	3,150.1	3.38 %	***22.78 %***
Other Vessels	1	0	0.2	3.7 hrs.	47.9	0.05 %	***0.35 %***
TOTAL	***174***	***0***	***53.8***		***13,826.7***	***14.85 %***	***100 %***

Finger Pier (Tug/Ferry) Length 300 ft.	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 109,500***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Tugs/Workboats	166	0	246.4	35.6 hrs.	34,988.6	32.0 %	***50.13 %***
Excursion Vessels#	1,332	0	339.4	6.1 hrs.	33,365.1	30.5 %	***47.81 %***
Launch Vessels	15	0	14.5	23.2 hrs.	1,406.7	1.3%	***2.02 %***
Fishing Vessels	2	0	0.2	2.8 hrs.	30.9	0.0 %	***0.04 %***
Gov't Vessels	1	0	0.0	0.3 hrs.	2.1	0.0 %	***0.0 %***
TOTAL	***1,516***	***0***	***600.5***		***69,793.4***	***63.74 %***	***100 %***

(#) Excursion Vessels engaged in Intra-Island activity)

PIER 5A ***Length 300 ft.***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 109,500***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Freight Barges	0	18	27.1	36.1 hrs.	12,937.7	11.8 %	***35.71 %***
Fuel Tank Ships *	0	10	30.1	72.2 hrs.	12,866.9	11.8 %	***35.52 %***
Fuel Barges *	10	0	14.8	35.5 hrs.	5,430.0	5.0 %	***14.99 %***
Tugs/Workboats	197	36	43.3	4.5 hrs.	4,641.5	4.2 %	***12.81 %***
Dry Barges *	3	0	1.9	15.2 hrs.	307.6	0.3 %	***0.85 %***
Other Vessels	6	0	0.2	0.8 hrs.	42.5	0.0 %	***0.12 %***
TOTAL	***216***	***64***	***117.4***		***36,226.2***	***33.08 %***	***100 %***

(*) Fleeting-nesting of Vessels idle, lay-berth status)

PIER 5 ***Length 800 ft.***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 292,000***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Fuel Barges	149	2	132.1	21.1 hrs.	57,632.2	19.8 %	***41.86 %***
Fuel Tank Ships	0	36	63.7	42.5 hrs.	40,384.6	13.8 %	***29.33 %***
Tugs/Workboats	397	2	239.9	14.4 hrs.	37,101.0	12.7 %	***26.95 %***
Dry Bulk Ships	0	2	1.9	22.2 hrs.	1,721.1	0.6 %	***1.25 %***
Ro/Ro Ships	0	1	0.4	10.5 hrs.	374.5	0.1 %	***0.27 %***
Dry Barges	1	0	1.6	38.4 hrs.	211.1	0.1 %	***0.15 %***
Other Vessels	26	0	2.6	2.4 hrs.	253.4	0.1 %	***0.18 %***
TOTAL	***573***	***43***	***442.2***		***137,677.9***	***47.15 %***	***100 %***

PIER 6 ***Length 800 ft.***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 292,000***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Dry Bulk Ships	0	17	94.5	133.4 hrs.	88,342.7	30.3 %	***63.65 %***
Fuel Barges	56	1	45	19.2 hrs.	19,385.3	6.6 %	***13.97 %***
Tugs/Workboats	220	1	93.4	10.1 hrs.	14,260.3	4.9 %	***10.27 %***
Fuel Tank Ships	0	9	18.7	49.87 hrs.	7,984.9	2.7 %	***5.75 %***
General Cargo Ships	0	2	6.8	81.8 hrs.	5,050.0	1.7 %	***3.64 %***
Ro/Ro Ships	0	2	3.7	44.0 hrs.	3,129.2	1.1 %	***2.25 %***
Non-Fuel Tank Ships	0	1	1.1	26.4 hrs.	479.2	0.0 %	***0.35 %***
Dry Barges	2	0	0.4	5.0 hrs.	159.1	0.1 %	***0.11 %***
TOTAL	***278***	***33***	***263.6***		***138,790.7***	***47.53 %***	***100 %***

PIER 7 ***Length 800 ft.***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 292,000***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Cement Barge #	65	0	248.7	91.8 hrs.	70,623.9	24.2 %	***44.14 %***
Dry Bulk Ships	0	11	74.7	162.9 hrs.	59,588.5	20.4 %	***37.24 %***
Fuel Tank Ships	0	4	24.7	147.8 hrs.	16,786.7	5.7 %	***10.49 %***
Tugs/Workboats	194	1	49.9	6.1 hrs.	7,288.4	2.5 %	***4.56 %***
Non-Fuel Tank Ships	0	1	3.1	74.4 hrs.	2,513.5	0.9 %	***1.57 %***
Fuel Barges *	5	0	4.5	21.98 hrs.	1,793.0	0.6 %	***1.12 %***
Gov't Vessels	0	1	2.8	166.6 hrs.	888.9	0.3 %	***0.56 %***
Other Barges *	3	0	5.0	39.9 hrs.	518.0	0.2 %	***0.32 %***
TOTAL	***267***	***18***	***413.4***		***160,000.9***	***54.79 %***	***100 %***

(*) Fleeting-nesting of Vessels, idle lay-berth status

(#) Dedicated Inter-Island Cement Barge

PIER 8 (Area) ***Length – n/a***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) n/a***	***Percentage Berth Utilization (Year)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Tugs/Workboats	13	0	80.2	148.1 hrs.	7,784.4	21.97 %	**52.63 %**
Other Barges	1	0	40.0	961.0 hrs.	7,007.8	10.96 %	**47.37 %**
TOTAL	***14***	***0***	***120.2***		***14,792.2***	***32.93 %***	***100 %***

PIER 9 (Area) ***(Floating Dry-Dock)*** ***Length 380 ft.*** ***(Marisco Area)***	***Port Calls***		***Berth Days***	***Average Port Call (hours)***	***Available Berth Foot Days (BFD) 138,700***	***Percentage Berth Utilization (BFD)***	***Percentage of Vessel Port Call by Used BFD***
Vessel Type	***Inter-Island***	***Overseas***			***Used BFD***		
Barges	3	0	6.2	529.5 hrs.	19,398.5	14.0 %	***65.03 %***
Excursion Vessels	32	0	36.0	27.0 hrs.	6,574.2	4.7 %	***22.04 %***
Tugs/Workboats	13	0	15.5	28.6 hrs.	2,016.4	1.5 %	***6.76 %***
Other Vessels	1	0	7.7	183.7 hrs.	1,545.9	1.1 %	***5.15 %***
Gov't Vessels	1	0	2.1	49.4 hrs.	277.6	0.2 %	***0.93 %***
Fishing Vessels	1	0	0.1	3.0 hrs.	16.6	0.0 %	***0.06 %***
TOTAL	***51***	***0***	***67.6***		***29,829.2***	***21.51 %***	***100 %***

Appendix D

Fuel Forecast Report
(Amergent Techs)

Summary

Although the future demand for liquid bulk petroleum products in Hawaii is forecasted to decline by 2030, the demand for waterborne movements of liquid bulk petroleum products in and out of Hawaii between 2015 and 2040 is forecasted to increase, resulting in an increase in the number of ships calling KBPH. The primary reason for the increase in ship activity at the fuel pier over the forecast period is that any decreases in fuel oil demand from the power generation sector, whether from conservation or replacement fuels, ultimately results in excess local fuel oil supply from the refineries. With no local market, this excess fuel oil needs to be exported by ship or barge to other markets through KBPH facilities. In other cases, such as one or both of Hawaii's refineries closing, it would be necessary to bring in large volumes of liquid bulk commodities such as jet fuel, diesel and gasoline through the waterfront facilities at KBPH to meet Hawaii demand.

Based on the four cases outlined in the Facts Global Energy (FGE) report *Fuels Market in Hawaii: Current Situation and Future Prospects* (both refineries operating, no refineries operating, Chevron only and Hawaii Independent Energy only) and the eight scenarios within each case, this analysis quantifies the kilo barrel per day (kb/d) impact on KBPH and the associated ship activity for the time frames 2015, 2020, 2025, 2030, 2035 and 2040. As each scenario results in a different volume outcome; the resulting increase in the number of ships varies from two to thirteen per month, in the cases with both or just one of the refineries operating. In the case where no refineries are operating and all product demand is met through imports, the number of additional monthly ship calls ranges from 16-18 per month. However, in the no refinery case, there would be no crude oil coming in through the off-shore mooring system. Therefore it is reasonable to consider the off-shore system might be utilized for product imports and significantly reducing the impact on the KBPH fuel pier.

Methodology

This purpose of this analysis is to forecast the fuel pier ship activity at KBPH in the years 2015, 2020, 2025, 2030, 2035 and 2040. The Facts Global Energy (FGE) report *Fuels Market in Hawaii: Current Situation and Future Prospects* was used as a basis for this analysis, specifically, *Section 2.6., Implications for Product Imports,* which also includes inferred product exports. This data was used to derive the incremental impacts to KBPH and to quantify the resulting increases in ship activity.

The four cases presented in the FGE report: both refineries operating, no refineries operating, Chevron only and Hawaii Independent Energy (HIE) only were analyzed from a KBPH perspective and the incremental impacts calculated. Additionally, each case included the eight scenarios from the FGE report: Business as usual (BAU), Renewable Portfolio Standard (RPS) falls short, RPS succeeds and Hawaii Clean Energy Initiative (HCEI) mostly succeeds, with and without LNG. The results were then presented as the number and frequency of incremental ships that would be required in each case.

In the case of both refineries operating, the volumes of imports as presented in the FGE report on page 79 were used for each scenario. Export volumes were obtained from the FGE report, page 80, *Figure 51. Inferred Product Exports, 'both refineries', kb/d.* These were added together to provide a total incremental volume for KBPH. In the case of no refineries operating, the volumes of imports as presented in the FGE report on page 79 were used for each scenario, less the current total imports of product. Export volumes were assumed to be zero for this case. In the case of one or the other refineries operating, the volumes of imports as presented in the FGE report on page 79 were used for each scenario, less the current total imports of product. Export volumes were obtained from the FGE report, page 80, *Figure 51. Inferred Product Exports, 'both refineries', kb/d* but the export volumes were attributed to each refineries based on a percentage of their output volumes. Import and export volumes were added together to provide a total incremental volume for KBPH.

From the volume information calculated for each five year period: 2015, 2020, 2025, 2030, 2035 and 2040, the number and frequency of ships was then calculated based on 10 kb/d equaling an additional 50,000 DWT ship/month. However, due to draft restrictions, a 50,000 DWT can only bring in 7 kb/day. Therefore, an additional adjustment was made to account for the smaller amount of cargo that can be brought into KBPH on this size ship at the current draft of 36 ft.

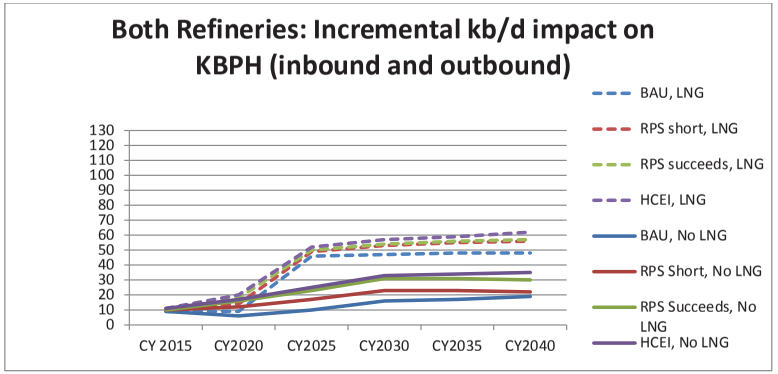
Other information obtained from the FGE report and used in this analysis includes current Hawaii import volumes, refinery output volumes, and general information about the refining process. Current throughput for KBPH was calculated using volumes provided by the Harbor Department for FY2012 (56 kb/d). Additionally, to keep this analysis within the project scope, certain assumptions were used:

- KBPH will absorb any increases in inbound or outbound waterborne petroleum activity. Honolulu activity will be held constant for this analysis.
- Any changes in crude oil volumes through the off-shore moorings will not impact the fuel pier except possibly in the no refineries operating case.
- Current shoreside storage/pipeline infrastructure is sufficient.
- Asphalt will not be considered as part of this analysis.
- Increases/decreases in jet, diesel ethanol and gasoline have been accounted for in the data set used for this analysis.
- Neighbor island demand is accounted for in the data set used for this analysis.
- LPG imports, although reported as likely to grow in the FGE report, are not included in this analysis.
- Bunkering impacts due to increases in ship traffic are not included in this analysis.

Both Refineries Operating:

The incremental kb/d impact on KBPH above the current 56 kb/d for all scenarios (capturing both inbound and outbound movements) with both refineries continuing to operate out to 2040 is illustrated in the graph below. For the no LNG case, in the scenarios where RPS and HCEI succeed, there is a gradual increase in volume from about 10 kb/d in 2015 until about 2030 where it remains relatively steady between 30 and 35 kb/d through 2040. In the cases of BAU and RPS falls short, the trend is similar, but at a smaller volume level. The increase between 2015 and 2040 is primarily due to exports of the excess fuel oil that is produced but not used in Hawaii.

With the introduction of LNG, the graph illustrates a steeper climb between 2020 and 2025 due to the more rapid displacement of fuel oil as an energy source for the power generation sector and the resulting exports out of KBPH. This levels off for the BAU, LNG case, but continues to rise slightly in the other scenarios as exports of fuel oil continue to grow out through 2040.



Both Refineries Operating, Fuel Pier Activity Impacts:

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at current 36 ft draft conditions, (covering all eight of the scenarios) with both refineries continuing to operate.

Both Refineries: incremental monthly ship counts at KBPH @ 36 ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	2	1-3	2-4	3-5	3-5	3-5
With LNG	2	2-3	7-8	7-9	7-9	7-9

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at potential future dredged draft conditions of 42 ft, (covering all eight of the scenarios) with both refineries continuing to operate.

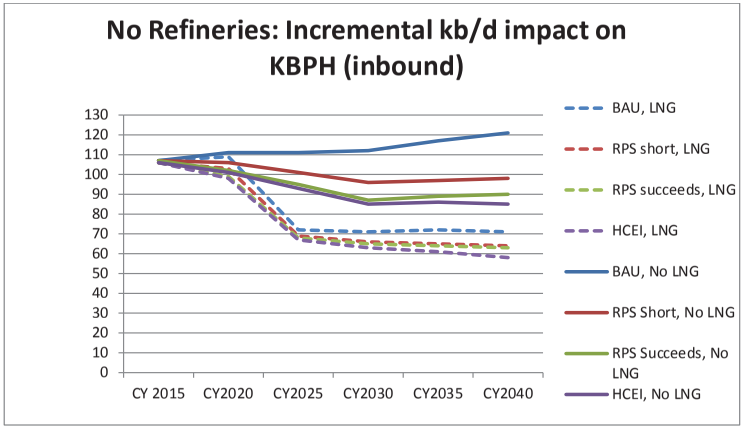
Both Refineries: incremental monthly ship counts at KBPH @ 42 ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	1	1-2	2-3	2-3	3-4	2-4
With LNG	1	1-2	5	5-6	5-6	5-6

No Refineries Operating:

The incremental kb/d impact on KBPH above the current 56 kb/d for all scenarios with neither refinery continuing to operate out to 2040 is illustrated in the graph below. With both refineries closing, all of Hawaii's liquid bulk energy would need to be imported. With or without the introduction of LNG, this would result in an immediate jump in import volume of approximately 105 kb/d. For the no LNG case, volumes would gradually decrease between 2020 and 2030 in all scenarios except the BAU, No LNG. After 2030, volumes would rise in all cases as energy demand overcomes the conservation efforts. The BAU, No LNG case rise is somewhat steeper as there are no additional conservation elements.

With LNG, the decline would be steeper between 2020 and 2025 when the commodity is introduced, leveling off for the BAU scenario, but continuing to decrease in the other scenarios. Without LNG, with the exception of the BAU scenario, the incremental volume through KBPH would be between 85 and 100 kb/d. With LNG it is lower, between 60 – 70 kb/d.



No Refineries Operating, Fuel Pier Activity Impacts:

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at current 36 ft draft conditions, (covering all eight of the scenarios) with no refineries operating. However, in the no refinery case, there would be no crude oil coming in through the off-shore mooring system. Therefore it is reasonable to consider the off-shore system might be utilized for some or all of the product imports, significantly reducing the impact on the KBPH as they would not have the complexities of conducting line displacements and the potential for cargo contamination that comes with switching between crude oil and clean products.

No Refineries: incremental monthly ship counts at KBPH @ 36 ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	16	15-16	14-16	13-16	13-17	13-18
With LNG	16	14-16	10-11	9-11	9-11	9-11

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at potential future dredged draft conditions of 42 ft, (covering all eight of the scenarios) with no refineries operating. As stated before, if both refineries are closed, there will be no movement of crude oil through the off-shore moorings allowing for some or all of the inbound product volume to be brought in from off-shore, significantly decreasing the activity on the fuel pier below what is shown in the table.

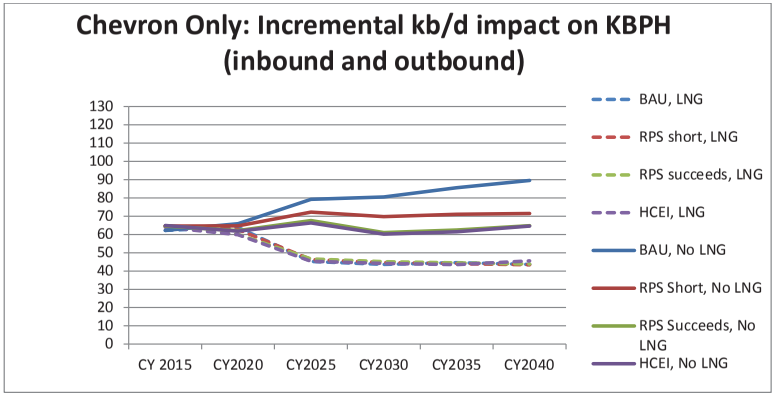
No Refineries: incremental monthly ship counts at KBPH @ 42ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	11	10-11	9-11	9-11	9-12	9-12
With LNG	11	10-11	7	6-7	6-7	6-7

Chevron Refinery Only:

In the case where one refinery chooses to close and the other continues to operate, the KBPH impact would include an increase in imported products to meet the local demand as well as an increase in exports of refinery produced fuel oil in excess of local demand. As the Chevron refinery is smaller than HIE, the import impact is larger, and the export impact smaller.

With only the Chevron refinery operating, the incremental volume impact on KBPH would jump immediately by approximately 65 kb/d in all scenarios. In the case of no LNG, there would be a moderate rise between 202O and 2025, becoming somewhat stable after 2025 within a 10 kb/d band for all scenarios other than BAU. With the introduction of LNG, the impact is about the same until 2020, with a decrease of about 15 kb/d occurring between 2020 and 2025, leveling off out until 2040.



Chevron Only Operating, Fuel Pier Activity Impacts:

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH at current 36 ft draft conditions (covering all eight of the scenarios) in the case that Chevron is the only refinery that continues to operate.

Chevron Only: incremental monthly ship counts at KBPH @ 36 ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	9-10	9-10	10-12	9-12	9-13	10-13
With LNG	9-10	9-10	7	7	7	7

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at potential future dredged draft conditions of 42 ft, (covering all eight of the scenarios) in the case that Chevron is the only refinery that continues to operate.

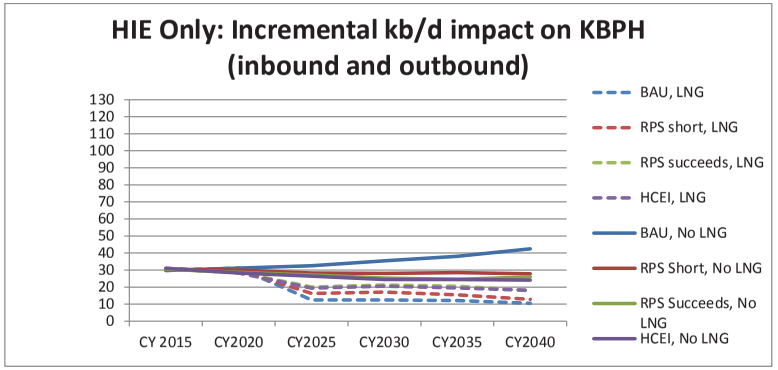
Chevron Only: incremental monthly ship counts at KBPH @ 42ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	6	6-7	7-8	6-8	6-9	6-9
With LNG	6	6	5	4-5	4	4-5

Hawaii Independent Energy (HIE) Refinery Only:

With only the HIE refinery operating, the incremental volume impact on KBPH would be approximately 30 kb/d in all scenarios. In the BAU, No LNG scenario, there would be a moderate rise between 202O and 2040 of slightly over 10 kb/d. In the other no LNG scenarios, volumes remain quite stable with a slight decline in the RPS and HCEI succeeds scenarios.

With the introduction of LNG, the impact is about the same until 2020, with a decrease between 15 and 20 kb/d occurring between 2020 and 2025 and basically leveling off out until 2040.



Hawaii Independent Energy (HIE) Only Operating, Fuel Pier Activity Impacts:

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at current 36 ft draft conditions, (covering all eight of the scenarios) in the case that HIE is the only refinery that continues to operate.

HIE Only: incremental monthly ship counts at KBPH @ 36 ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	5	4-5	4-5	4-5	4-6	4-6
With LNG	5	3-5	2-3	2-3	2-3	2-3

The following table reflects the additional number of 50,000 DWT ships that would be needed each month at KBPH, at potential future dredged draft conditions of 42 ft, (covering all eight of the scenarios) in the case that HIE is the only refinery that continues to operate.

HIE Only: incremental monthly ship counts at KBPH @ 42ft draft

	CY 2015	CY2020	CY2025	CY2030	CY2035	CY2040
Without LNG	3	3	3	2-4	2-4	2-4
With LNG	3	3	1-2	1-2	1-2	1-2

Appendices:

Appendix A: KBPH Water Movements FY 2012 (bbls)

KBPH Water Movements		
FY 2012 (bbls) 411 days	bbls	Kb/d
Diesel	**4,676,190.80**	**11.38**
(Barge Inter-Island)	2,608,611.10	**6.35**
(Tank Ship Overseas)	2,067,579.70	**5.03**
Fuel Oil	**2,521,769.50**	**6.14**
(Barge Inter-Island)	2,027,731.00	**4.93**
(Tank Ship Overseas)	494,038.50	**1.20**
Gasoline	**2,417,837.30**	**5.88**
(Barge Inter-Island)	2,356,358.30	**5.73**
(Tank Ship Overseas)	61,479.00	**0.15**
Jet Fuel	**1,851,321.00**	**4.50**
(Barge Inter-Island)	1,811,293.00	**4.41**
(Tank Ship Overseas)	40,028.00	**0.10**
Total	***11,467,118.60***	***55.80***

Source: Harbor Department

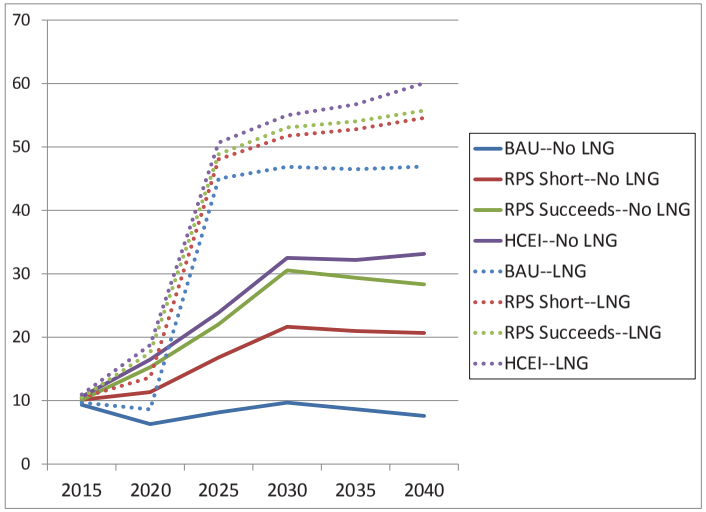
Appendix B: Product Import Scenarios (Typical Output Slates), (kb/d)

Product Imports--No LNG				
	BOTH REFINERIES	CHEVRON ONLY	TESORO ONLY	NO REFINERIES
	Business-As-Usual LNG Imports			
2015	0	74	39	122
2020	1	78	43	126
2025	3	78	43	126
2030	6	79	44	127
2035	9	84	48	132
2040	12	88	53	136
	RPS Falls Short--LNG Imports			
2015	0	76	39	122
2020	1	75	38	121
2025	1	70	33	116
2030	1	66	29	111
2035	2	67	30	112
2040	2	67	30	113
	RPS Succeeds--LNG Imports			
2015	0	76	39	122
2020	1	71	34	117
2025	1	65	28	110
2030	1	57	21	102
2035	2	58	21	104
2040	2	60	23	105
	HCEI Mostly Succeeds--LNG Imports			
2015	0	76	39	121
2020	1	70	33	116
2025	1	63	26	108
2030	1	55	19	100
2035	2	56	19	101
2040	2	58	18	100

Product Imports--LNG Imports				
	BOTH REFINERIES	CHEVRON ONLY	TESORO ONLY	NO REFINERIES
	Business-As-Usual LNG Imports			
2015	0	74	39	122
2020	1	76	43	124
2025	1	44	23	87
2030	1	42	21	86
2035	2	43	22	87
2040	2	42	21	86
	RPS Falls Short--LNG Imports			
2015	0	76	39	121
2020	1	73	38	118
2025	1	44	21	84
2030	1	41	18	81
2035	2	40	17	80
2040	2	39	15	79
	RPS Succeeds--LNG Imports			
2015	0	76	39	121
2020	1	69	34	114
2025	1	44	21	83
2030	1	41	17	80
2035	2	40	17	79
2040	2	39	15	78
	HCEI Mostly Succeeds--LNG Imports			
2015	0	75	39	121
2020	1	68	33	113
2025	1	42	19	82
2030	1	39	15	78
2035	2	38	14	76
2040	2	39	12	73

Source: Facts Global Energy (FGE) report Fuels Market in Hawaii: Current Situation and Future Prospects, page 79

Appendix C: Inferred Product Exports, 'both refineries', (kb/d)



Source: Facts Global Energy (FGE) report Fuels Market in Hawaii: Current Situation and Future Prospects, page 80

APPENDIX E
HARBOR USER QUESTIONNAIRE

Respondent

Name _____ Position: _____

Company: _____ Address: _____

E-mail:_____ Phone: _____

Project Contact (if different from Respondent)

Name _____ Position: _____

E-mail: _____ Phone: _____

Business Overview
Please describe the services your company provides and the kinds of operations they require at Kalaeloa Barbers Point Harbor.

In planning for the future of the Kalaeloa Barbers Point Harbor, the current and future needs of harbor users need to be considered. Please answer the questions that follow as completely as possible. Thank you for your participation.

1. Harbor / Water Area:	Adequate? (*Check response*)		Improvements Necessary (*Please explain*)
	Yes	No	
a. Size of harbor			
b. Draft in harbor			
c. Navigation in harbor			
d. Configuration of harbor			
e. Accommodation of different ship types			
f. Night time operations			

2. Which vessels are typically used in operations? *(Check all that apply)*

	Freight Barges		Neobulk Ships		Tank Barges		Tugs
	Dry Bulk Ships		Passenger Vessels		Tank Ships		Other *(Describe)*:

Vessel Dimensions (*Please list values.*)	Current Size (Maximum)	Preferred Size (Maximum)
Length Overall:		
Beam:		
Draft:		

Comments:

What is your current vessel schedule and port call frequency?
(*Select one time frame for your response.*)

_____ times per week **OR**	_____ times per month **OR**	_____ times per year.

What is your average port call duration (in hours) for various types of vessels (listed above) and cargo handling operations (i.e., crane grab, bulk unloader, RO/RO, LO/LO, cargo hose)?
(*Example: Dry Bulk / bulk unloader = 30 hours.*)

3. Docks:	Adequate? (*Check response*)		Improvements Necessary (*Please explain*)
	Yes	No	
a. Height			
b. Construction			
c. Regulatory requirements			
d. Fendering			
e. Mooring arrangements			
f. Pollution control			
g. Certification			
h. Fire protection			
i. Safety features			
j. Lighting			

Comments:

Which piers do you currently utilize?

(Please circle, or highlight, your choice(s).)

1. **P-1**
2. **Marisco**
3. **"Finger Pier "**
4. **P-5A**
5. **P-5 (aka "Pier 5 Bravo")**
6. **P-6**
7. **P-7**
8. **P-9 (Floating Dry Dock)**

What are their limitations?

Which piers would you prefer to utilize?

(Please circle, or highlight, your choice(s).)

1. **P-1**
2. **Marisco**
3. **"Finger Pier "**
4. **P-5A**
5. **P-5 (aka "Pier 5 Bravo")**
6. **P-6**
7. **P-7**
8. **P-9 (Floating Dry Dock)**

What are their limitations?

4. Marine Terminal Area (square footage):	**Current**	**Future Needs**
a. Dock Area Utilized:		
b. Storage Area Utilized:		
c. Other Area Utilized:		
Total Area:	0	0
Alternate Operational Area:		
Alternate Storage Area:		

5. Marine Terminal:	**Adequate?** (*Check response*)		**Improvements Necessary** (*Please explain*)
	Yes	**No**	
a. Area			
b. Berth scheduling			
c. Availability			
d. Suitability			
e. Cargo handling features			
f. Storage			
g. Operational office space			
h. Fuel piping / Fuels			
i. Tank cleaning			
j. Passenger / Ferry operations			

Comments:

Are facility improvements needed to increase the efficiency of current operations? If so, which types would you recommend?

6. Support Services / Utilities:	Adequate? (*Check response*)		Improvements Necessary (*Please explain*)
	Yes	No	
a. Water			
b. Electrical			
c. Ramps			
d. Navigation capabilities (dGPS, navigation lights)			
e. Fencing			
f. Security guards			
g. Office space			
h. Person in Charge (PIC) accommodations			
i. Hazardous waste handling			
j. Garbage handling			
k. Pilotage			
l. Tugs			
m. Telephone service			
n. Wireless service			
o. Internet service			
p. Sewage pump out			
q. Bunkering			
r. Vessel repairs			
s. Tank cleaning			

Comments:

7. Company Operations: Cargo Volume Throughput by Year

Year (*CY*)	Cargo / Neobulk *Circle Unit of Measure:* (*S/Tons M/Tons*)	Fuel / Liquid Bulk (No. of Barrels)	Dry Bulk *Circle Unit of Measure:* (*S/Tons M/Tons*)
2002			
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010			
2011			
2012			
2013			
Information for Planning:			
How much of the cargo (%) is currently trans-shipped inter-island?			
What is the estimated throughput capacity?			
When (i.e., year) will this throughput capacity be reached?			
Volume Forecast:			
2015			
2020			
2025			
2030			
2035			
2040			

8. Company Operations: Passenger Traffic (Passenger Cruise, Ferry, or Excursion) by Year

Year (*CY*)	Passenger Cruise		Ferry		Excursion Vessel	
	# Passengers	# Vessels	# Passengers	# Vessels	# Passengers	# Vessels
Passenger Traffic Forecast:						
2015						
2020						
2025						
2030						
2035						
2040						

9. Ship Repair / Dry Docking

	Barge		Tug / Workboat		Govt.-Owned Vessel		Other Vessels	
Year *(CY)*	# Vessels Repaired	Total Days Under Repair	# Vessels Repaired	Total Days Under Repair	# Vessels Repaired	Total Days Under Repair	# Vessels Repaired	Total Days Under Repair
2002								
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
Forecast of Vessels for Repair:								
2015								
2020								
2025								
2030								
2035								
2040								
Information for Planning:								

Are ship construction facilities needed at Kalaeloa? *(Circle, or highlight, your response.)*

Yes **No**

Does your company have any plans for ship construction? *(Circle, or highlight, your response.)*

Yes **No**

What is required for this operation? *(Please comment.)*

10. Other Data / Regulatory Compliance:

Of which of the following has your company had to meet regulatory compliance requirements?

	Check box if applicable
a. U.S. Coast Guard (USCG)	
b. Environmental Protection Agency (EPA)	
c. National Pollutant Discharge Elimination System (NPDES) Permit	
d. Public Utilities Commission (PUC)	
e. Americans with Disabilities Act of 1990 (ADA)	
f. Oil Companies International Marine Forum (OCIMF)	
g. Ship Inspection Report Programme (SIRE)	
h. Occupational Safety and Health Administration (OSHA)	
i. Hawaii Dept of Health environmental permits (e.g., clean water, air emissions)	
j. International Maritime Organization (IMO)	
k. Ship / Terminal Vetting	
l. Passenger Vessel Association (PVA)	

Comments:

11. Other issues:

a. Please tell us your Top 5 priority issues and / or areas of concern. *(List them in order of importance to you.)*

1	
2	
3	
4	
5	

b. How would you rate the harbor facilities and services? *(Circle, or highlight, one score)*

5	4	3	2	1
Excellent	Good	Average / Adequate	Fair	Poor

c. New development or use: Which types would you like to see?

d. New development or use: Which types would you not like to see?

e. Are there any other issues that the Master Plan should consider? Please feel free to comment.

Thank you for your participation. The information you provide will assist in the development of the Kalaeloa Barbers Point Harbor Master Plan.

Please return completed questionnaire to:
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, HI 96813

If you have any questions, please call
(808) 523-5866 or e-mail:
kbph@group70int.com

APPENDIX F
SUMMARY OF QUESTIONNAIRE RESULTS

Kalaeloa Barbers Point Harbor - 2040 Master Plan
User Survey Summary

Introduction:

The following report is a summary of the information and responses recorded through the Kalaeloa Barbers Point Harbor user survey. Through this survey, Group 70 recorded the current and future needs of Kalaeloa Harbor users in preparation for the 2040 Master Plan. 35%, or 28 of the 80 companies receiving the survey, participated. The percentages in the information tables below represent the percentage of harbor users participating in the survey that responded "yes, this harbor feature is adequate." The categories are color-coded for convenience: red (<60%), yellow (60%-80%), and green (80%-100%).

Participating Companies:

Aloha Consulting
Aloha Petroleum
Amerigas
Ameron Hawaii
BAE Systems
Chevron
Clean Islands Council
Daehan Shipping Agency
GLP Asphalt LLC
Grace Pacific Corp.
Hawaii Gas (LNG/Propane)
Hawaii Pilots Assoc.
Hawaii Stevedores, Inc.
HECO
Hidden Villa Ranch
HTB/YB (Young Brothers)
ILWU
Inchcape
Kirby Offshore Marine
Marine Cargo Surveys
Maritime Licensing Ctr.
McCabe, et al. Co.
P&M Marine Svcs and P&R Water Taxi
Pasha Hawaii
PENCO
Star of Honolulu
Tesoro Hawaii, LCC
Zilkha Biomass Fuels

Summary:

On average, the Kalaeloa harbor facilities and services are rated at 3.48 on a scale of 1 to 5. This rating is slightly above average or adequate, as the majority of users ranked the harbor with a 3 or a 4. Harbor users expressed that the harbor/water areas and marine terminal are the main issues that should be addressed.

Harbor/Water Areas:

The Kalaeloa harbor and water areas are 62.47% satisfactory. The main issues that need to be addressed are the harbor size, draft, night time operations, and ship accommodation. Harbor navigation and configuration are rated at 66.7% and 72.0% respectively. Some users suggested the need for more pier docking space and deeper drafts to allow for fully loaded vessels. Users also indicated that ship accommodation should be improved to support large Navy and commercial vessels. Improvements should be made to the shore side of the harbor in order to better accommodate several vessels at once. Additionally, the channel should be widened and a current meter should be installed.

Harbor/Water Areas			
Size of Harbor	68.0%	Configuration of Harbor	72.0%
Draft in Harbor	54.2%	Ship Accommodation	64.0%
Navigation in Harbor	66.7%	Night Time Operations	50.0%

Vessels/Cargo:

The majority of harbor users utilize tank ships, tank barges, tugs, and dry bulk ships. The companies' respective vessel schedules, port call frequencies, port call durations, and cargo volume throughputs vary.

No. Companies Utilizing Vessels			
Freight Barges	8	Dry Bulk	9
Neobulk Ships	2	Passenger Vessels	3
Tank Barges	10	Tank Ships	11
Tugs	8	Other	4

Ship Repair/Dry Docking:

92.86% of all companies surveyed agree that ship construction facilities are not needed at Kalaeloa. Only one of the surveyed companies has plans for ship construction at this point.

Docks:

Pier 6 is utilized most frequently by harbor users, closely followed by Pier 5, Pier 5A, and Pier 7. Harbor users expressed concern that cargo operations can only happen at Piers 5 and 6, and that Pier 7 does not have a cargo pipeline. Additionally, the vessel at Pier 5A often infringes on the berth at Pier 5. Pier 7 lacks sufficient bollards and winches to pull lines. Users also requested the construction of a permanent structure at Pier 7.

Docks			
Height	100%	Pollution Control	93.7%
Construction	90.0%	Certification	94.1%
Regulatory Requirements	94.7%	Fire Protection	100%
Fendering	90.0%	Safety Features	84.2%
Mooring Arrangements	80.0%	Lighting	85.0%

The dock facilities were deemed to be 91.2% adequate by harbor users. Mainly, improvements to the safety features of the docks are necessary. More life-rings need to be added, as the only ones apparent are on the off-loader machines. The height and fire protection of the docks received a 100% satisfaction rating. The harbor fendering should be improved to allow for larger ships and side-by-side berthing. In regards to construction, a larger pier pad is needed to accommodate heavier lift items. Users suggested the addition of restroom facilities at Piers 6 and 7 as well as more covered pavement at Pier 7. The limited access and storm and wave surges at Pier 1 should be addressed as well. Users also suggested improving the run-off containment system and implementing a wash-off station for workers exposed to hazardous spills. Lighting should be improved in the dry-dock areas. Fire protection, First-Aid life saving stations, and emergency communication should be incorporated into the dock improvements as well.

Marine Terminal:

The marine terminal is 69.61% satisfactory. Users' main concerns include availability, berth scheduling, passenger/ferry operations, and fuel piping. The companies unanimously agreed that the harbor's tank cleaning was satisfactory. Users expressed concern that Pier 6 is frequently congested and not enough berths are available throughout the harbor as a whole. More pier space and pipelines at all berths are needed to improve efficiency. It will be important not to disrupt the utilization of the supply chain during berth scheduling improvements. Space needs to be added for handling and storing large cargo; more covered storage area is needed as well. Additionally, more fueling positions are required and the equipment holding area should be improved to have better pier access. Users also suggested constructing a permanent receiving hopper and conveyance system at Pier 7.

Marine Terminal			
Area	71.4%	Storage	75%
Berth Scheduling	50%	Operational Office Space	72.7%
Availability	40.0%	Fuel Piping/Fuels	66.7%
Suitability	91.7%	Tank Cleaning	100%
Cargo Handling Features	71.4%	Passenger/Ferry Operations	57.1%

Support Services/Utilities:

The Kalaeloa support services and utilities were rated with 75.3% satisfaction. The main issues that need to be addressed are water utilities, office space, navigation capabilities, and internet and telephone service. The facility's bunkering, vessel repairs, and tank cleaning services were 100% satisfactory. With respect to hazardous waste handling, emergency and response systems should be built in. Users requested sewage pump out systems to be installed at every pier. The office space should be in a position that allows users to monitor harbor activity. Additionally, water and electrical services should be expanded at Pier 7.

Support Services/Utilities			
Water	60.0%	Electrical	63.6%
Ramps	75.0%	Navigation Capabilities	55.6%
Fencing	85.7%	Security Guards	80.0%
Office Space	62.5%	PIC Accommodations	70.0%
Haz. Waste Handling	90.0%	Garbage Handling	75.0%
Pilotage	92.3%	Tugs	85.7%
Telephone Service	57.1%	Wireless Service	57.1%
Internet Service	42.9%	Sewage Pump Out	77.8%
Bunkering	100%	Vessel Repairs	100%
Tank Cleaning	100%		

Regulatory Compliance:

The majority of companies utilizing Kalaeloa Harbor reported having to meet the regulatory compliance requirements of the U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), Hawaii Department of Health Environmental Permits, and National Pollutant Discharge Elimination System (NPDES). A select few also had to meet the regulatory compliance requirements of the Public Utilities Commission (PUC), Americans with Disabilities Act of 1990 (ADA), Oil Companies International Marine Forum (OCIMF), Ship Inspection Report Programme (SIRE), International Maritime Organization (IMO), Ship/Terminal Vetting, and Passenger Vessel Association (PVA).

No. Companies Meeting Req.			
USCG	21	EPA	18
NPDES	15	PUC	5
ADA	10	OCIMF	4
SIRE	4	OSHA	18
Dept. Health	15	IMO	8
Ship Vetting	5	PVA	2

Additional Comments:

Kalaeloa Harbor users' main areas of concern include nighttime operations, pier availability and access, harbor congestion, security, and the implementation of a fuel pier. Users also expressed concern over water, air, and electrical utilities, office facilities, scheduling, dock space, and berthing conflicts. Users suggested the addition of cameras, so that those at Aloha Tower can see the piers. It was also suggested to provide vessel crews with affordable transportation or escorts off the terminal. Another option would be to create a vessel crew recreational facility for the use of phones, internet, etc. Access to and egress from the pier should be allowed via highway. Users requested that all unused vessels be removed from DOT harbors. Additionally, an offshore current meter should be installed and a permanent structure should be constructed at Pier 7. The suggestions and comments listed above should be taken into consideration in the planning and implementation of a new master plan at Kalaeloa Harbor.

Appendix G

Consideration of Liquefied Hazardous Gas Shipments and Storage at Kalaeloa Barbers Point Harbor (Group 70)

CONSIDERATION OF LIQUEFIED HAZARDOUS GAS SHIPMENTS AND STORAGE AT KALAELOA BARBERS POINT HARBOR

1.0 Executive Summary

Liquefied Hazardous Gas (LHG) is a general industry term for a liquid that contains one of 19 specific chemical compounds that are either flammable or toxic. Liquefied Petroleum Gas (LPG, also known as propane) and Liquefied Natural Gas (LNG, or methane) are the two primary types of LHG fuel sources that are shipped in large tankers across open ocean waters. The transport, handling, and storage of these hazardous products at any harbor and port require special consideration in the planning and management of harbor facilities. This document summarizes what issues were identified in consideration to expand LHG activities as part of the planning and development of the *KBPH 2040 Master Plan (2040 Master Plan)*, including public safety and harbor security concerns in transshipment and storage.

Over the years, there have been many discussions regarding the introduction of LNG to Hawai'i as a means to reduce power generation cost and help meet environmental mandates. Natural gas burns cleaner than the currently used low sulfur fuel oil, and condensing the gas to a liquid makes transport of LNG more cost efficient. The only existing LHG activity at KBPH is the bulk importation, ISO-container storage (off-site), and transshipment of LPG by Hawai'iGAS to the Neighbor Islands via Pier 1. Additionally, a new potential user (AmeriGAS) initiated a request to install pipelines in the harbor to transfer bulk LPG to storage at a nearby location. The design of the proposed facilities to support this action was not thoroughly presented by the applicant, but the land requested for this activity is accounted for in the Bulk B area of the *2040 Master Plan (Section 5.2.11)* preferred alternative.

During the preparation of the *2040 Master Plan*, an existing user (Hawai'iGAS) provided a conceptual plan for the transfer and storage of bulk LNG for consideration by Department of Transportation, Harbors Division (DOT-H). No formal proposals were made as the design was still preliminary. A *2040 Master Plan* alternative was formulated with a bulk LNG terminal as a place holder so that further evaluation can be conducted in the event an applicant decides to pursue this endeavor and provide additional details. The conceptual plan of the proposal is presented in *Section 5.0* (as well as in *Section 5.2.12* of the *2040 Master Plan*). The importation of bulk LNG at some level may be possible at KBPH, but will require a significant amount of advanced planning and engineering studies to assess its feasibility.

Numerous rules, regulations, guidelines, and standards exist for LHG facilities, particularly for vessels and onshore terminals. United States LHG safety regulations are largely prescriptive, requiring specific design elements (e.g., location and requirements for impoundment and loading areas, piers and wharves able to resist earthquake forces, etc.), and specify the manner in which risk to the public must be minimized (e.g., adequate protection distances and safety zones, remote siting of operations, etc). Collectively, they are intended to assure that proposed and existing vessels that would transport LHG as well as onshore terminals are designed, programmed, and managed to address the critical safety issues associated with LHG. Because of the many possible engineering solutions and multiple agencies that would be involved in designing and permitting of such facilities, determining the specific impact of new LHG facilities on other harbor operations and landside activities in KBPH is uncertain at this time. Once specific designs are approved and exclusions zones (distance and proximity constraints to guard against adverse public safety impacts related to LNG leaks) have been calculated through the appropriate computer models, impacts will be more defined.

Specific handling standards, such as those from the National Fire Protection Association (NFPA), dictate the distance of allowable activities from both the point of transfer of the fuel and from their storage locations. For example, it is understood that the handling of general cargo over a pier or dock, other than ships' supplies for an LHG tank vessel, is not allowed within 100 feet from the point of transfer connection while LHG is being transferred through piping systems (NFPA 58, Section 13.2.1.2 (2004) and NFPA 59A, Section 11.4.1 (2001)).

However, other regulations are more difficult to interpret at this time. For example, exclusion zones *(Section 3.2.2)* surrounding bulk LNG terminals are determined through the use of computer models. Changes in terminal design can either increase or reduce these exclusion zones. In addition, the activities allowed within a security zone (an area surrounding an LHG vessel during transit and transfer and enforced by security vessels) *(Section 3.1)* are determined by the United States Coast Guard (USCG), Captain of the Port (COTP). The allowable activities can vary for each COTP in their respective areas, and would not be known until such time an LHG terminal is in the permitting stages.

Compared to LPG storage facilities, siting bulk LNG import terminals can be a lengthy process lasting several years. The applicant must work with several federal agencies in order to obtain a number of permits to build a terminal, associated storage facilities, and pipeline infrastructure to import the LNG product. Although the Federal Energy Regulatory Commission (FERC) process is fairly well defined, a realistic schedule to develop a bulk LNG terminal in Hawai'i is approximately six to eight years *(Section 4.2)*.

While further evaluation would need to be conducted through more detailed engineering and design studies in collaboration with FERC, USCG, DOT-H and other harbor users, the preliminary assessment through this document is that an LNG terminal could be established at Pier 3 in concert with the redevelopment of the Piers 3 and 4 area as part of the Fuel Pier. Evaluation of LPG facilities, alternatively, prioritizes delivery at Piers 1 and 3 for regular shipments, with Piers 5 and 7 as potential redundant systems.

Any applicant interested in siting an LHG terminal at KBPH will be responsible for fulfilling all planning standards and permitting associated with such facilities. Specifically, the applicant will be required to comply with all protection distances established by regulations. The *2040 Master Plan* recommends that applicants satisfy the following conditions:

1. **Must be compatible and not conflict with the safety and functionality of other uses, operations and land use designations within the harbor.**
2. **Must satisfy all Federal, State and County permitting and environmental requirements.**

The remainder of this document will provide an overview of the regulatory framework in the transport and storage of these fuel products; a summary of the LHG planning protection distances and their impacts to neighboring users; an overview of the LNG terminal permitting process; a proposal for a bulk LNG Terminal provided by Hawai'iGAS; and opinions and recommendations of the *2040 Master Plan* in relation to these topics.

2.0 Regulatory Framework

2.1 Federal Agencies

The following agencies have oversight of LHG products and marine import terminals, with the USCG overseeing permitting for offshore projects and the FERC handling similar duties for onshore projects.

US Coast Guard (USCG)

The movement of an LHG vessel into KBPH is under the regulatory control of the USCG, COTP. The COTP is responsible to ensure the safety of the LHG vessel prior to entry into the harbor by making certain it complies with the prescribed regulations and safety standards, and establishing security zones around the transiting ship and around the storage terminal. The COTP is also responsible for reviewing *Waterway Suitability Assessments* and LHG terminal plans to determine the suitability of the waterway for LHG marine traffic. In addition, the COTP is responsible for reviewing whether or not proper safety precautions are being taken to protect the facility, its employees and the public from hazards and security risks associated with the transfer and storage of LHG products.

US Department of Energy (DOE), Federal Energy Regulatory Commission (FERC)

FERC is an independent federal agency within DOE that regulates the interstate transmission of electricity, natural gas and oil. FERC grants federal approval for the siting of new LNG onshore import and export facilities, under the Natural Gas Act of 1938, as amended. This approval process incorporates minimum safety standards for LNG storage established by the US Department of Transportation (USDOT), which, in turn, incorporates siting standards set by the National Fire Protection Association (NFPA) and the regulatory requirements of the Pipeline and Hazardous Materials Safety Administration (PHMSA). Most importantly, FERC is the lead agency responsible to conduct the necessary environmental evaluation for LNG projects, and oversees the preparation and completion the Draft Environmental Impact Statement (EIS) and Final EIS per requirements under the National Environmental Policy Act. In addition to evaluating environmental concerns, FERC reviews the engineering design of the facility and monitors construction of the project.

US Department of Transportation (USDOT), Pipeline and Hazardous Materials Safety Administration (PHSMA)

The mission of PHMSA is to protect people and the environment from the risks of transporting hazardous materials. This is fulfilled through the establishment of national policy; setting and enforcing standards for the design, construction, operation, maintenance or abandonment of pipelines; educational training; and conducting research to prevent incidents. PHMSA also has the responsibility of informing the public and preparing first responders to minimize consequences if an incident does occur. PHMSA leads two national safety programs that identify and evaluate safety risks: Hazardous Materials Safety, which develops and enforces standards for transporting hazardous materials, and Pipeline Safety, which develops and enforces standards for design, construction, operations and maintenance of pipelines carrying natural gas or hazardous liquids.

2.2 Codes and Standards

The *Code of Federal Regulations* (CFR) outlines the general and permanent rules and regulations published in the *Federal Register* by the executive departments and agencies of the federal government. *Table 1* below outlines the CFRs that are applicable to the handling and storage of LHG within a harbor. Additional information, such as standards related to design and operation of an LHG vessel or terminal, can be found within the CFR but are not listed in the table below.

Table 1. Code of Federal Regulations Related to Waterfront LHG Facilities

Standards Body	CFR Section – Document Name	Applicable Synopsis
FERC	18 CFR 153 – Conservation of Power and Water Resources: Applications for Authorization to Construct Operate, or Modify Facilities Used for the Export or Import of Natural Gas	Establishes filing requirements an applicant must follow to obtain authorization under section 3 of the Natural Gas Act for the siting, construction, operation, and place of entry for imports or place of exit for exports of natural gas.
USCG	33 CFR 127 – Navigation and Navigable Waters: Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas	Owner / Operator submits Letter of Intent and *Waterway Suitability Assessment* to COTP at least one year before construction of a new facility. COTP issues letter of recommendation as to the suitability of the waterway for LHG or LNG marine traffic. COTP is allowed to examine the facility and issue suspension of operations if needed. Owner / Operator submits Operations Manual and Emergency Manual for the active facility. Requirements are listed for LHG facility design and construction, equipment, operations, maintenance, firefighting equipment, and fire protection. Requirements are also listed for LNG waterfront facility infrastructure, equipment, operations, maintenance, personnel training, firefighting, and security.
USCG	33 CFR 165 – Navigation and Navigable Waters: Regulated Navigation Areas and Limited Access Areas	Prescribes specific requirements for established areas: regulated navigation areas, safety zones, security zones, restricted waterfront areas, limited access areas, and protection of naval vessels.
PHMSA	49 CFR 192 – Transportation: Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards	Prescribes minimum safety requirements for pipeline facilities and the transportation of gas, including pipeline facilities. Each pipeline system subject to 49 CFR 192 that transports only petroleum gas or petroleum gas / air mixtures must meet the requirements of 49 CFR 192 and of NFPA 58 and 59 (see *Table 2*).
PHMSA	49 CFR 193 - Transportation: Liquefied Natural Gas Facilities: Federal Safety Standards	Describes the safety standards for siting LNG facilities pertaining to the system or facilities between the marine vessel and the last manifold / valve located immediately before a storage tank.

The CFRs reference multiple standards for the construction and operation of LHG terminals. The most applicable references for the LHG terminals and their impacts to harbor operations and landside activities are listed in *Table 2*.

Table 2. Applicable Material Approved for Incorporation by Reference

Title of Referenced Material	CFR Reference
Gas Technology Institute (GTI) formerly the Gas Research Institute (GRI)	
GTI-04/0032 LNGFIRE3 (March 2004): A Thermal Radiation Model for LNG Fires	49.193.2057(a)
GTI-04/0049 (April 2004): LNG Vapor Dispersion Prediction with the DEGADIS 2.1: Dense Gas Dispersion Model For LNG Vapor Dispersion	49.193.2059
GRI-96/0396.5 (April 1997): Evaluation of Mitigation Methods for Accidental LNG Releases, Volume 5: Using FEM3A for LNG Accident Consequence Analyses	49.193.2059
National Fire Protection Association (NFPA)	
NFPA 58 (2004): Liquefied Petroleum Gas Code	49.192.11(a,b,c)
NFPA 59A: Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)	(1994): 33.127.101; 33.127.201; 33.127.405; 33.127.603. (2001): 49.193.2019; 49.193.2051; 49.193.2057; 49.193.2059; 49.193.2101(a); 49.193.2301; 49.193.2303; 49.193.2401; 49.193.2521; 49.193.2639; 49.193.2801. (2006): 49.193.2101(b); 49.193.2321(b)

3.0 LHG Safety: Categories and Descriptions

The intent of LHG safety regulations is to reduce the risks of human injury and asset loss. Safety in the LHG industry is ensured by four elements that provide multiple layers of protection both for the LHG industry employees and the communities that surround the facilities:

1. **Containment systems** are the first and most important requirement for containing the LHG product, and involve the use of appropriate materials as well as proper engineering and design of storage tanks onshore and on LHG transport vessels. Containment tanks for products must meet the stringent requirements established by the regulations, such as the American Petroleum Institute (API) Standard 620: Design and Construction of Large, Welded, Low-Pressure Storage Tanks.
2. **Secondary containment** ensures that if leaks or spills occur at the onshore LHG facility, the LHG can be contained and meet the standards established to prevent hazardous concentrations of gas or radiated heat from impact off-site.
3. **Safety systems** minimize the potential, frequency, and extent of LHG releases both onshore and offshore through established equipment requirements, operating procedures, training, emergency response systems, and regular maintenance.
4. **Protection distances** are required by regulation around LHG ships and land-based facilities to site them at a safe distance from adjacent industrial facilities, residential communities and other public access and use areas. Within these protection distances, plans are made for the appropriate operational procedures within these distances.

Further discussion on **Protection Distances** is provided below. Terms, such as security zone, zones of concern, exclusion zone, and separation distances are used for specific LHGs. These terms are summarized below and specific details are provided further in this chapter:

- All LHG vessel operating areas and LHG facilities are established as **Security Zones** *(Section 3.1)*. These zones are required to be patrolled by the USCG and are intended to protect LHG vessels from security risks and to prevent attack from other marine sources. The operating requirements within an established security zone vary depending upon risk and requirements established for each zone.
- Projects submitted for LNG vessels and FERC regulated facilities must submit a *Waterway Suitability Assessment* using established **Zones of Concern** *(Section 3.2.1)*. The three zones of concern portray varying consequences to life and property near or within the transit areas of the LNG vessels. The zones were developed by Sandia National Laboratories in concert with a panel of experts to be used in reviewing mitigation measures around LHG vessels and land-based facilities.
- LNG terminals have two types of **Exclusion Zones** *(Section 3.2.2)* which must be used in the design: a thermal radiation/heat flux zone and a vapor dispersion zone. These planning zones are used to examine radiated heat and gas dispersion from potential spills located at the transfer point, with spill duration up to 10 minutes. Once these zones are established through the use of computer models, developers must ensure they site the facility at a minimum safe distance to areas that are inhabited or frequented by the public, such as residences, hospitals, schools and other gathering areas.

- LNG and LPG storage containers have **Separation Distances** *(Sections 3.2.3 and 3.3)* with respect to the nearest container, important buildings (such as operations), group of buildings, or line of adjoining property that can be built upon, as defined by NFPA 58 and 59A.

3.1 LHG Vessel Security Zones

According to 33 CFR 165, the USCG COTP has the authority to regulate the movement of all LHG vessels (both LPG and LNG), and can designate security zones around the transiting ship and around the storage terminal. To reduce the risk of a terrorist attack upon critical energy infrastructure, USCG can designate security zones around high-interest vessels that might pose security risks in specific harbors and channels.

It would be expected that an LHG vessel would be assisted by a minimum of two tugs, and would enter KBPH during daylight hours. The tugs are required to stand by the LHG vessel while at berth to assist in the event of an emergency or natural disaster. In addition to the tugs, armed security vessel(s) (provided by the facility) would maintain the USCG established security zone around the vessel as it enters KBPH and while at the LHG berth. A security vessel would be expected to remain on station in or around KBPH enforcing the security zone while the LHG vessel is unloading its cargo, as well as protect the LNG facility while the vessel is away.

The security zone established by the COTP is not expected to disrupt other marine traffic, including that of the adjacent Ko ʻOlina Marina. Since KBPH is a one-way traffic harbor, and two ships are not able to pass within the entrance channel at the same time, other vessels desiring to move currently have to wait during the entry / exit of the other vessel. This would remain the same with an LHG vessel. However, security zones are regulated navigational areas and other vessel movement which may impact the zone must have permission to transit by the COTP (33 CFR 165.33). The COTP determines any and all activities which are acceptable within an established security zone.

Table 3. Security Zones Applicable to LHG Vessels

Zone	Regulation	Description	Calculation	Extent	Acceptable Activities
Security Zone	USCG, 33 CFR 165	A security zone is an area of land, water, or land and water which is designated by COTP or District Commander for such time as is necessary to prevent damage or injury to any vessel or waterfront facility. The purpose of a security zone is to safeguard vessels, harbors, ports, and waterfront facilities from destruction, loss, or injury from sabotage or other subversive acts, accidents, or other causes of a similar nature.	Entry into the security zones is prohibited unless authorized by COTP, or designated representatives. The security zone will be enforced-at all times according to USCG policy.	Current existing security zones are located around Barbers Point Offshore Moorings and all waters contained within KBPH.	COTP determines any and all activities which are acceptable; however, LHG activity is not expected to disrupt other marine traffic.

Existing security zones as listed in 33 CFR 165.1407 are located around Barbers Point Offshore Moorings and all waters contained within KBPH. The security zone for KBPH *(Figure 1)* is currently enforced when the Maritime Security (MARSEC) level, as defined in 33 CFR 101, is raised to 2 or higher. The security zone is also enforced whenever the COTP determines that there is a heightened risk of a transportation security incident or other serious maritime incident, including but not limited to any incident that may cause a significant loss of life, environmental damage, transportation system disruption, or economic disruption in a particular area.

Figure 1. Current Security Zone at KBPH as defined by 33 CFR 165.1407

Currently during their LPG transfer operations, Hawai'iGAS establishes their own security zone around the LPG barge and the dockside transfer manifold hose connection. However, the COTP currently does not require a waterborne security vessel for LPG activity as would be in place for LNG transfer operations.

3.2 LNG Safety

The applicant seeking a lease for an LNG terminal remains responsible for the full development of the planned LNG terminal. The facility design and operation would be subject to stringent regulations as required by the safety standards in 33 CFR 127 and 165, 49 CFR 193 and NFPA 59A. Activities within the facility's secured area would be restricted to LNG facility operations only as per 49 CFR 193. Upon completion of the *Waterway Suitability Assessment,* other port-related activities could be permitted outside of the gated restricted area.

3.2.1 LNG Vessel Zones of Concern

The 2004 Sandia National Laboratories report (SAND2004-6258) identified three concentric, circular Zones of Concern for intentional spills from LNG tankers. That report, coupled with a Sandia study conducted in 2007 for larger volume LNG tankers (SAND2008-3153), indicates that the Zone of Concern sizes described in *Table 4* can be used for LNG vessels with a cargo carrying capacity of up to 265,000 cubic meters. The Sandia Labs reports provide the foundation for the USCG's current position on LNG safety and provide a basis for evaluating the risks associated with LNG marine traffic. It does this through applying the study's three-zone approach as it relates to defining hazards and consequences from a large LNG spill over water and the resulting fire. This Zone of Concern model helps decision makers identify the areas at greatest risk, plan mitigation measures, and develop emergency response plans. The Zones of Concern as they apply to KBPH are illustrated in *Figure 2.*

The USCG COTP may find the Zone of Concern size information and data particularly useful when reviewing an applicant's *Waterway Suitability Assessment* and in making a recommendation to FERC on the suitability of a waterway to support LNG marine traffic associated with a proposed project (see *Section 4.0, Bulk LNG Terminal Permitting Process* for more detail). The USCG expects applicants to analyze and graphically represent the zones of concern and their intersections with populations, infrastructure, assets, and waterways, as well as commercial, residential, industrial, and environmentally sensitive areas. These representations must apply appropriate models, such as those set forth by the Sandia reports, to identify areas where a release of LNG would have the worst consequences. Where the applicant's *Waterway Suitability Assessment* reveals that potential impacts on public safety and property could be high and where interactions with shore terrain or structures could occur, modern, validated computational fluid dynamics (CFD) models may be used to improve analysis of the site-specific hazards, consequences and risks.

Table 4. Zones of Concern Applicable to LNG Vessels

Zone	Regulation	Description	Extent	Acceptable Uses and Activities
Zone 1	33 CFR 127	This is the area with the most severe consequences around the LNG vessel, where an LNG spill could pose a severe public safety and property hazard and could damage or significantly disrupt critical infrastructure and key assets located within this area. The most rigorous deterrent measures are recommended, including strict vessel security and control and waterway traffic management. It also recommends careful evaluation and coordination of port security and emergency-response stakeholders.	Within 0.3 miles of an intentional breach of an LNG vessel	Commercial and industrial activities
Zone 2	33 CFR 127	This is an area with less severe consequences of an LNG fire than Zone 1 and is considered to extend from 0.3 miles to 1 mile for an intentional breach of an LNG tanker. Injuries and property damage could still occur. Risk mitigation strategies should focus on vapor dispersion and fire hazards, with strategies to include emergency response planning and community education and warnings to ensure that inhabitants understand the risks and precautionary measures.	Between 0.3 miles to 1 mile of an intentional breach of an LNG vessel	Commercial and industrial activities, residential areas
Zone 3	33 CFR 127	This is an area with the least likelihood of severe consequences and is considered to extend from 1 mile to a conservative maximum of 2.2 miles from the LNG vessel. While the effects in Zone 3 of a pool fire are significantly minimized, the chief danger is the possibility of a vapor cloud 'burn back' to the source of a spill. For this zone, the study recommends emergency response measures aimed at dealing with vapor cloud dispersion, as well as public education planning similar to that for Zone 2.	Between 1 mile to 2.2 miles an intentional breach of an LNG vessel	Commercial and industrial activities, residential areas

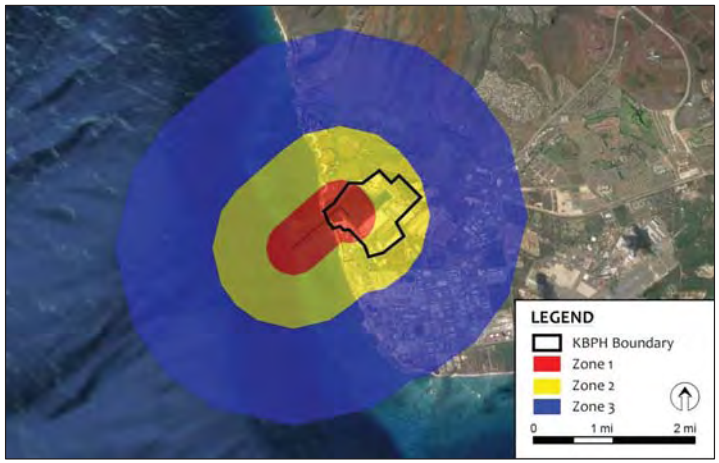


Figure 2 – Illustration of Zones of Concern for an LNG Vessel Entering the KBPH Channel and Berthing at Pier 3

3.2.2 LNG Pier Separation Distances and Other Harbor Operations

LNG safety provisions in the Pipeline Safety Act of 1968 require the Secretary of Transportation to "consider the...need to encourage remote siting" of new LNG facilities (49 USC 60103). However, Federal regulations contain no clear definition of what constitutes "remote" siting, relying instead on safety exclusion zones to protect the public and satisfy remoteness requirements under the Pipeline Safety Act (Congressional Research Service, 2004). Industry and government officials maintain that exclusion zones provide adequate public safety based on the current state of knowledge about LNG.

Although a majority of bulk LNG terminals are purpose-built ports used exclusively to export or import LNG, there are a number of facilities around the country and around the world that combine LNG with other activities, as would occur at KBPH. For example, the Port of Boston in Massachusetts has facilities dedicated to bulk cargo, petroleum, and LNG shipment and storage. Port Nikiski, Alaska has privately owned-docks that import seafood, crude oil, and petroleum products, as well as export LNG and ammonia products. The petroleum, LNG and ammonia piers are separated by a distance of approximately 2,000 feet (See *Figure 3)*.

Figure 3 – Oil, LNG and Fertilizer Docks at the Nikiski Harbor, Alaska

The Mareseille-Fos complex in France is the world's third largest harbor with various ports. Within the Mareseille-Fos complex, the Saint Louis du Rhone Port has facilities for roll on / roll off (RO/RO), LNG, tanker, and bulk vessels. The Fos Port can handle virtually all types of cargo including RO/RO, bulk, petroleum products, LNG, LPG, and containers. Although foreign ports are not subject to FERC regulations, countries that rely extensively on LNG to meet their energy needs – such as Japan, South Korea, and some European nations – have had to make considerable investment in policies and regulations that support a safe and secure LNG industry. These include (but are not limited to) the British Standards Institution (BSI), the United Kingdom Engineering Equipment and Materials Users Association (EEMUA), and the European Norm (EN) standards. These international standards and rules define containment with respect to types of structures and technologies in use around the world.

3.2.3 FERC Exclusion Zones

49 CFR 193 also establishes distance and proximity constraints around facilities handling LNG to guard against adverse impacts and protect the interests of public safety related to accidental LNG discharges. These exclusions zones, used for planning protection purposes, ensure that activities and structures outside the immediate LNG facility boundary are not at risk in the event of an LNG fire or the release of and exposure to a flammable vapor cloud. An LNG operator must be able to legally control all access and use activities within the exclusion zones, which are based on computer models as defined by NFPA 59A. Hazard analyses for LNG terminals and shipping depend heavily upon these computer models to approximate the effects of hypothetical accidents. Federal siting standards specifically require computer modeling for the boundary of thermal radiation coverage and extent of flammable vapor cloud exclusion zones (49 CFR 193.2057, 2059).

Such models are necessary because there have been no actual or real-time major LNG incidents of the type envisioned in LNG safety research and because historical LNG experiments have been limited in scale and scope. In its 2003 evaluation of the current Freeport LNG terminal, FERC defines a major storage tank spill. This spill assumes the release of 46.5 million gallons of LNG from an onshore storage tank, resulting in a thermal exclusion zone of 914 feet from the tank. The largest flammable vapor exclusion zone FERC considers, however, is based on a spill of approximately 220,000 gallons in the secondary containment drain, resulting in a vapor exclusion zone of 2,111 feet from the drain. FERC's report does not consider vapor dispersion from a larger tank spill because the NFPA does not view such an event to be likely.

The extent of the affected area and the severity of the impacts on objects within the exclusion zones would primarily be dependent on the material, quantity, and duration of the initial release, the surrounding terrain, and the environmental conditions present during the dispersion. Thermal radiation exclusion zones protect the public from exposure to thermal radiation from LNG fires, while a vapor dispersion exclusion zone protects the public from LNG clouds that have not ignited but could migrate to an ignition source while still in a potentially flammable state (i.e., gaseous concentrations between 5 and 15 percent in the air).

Thermal Radiation

An onshore LNG storage facility and transfer system must have thermal exclusion zones established in accordance with 49 CFR 193.2057 and NFPA 59A (which defines this as heat flux distance). Each onshore LNG storage tank must be within a secondary dike or impoundment/containment area that will contain any spills. The regulations specify that each LNG storage tank and LNG transfer system have a thermal radiation exclusion zone beyond the impoundment area. These thermal radiation exclusion zones must be large enough so that the heat from an LNG fire does not exceed a specified limit for people and property (see below for limits). The land within the thermal radiation exclusion zone must be owned or controlled by the operator of the LNG facility.

The code also specifies how the thermal radiation distance is calculated for each LNG facility. The Gas Technology Institute (GTI) computer model or a similar model is to be used along with wind speed, ambient temperature and relative humidity data to calculate the maximum exclusion distances subject to other detailed provisions within the regulation. Under US regulations, protection distances are to be calculated specific to each location to prevent exposure to fire or thermal radiation.

According to Section 2.2.3.2 of NFPA 59A (2001), to minimize the possibility of the damaging effects of fire to buildings beyond a property line, provisions should be made to prevent thermal radiation flux from a fire from exceeding the following limits:

(1) 1,600 Btu/hour/feet^2 at a property line that can be built upon for ignition of a design spill;
(2) 1,600 Btu/hour/feet^2 at the nearest point located outside the owner's property line that is used for outdoor assembly by groups of 50 or more persons;
(3) 3,000 Btu/hour/feet^2 at the nearest point of the building or structure outside the owner's property line that is used for occupancies classified as assembly, educational, health care, detention and correction or residential;
(4) 10,000 Btu/hour/feet^2 at a property line that can be built upon for a fire over an impounding area.

Vapor Dispersion
Similar to the provision for thermal radiation protection, 49 CFR 193 specifies that each LNG storage tank and LNG transfer system must have a flammable vapor dispersion exclusion zone around the facility that is owned or controlled by the facility operator. The vapor dispersion exclusion zone must be large enough to encompass that part of the vapor cloud which could be flammable. The code specifies how the flammable vapor dispersion distance is calculated for each LNG facility. In order to account for irregular mixing of the vapor cloud in the air (a range of concentrations depending on how the gas molecules move), the regulation designates the vapor cloud hazard area as the area where the average gas concentration in air is equal to or greater than 2.5 percent (half of the lower flammability limit of methane). This provides a margin of safety to account for irregular mixing. The regulation also specifies other parameters including dispersion conditions that should be used in computing the dispersion distances. Computer models are used to calculate dispersion distances.

Table 5. Protection Distances Applicable to LNG Container and LNG Transfer System

Zone	Regulation	Description	Calculation	Extent	Acceptable Uses and Activities
Exclusion Zone	49 CFR 193.2007	Federal safety regulations place exclusion zones surrounding an LNG facility in which an operator or government agency legally controls all activities in accordance with §193.2057 and §193.2059 for as long as the facility is in operation	Based on the thermal and vapor exclusion zone calculations	See below.	Facility in which an operator or government agency legally controls all activities
Thermal Exclusion Zone	49 CFR 193.2057	In the event of a pool fire, each LNG container and LNG transfer system must have a thermal exclusion zone in accordance with section 2.2.3.2 of NFPA 59A, 2001 (with some exceptions)	Thermal radiation distances must be calculated using Gas Technology Institute's (GTI) report or computer model GTI-04/0032 LNGFIRE3: A Thermal Radiation Model for LNG Fires (with exceptions)	(1) < 1,600 Btu/hr/ft^2 (2) < 3,000 Btu/hr/ft^2 (3) < 10,000 Btu/hr/ft^2	(1) Property line that can be built upon and can be used for outdoor assembly by groups of 50 or more persons (2) Can be used for occupancies classified as assembly, educational, health care, detention and correction or residential (3) Property line that can be built upon for a fire over an impounding area
Flammable Vapor-Gas Dispersion Zone	49 CFR 193.2059 (b)	In the event of a vapor cloud, each LNG container and LNG transfer system must have a dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA 59A, 2001 (with some exceptions). The design spill shall be determined in accordance with section 2.2.3.5 of NFPA 59A 2001.	Flammable vapor-gas dispersion distances must be determined in accordance with the model described in the Gas Technology Institute report GTI-04/0049 LNG Vapor Dispersion Prediction with the DEGADIS 2.1 Dense Gas Dispersion Model.	The spacing of an LNG tank impoundment to the property line and the area that encompasses that part of the vapor cloud which could be flammable.	The number of persons allowed that may suffer potential injuries from the vapor cloud is subjective based on the approved methods, procedures, and/or models

3.2.4 LNG Storage Container Separation Distances

For LNG container spacing within a terminal, NFPA 59A Section 2.2.4 provides the minimum separation distances for LNG storage tanks containing flammable refrigerants. The minimum distance begins from the edge of the impoundment or container drainage system to buildings and property lines. According to NFPA 59A Table 2.2.4.1, separation distances are dependent on the size of the storage containers (i.e., 15,001 to 30,000 gallons = 50 feet, 30,001 to 70,000 gallons = 75 feet, and over 70,000 gallons is 0.7 times the container diameter but not less than 100 feet). An exception to the rule is that with the approval of the authority having jurisdiction, these LNG storage tanks containing flammable refrigerants can be located a shorter distance from buildings or wall constructed of concrete or masonry but at least 10 feet from any building openings.

The following table summarizes the separation distances between LNG storage containers; from the containers to other objects such as trees, poles, or buildings; and from the transfer points to buildings or activities that occur within a harbor, including sources of ignition, vehicle traffic, and cargo transfer.

Table 6. Summary of LNG Separation Distances with Acceptable Uses and Activities

Regulation	Extent	Acceptable Uses and Activities
NFPA 59A, Section 2.2.4.1 (2001)	Dependent on the size of the storage containers (i.e., over 70,000 G is 0.7 times the container diameter but not less than 100 ft)	Spacing between containers, nearest off-site building, or property line that can be built upon
NFPA 59A, Appendix C.1 Section 193.2905 (2001)	Away from the protective enclosure of the following facilities so as to not be used to breach security: storage tanks; impounding systems; vapor barriers; cargo transfer systems; process, liquefaction, and vaporization equipment; control rooms and stations; control systems; fire control equipment; security communications systems; and alternative power sources.	Trees, poles, or buildings
NFPA 59A, Section 10.15.3.6.1 (2001)	Outside of the marine transfer area while transfer is in progress	Sources of ignition, such as welding, flames, and unclassified electrical equipment
NFPA 59A, Section 11.4.2 (2001)	On the pier or dock > 100 ft of the loading and unloading manifold while transfer operations are in progress	Vehicle traffic
NFPA 59A, Section 11.4.1 (2001)	> 100 ft of the point of transfer connection while LNG is being transferred through piping system.	The handling of general cargo over a pier or dock, other than ships' stores for the LNG tank vessel
NFPA 59A, Section 2.2.3.8 (2001)	> 50 ft from the nearest edge of impounded liquid or from the near edge of a navigable waterway as defined by federal regulations	A property line that can be built upon

Table 6. Summary of LNG Separation Distances (continued)

Regulation	Extent	Acceptable Uses and Activities
NFPA 59A, Section 2.2.3.8 (2001)	> 50 ft from the nearest edge of impounded liquid or from the near edge of a navigable waterway as defined by federal regulations	A property line that can be built upon
NFPA 59A, Section 2.2.7.2 (2001)	> 50 ft of LNG loading and unloading connections	Uncontrolled sources of ignition, process areas, storage containers, control buildings, offices, shops, and other occupied or important plant structures unless the equipment is directly associated with the transfer operation
NFPA 59A, Section 2.2.6.2 (2001)	> 50 ft from any impounding area or container drainage system	Fired equipment and other sources of ignition
NFPA 59A, Section 10.15.3.6.2 (2001)	> 25 ft of tank vehicle loading or unloading operations in progress	Vehicle traffic
NFPA 59A, Section 10.6.8 (2001)	> 25 ft of the point of transfer	The nearest important building (such as operations) not associated with the LNG facility or the line of adjoining property that can be built upon

3.3 LPG Safety

NFPA has issued code 58 (2004 edition) entitled *Liquefied Petroleum Gas Code*, which is the industry benchmark for safe LPG storage, handling, transportation and use. NFPA 58 mitigates risks and ensures safe installations, to prevent failures, leaks, and tampering that could lead to fires and explosions. NFPA 58 requires minimum distances with respect to the nearest container, important building (such as operations), group of buildings, or line of adjoining property that can be built upon.

According to NFPA 58 Table 6.3.1, separation distances are dependent upon the size of the storage containers (i.e., over 1 million gallons = 400 feet radius, up to 1 million gallons = 300 feet radius, up to 200,000 gallons = 200 feet radius, etc.), without regard to the total number of containers. The applicant will be expected to contain the minimum distance within their property boundaries. LPG also has a minimum distance of a 50 foot radius from point of transfer to outdoor places of public assembly (NFPA 58, 2014).

New bulk LPG terminals that require a USACE permit will require a combined federal and state environmental review process. All such projects will be required to undergo a National Environmental Policy Act (NEPA) environmental impact review and meet all associated federal regulatory requirements. The primary agency under NEPA for a marine terminal will be USCG and for a land-based terminal will be PHMSA. In addition to the federal codes and standards that apply to LPG terminals (i.e., 33 CFR 127, 49 CFR 192, NFPA 58), any additional and final control of permits and code compliance lies with the authority having jurisdiction.

Although the State of Hawai'i does not have a specific permitting process or regulations for LPG, the City and County of Honolulu (City) Building Code §16-1.1 has provisions for the design and construction of storage and handling systems for LPG distribution facilities. Container (tank) installations within the jurisdiction of the City are approved by the Department of Planning and Permitting Zoning Division prior to submitting an application for the Honolulu Fire Department's LPG Tank Installation Permit. For installations in State preservation-zoned areas, container installations are reviewed by the State Department of Land and Natural Resources.

All NFPA 58 regulations in the table below are from the 2004 edition.

Table 7. Summary of LPG Separation Distances with Acceptable Uses and Activities

Regulation	Extent	Acceptable Uses and Activities
NFPA 58 Section 6.3	The distance measured in any direction from the point of discharge of a container pressure relief valve (dependent on the size of the storage containers) applying the aggregate capacity rather than the capacity per container (i.e., over 1 MG = 400 ft radius)	Anything other than exterior sources of ignition (e.g., open flame, window A/C, compressor), openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes, other containers, important buildings, group of buildings, or line of adjoining property that can be built upon
NFPA 58 Section 13.2.1.3	> 100 ft of the point of transfer connection while transfer operations are in progress	Trucks and other motorized vehicles on the pier or dock
NFPA 58 Section 13.2.1.2	> 100 ft of the point of transfer connection while LPG or other flammable liquids are being transferred	The handling of general cargo, flammable liquids, or compressed gases (other than ships' general stores for the LPG tank vessel) over a pier or dock
NFPA 58 Section 13.2.2.3	> 100 ft of the point of transfer connection while transfer operations are in progress	The use of portable electrical equipment
NFPA 58 Section 6.3.5	> 10 ft from containers having a water capacity exceeding 500 gal	Buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations; otherwise distances specified in Table 6.3.1 shall be permitted
NFPA 58 Section 6.4.5.12	A vertical plane > 6 ft horizontally from an aboveground LPG container	Overhead electric power lines that are over 600 volts, nominal

Table 7. Summary of LPG Separation Distances (continued)

Regulation	Extent	Acceptable Uses and Activities
NFPA 58 Section 6.5	Distance Between LPG Point of Transfer and Exposures (1) 5 ft (2) 10 ft (3) 20 ft (4) 25 ft	Exposures (1) Driveways (2) Containers other than those being filled; Flammable and Class II combustible liquid dispensers and the fill connections of containers; Buildings, mobile homes, recreational vehicles, and modular homes with fire resistive walls (3) Flammable and Class II combustible liquid containers, aboveground containers, and containers underground (4) Building wall openings or pits at or below the level of the point of transfer, Buildings with other than fire-resistive walls, Line of adjoining property that can be built upon, Public ways including public streets, highways, thoroughfares, and sidewalks, Mainline railroad track centerlines

4.0 LNG Permitting and Timing

Siting LNG import terminals can be a lengthy process lasting several years. Applicants must work with several different federal agencies in order to obtain a number of permits to build a terminal, associated facilities, and pipeline infrastructure to import LNG. *Table 8* below provides a summary of each lead federal agency and their respective role and authority in siting LNG terminals in the US, followed by a description of the federal siting process.

Table 8 – Federal Agencies and Their Roles in Siting LNG Terminals
(Source: Proposed Liquefied Natural Gas Terminals in Oregon, 2013)

FEDERAL ENERGY REGULATORY COMMISSION (FERC)	
AUTHORITY	PROCESS
FERC is responsible for authorizing the siting, construction, and operation of onshore LNG facilities. Once it receives an application, FERC is required to conduct an EIS to determine whether the agency will issue a permit to the applicant.	FERC's EIS evaluates environmental impacts to the region ranging from air quality, biological impacts, cultural and socioeconomic impacts, as well as safety and security impacts for each proposed project.
PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION (PHMSA)	
AUTHORITY	PROCESS
PHMSA has authority to establish and enforce safety standards for onshore LNG facilities, and has issued its regulations in 49 CFR 193. PHMSA is a cooperating agency assisting FERC in its review of facilities under NEPA.	PHSMA reviews a Design Spill Package submitted by the applicant. FERC consults with PHMSA as needed. Once FERC approves a project and the applicant moves forward in the process, PHMSA inspects sites during and after construction, and during facility operation.
US FISH & WILDLIFE SERVICE (USFWS) AND NATIONAL MARINE FISHERIES SERVICE (NMFS)	
AUTHORITY	PROCESS
FERC consults with USFWS and NMFS on whether proposed projects would likely jeopardize the continued existence of species protected under the Endangered Species Act or destroy or adversely modify their critical habitats.	USFWS and NMFS evaluate the potential effects of a proposed project on proposed, endangered, threatened, and sensitive fish, animal, and plant species and their habitats. This includes: • Reviewing FERC's Biological Assessment • Issuing a Biological Opinion
US ARMY CORPS OF ENGINEERS (USACE)	
AUTHORITY	PROCESS
The USACE has jurisdictional authority pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act.	The USACE must comply with the requirements of NEPA before issuing permits under these statutes. Therefore, USACE provides content in regards to its jurisdictional authority for preparation of the EIS.

Table 8 – Federal Agencies and Their Roles in Siting LNG Terminals (continued)

US COAST GUARD (USCG)	
AUTHORITY	PROCESS
USCG is the lead federal agency to ensure LNG developers comply with all applicable federal, state, local and industry safety and security standards and regulations for marine facilities. This includes working with state and local emergency response organizations to develop and maintain the plans and procedures to protect public health and safety.	***Waterway Suitability Assessment* and Letter of Recommendation to FERC** – Evaluates LNG waterway transit route safety and security concerns.
	Emergency Response Plan – Identifies procedures, resources, equipment, and systems to prepare decision-makers and responders to respond to and recover from LNG emergencies.
	Security Plan – Identifies procedures, resources, equipment, and systems to deter security threats to the LNG facility.
	LNG Vessel Transit Management Plan – Identifies procedures, resources, equipment, and systems to deter security threats prior to entry of LNG vessels into port and along the transit route.

4.1 FERC Process

The construction of a marine bulk LNG terminal is required to follow the FERC permitting process. The FERC *Guidance Manual for Environmental Report Preparation* is part of the Commission's effort to streamline the environmental review process and identifies information often found missing from filings. The permitting process is outlined below:

1. Applicant requests use of the FERC's Pre-filing (PF) Process.
2. FERC formally approves the NEPA Pre-Filing Process, issues a PF Docket number to the applicant, and begins project review. DOT-H should be notified of this action for their consideration.
3. An open house is held to discuss the project, and then FERC issues a Notice of Intent for Preparation of an Environmental Impact Statement (EIS) or Environmental Assessment (EA).
4. FERC holds NEPA scoping meeting(s) and conducts a site visit in the project area.
5. Interested agencies are then consulted.
6. The applicant provides the USCG COTP of the proposed location with a Letter of Intent and a Preliminary *Waterway Suitability Assessment*. The COTP issues a letter of recommendation as to the suitability of the waterway for LHG or LNG marine traffic.
7. The applicant must complete a series of 13 resource reports, which document the effects of the proposed facility upon the surrounding environment. These include General Project Description; Water Use & Quality; Fish, Wildlife & Vegetation; Cultural Resources; Socioeconomics; Geological Resources; Soils; Land Use, Recreation, & Aesthetics; Air & Noise Quality; Alternatives; Reliability & Safety; PCB Contamination (for pipelines only); and LNG Engineering & Design Details.
8. Once the applicant files a formal application with FERC, it will use the resource reports to compile a draft EIS.

9. The applicant is also required to submit a Draft Biological Assessment (BA). The BA is used by the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) to create a Biological Opinion to determine that the project is consistent with federal environmental goals.
10. FERC carries the EIS / EA through their respective processes, and approves or denies the project.
11. If the project is approved, the applicant may construct and operate the project, only after obtaining Clean Water Act, Coastal Zone Management Act, and Clean Air Act permits (among others – see *Section 4.3)*.
    a. If the project is denied, the applicant and / or public can ask FERC to rehear the case or refer to the FERC Administrative Law Judge.

4.2 FERC Process Timeframe

Draft and Final EIS documents that are posted on the FERC website (http://www.ferc.gov/industries/gas/enviro/eis.asp) describe the length of the process for their particular project, which has an approximate average of three years and six months. Some reasons to account for this length of time are discussed within this section. Not all of the start dates were available within the reports to determine this timeframe beginning at the request for pre-filing. Some dates begin at the FERC approval of the pre-filing, others are for the application submittal, and still other dates are when the notice of intent to prepare an EIS was filed. The end date includes the published date of the Final EIS, or if still in draft EIS, was capped at 2015. Some examples follow:

Table 9 – Examples of FERC Process Times

LNG PROJECT	START DATE	END DATE	TOTAL PROCESS TIME (APPROXIMATE)
Creole Trail LNG Terminal	Request for Pre-Filing: January 2005	Date of DEIS: October 2005 Date of FEIS: TBD	10 yrs +
Downeast LNG / Washington County, Maine	Approved request for Pre-Filing: January 2006	Date of FEIS: May 2014	8 yrs, 4 mos
Corpus Christi LNG Terminal	Application filed: August 2012	Date of FEIS: October 2014	2 yrs, 2 mos
Jordan Cove LNG Terminal	Notice of Intent to Prepare an EIS: June 2006	Date of FEIS: May 2009	2 yrs, 11 mos

Although the FERC process is fairly well defined, there are substantial differences between projects that vary the overall timeline. After consulting with FERC on a separate LNG project, Hawaiian Electric Company (HECO) determined that a realistic schedule to develop a bulk LNG terminal in Hawai'i is approximately six to eight years.

4.2.1 Roadblocks Prior to FERC Approval

According to *2040 Master Plan* consultants and industry experts Amergent Techs, there are eight projects in California that have been denied prior to completing the EIS process. In Oregon, one project went bankrupt, one project could not get County approval and lost a case in the Supreme Court, and one project took six years to get an import license and is still working to get an export license. Alaska has been working on a conceptual plan for about eight years, and just recently (September 2014) FERC accepted their project into pre-file status. In Hawai'i, Hawai'iGAS has been researching alternatives for approximately three years.

Location
The location of a project affects the speed of the process. Gulf of Mexico projects usually have shorter EIS process timeframes than those on the West Coast (which includes Alaska and Hawai'i), or even the East Coast. In the Gulf, very little opposition exists to the EIS process. When a Gulf project submits a draft EIS, they may get one hundred comments. However, when a West Coast project submits a draft EIS, they get tens of thousands of comments. Each comment must be answered to the satisfaction of FERC. If a comment requires more study before an answer can be provided, the project is delayed.

Community Opposition
The timeline of the FERC process can be hindered due to opposition of the project by the community and by organized groups. Community opposition may produce additional comments during the EIS period, all of which must be answered to the satisfaction of FERC. Associated changes within the Final EIS may require additional time. Legal challenges may also ensue, slowing or even stopping the process to obtain a permit.

High Cost
The entire approval process is very expensive. For example, the typical cost for FERC permitting (to include all State and local efforts) is between $100 and $200 million. Not all projects are that costly, but the applicant must bear all of the FERC costs. The applicant must pay FERC to hire a third party reviewer, contractors to conduct and perform the required environmental, safety and security studies, and the engineering costs to develop the facility. There may also be considerable legal costs involved.

Agency Coordination
Typically FERC, federal and state agency permitting processes are not aligned. There are a variety of factors which influence the timeline for review and approval, including the volume of previously submitted applications, where the applicant is in the siting process, and the completeness of the submitted information. When a delay occurs with one agency, the overall process will be delayed until that agency completes their review.

4.3 Permits

While FERC has exclusive authority to site LNG terminals in the US, its authority is conditioned on the applicant's ability to comply with other statutory requirements for various aspects of the project. The federal government has delegated authority to the states to regulate various federal statutes such as the Clean Water Act or the Clean Air Act. LNG developers must comply with conditions imposed by states carrying out these regulatory authorities. Below is a list of permits or approvals from federal, state, and local agencies that may be required prior to and during construction of a bulk LNG import terminal. These policies and permits could include, but are not limited to, the following:

Table 10 – Possible LNG Permits and their Approving Authorities

Approving Authorities	Permit or Approval
Federal	
Advisory Council on Historic Preservation	• National Historic Preservation Act of 1966 (NHPA), Section 106
Department of the Army US Army Engineer District, Regulatory Branch	• Department of the Army Permit (DA Permit) o Rivers and Harbors Act, Section 10
US Environmental Protection Agency	• Clean Air Act • Clean Water Act o Water Quality Certification, Section 401 o National Pollutant Discharge Elimination System (NPDES), Section 402 o Discharge of Dredged or Fill Materials, Section 404 • Noise Control Act of 1972 • RCRA / CERCLA / TOSCA
National Park Service	• Archaeological and Historic Preservation Act of 1974
NOAA, National Marine Fisheries Service	• Endangered Species Act of 1973 Consultation, Section 7 • Marine Mammal Act Consultation • Magnuson-Stevens Fishery Conservation and Management Act
NOAA, Office of Ocean and Coastal Resource Management	• Coastal Zone Management Act of 1972 (CZM)
US Fish and Wildlife Service	• Endangered Species Act of 1973 Consultation, Section 7 • Fish and Wildlife Coordination Act

Table 10 – Possible LNG Permits and their Approving Authorities (cont.)

Approving Authorities	Permit or Approval
State	
Coastal Zone Management Program State Office of Planning	• Coastal Zone Management Act of 1972 (CZM) Federal Consistency Determination
Department of Health Clean Water Branch (For US Environmental Protection Agency)	• Clean Water Act o Water Quality Certification, Section 401 o National Pollutant Discharge Elimination System (NPDES), Section 402 • Community Noise Permit for Construction Activities
Department of Health Solid and Hazardous Waste Branch (For US Environmental Protection Agency)	• Hazardous Waste Treatment, Storage, and Disposal Permit
Department of Health Office of Environmental Quality Control Accepting Authority Office of the Governor	• Hawai'i Admin Rules (HAR) Chapter 200 (EIS Rules) o Adequacy Determination • Hawai'i Revised Statutes (HRS) Chapter 343 (EIS) o Acceptability Determination
Department of Land and Natural Resources Historic Preservation Division	• Historic Preservation Review •Chapter 6E-42
City and County of Honolulu	
Department of Planning and Permitting	• Building Permit • Special Management Area Permit

Once the permits and approvals have been obtained, FERC will again review the project for compliance. Upon FERC approval, the applicant will receive:

1. A Commission Order stating its decision on whether to approve construction and operation of the bulk LNG terminal;
2. Market rate authority (this allows an applicant to request authority to charge market-based rates even if a lack of market power has not been demonstrated, in circumstances where market-based rates are in the public interest and necessary to encourage the construction of storage capacity in the area needing storage service and that customers are adequately protected); and
3. Conditions that must be met prior to construction such as working with federal, state, and local emergency response organizations to develop safety and security plans for the facility and waterway to protect public health and safety in the event of an LNG emergency.

4.4 Design and Construction Monitoring

After an applicant receives FERC approval for the project and has met all pre-construction conditions required by the FERC Order, FERC authorizes the commencement of construction. The applicant is then required to file monthly reports to FERC detailing the following:

1. Construction activity summary;
2. The status of any outstanding project permits;
3. An updated project schedule; and
4. Details of compliance with environmental conditions.

FERC and PHMSA will also inspect the project site as frequently as needed throughout the entire construction process to identify any deviations from the approved facility.

4.5 Commencement of Service

Prior to commencement of service of the bulk LNG terminal, the applicant must receive written approval from FERC. Only after complying with all pre-operation conditions listed in the Commission Order would a company receive authorization to begin operation. Each LNG facility under FERC jurisdiction is required to file semi-annual reports to summarize:

1. Plant operations;
2. Maintenance activity; and
3. Abnormal events for the previous six months.

In addition, FERC and PHMSA staff periodically conduct inspections (focusing on equipment, operation, and safety) of each facility throughout its operational life.

USCG annually reviews each project's *Waterway Suitability Assessment* to reflect changes to the project mission or changes within the port. Should any changes invalidate portions of the *Waterway Suitability Assessment*, USCG will require the applicant to update it. USCG also requires an *LNG Emergency Response Plan*, *Facility Security Plan* and *LNG Vessel Transit Management Plan*. These plans must be updated at least every five years and be re-approved whenever a design change is made to a tanker that could affect the vessel's security.

5.0 Hawai'iGAS LNG Proposal

The *2040 Master Plan* considers the potential siting of a bulk LNG terminal as an alternative land use scenario within the harbor property. After considering a number of sites, the recommended location for such a terminal is at the Piers 1 and 3 area. Any potential applicant, such as Hawai'iGAS, would be responsible for conducting extensive technical studies, completing an environmental impact evaluation, and securing regulatory approvals and permits to determine potential impacts to harbor operations and landside activities. The entire process could take a number of years to complete with no absolute guarantee that the project will receive necessary development and operational approvals to proceed to construction. This section presents Hawai'iGAS' conceptual plan of a bulk LNG terminal at KBPH as a good illustration of how complex this process can be.

From 2013 to 2014, Hawai'iGAS conducted preliminary planning studies to develop a 15 million gallon bulk LNG storage terminal and proposed several locations for the facility within the harbor. The *2040 Master Plan* process evaluated the various proposed locations and determined that, although several procedural challenges remain to be addressed, the Piers 1 and 3 area would be the most suitable location for further evaluation (see *Section 6.1* below or *Section 5.2.12* of the *2040 Master Plan* for more information). The Piers 1, 3 and 4 landside area contains approximately 12 acres. At minimum, an additional eight acres of adjoining property would need to be acquired to provide the approximately 20 acres necessary (calculated by Hawai'iGAS according to 49 CFR 193, with a 500 foot vapor exclusion zone at point of transfer) to legally control all activities within the zone. These are generalized acreages based upon existing information from Hawai'iGAS. As they refine their shoreside facility design and incorporate engineering measures to reduce the planning protection distances, it may be possible to further reduce the amount of acreage needed.

The LNG delivery model currently envisioned by Hawai'iGAS includes the use of a Floating Storage Regasification Unit (FSRU) vessel that may be moored near the current Barbers Point Offshore Moorings *(Figure 4)* or nearshore within Pearl Harbor, depending on negotiations with the Navy and potential partner HECO. The FSRU would be a storage facility and would also have the capability to re-gasify the LNG onboard the unit into natural gas. The natural gas would be delivered to shore via a subsea gas pipeline (not cryogenic or low temperature insulated pipelines) and transferred to landside storage facilities. Once on shore, the natural gas will enter directly into the existing Hawai'iGAS pipeline network serving O'ahu. This supply of natural gas would satisfy most of the fuel demand for the local utility (HECO) as well as Hawai'iGAS' own O'ahu gas customers.

While the FSRU stationed off-shore near KBPH or at Pearl Harbor would supply the majority of natural gas to O'ahu, the transfer and storage of bulk LNG at KBPH would also be required for (1) Neighbor Island distribution, (2) supplying marine transportation system users and surface transport users (fleet vehicles), and (3) back-up emergency LNG supplies for Hawai'iGAS and others, should there be an outage, storm or other event that disrupts FSRU operations. A significant amount of bulk LNG stored at KBPH would be delivered to the Neighbor Islands via ISO-containers. Smaller bulk deliveries to the Neighbor Islands have been dismissed due to the requirement of small LNG receiving terminals with storage and re-gasification facilities at each port, which would significantly increase infrastructure costs.

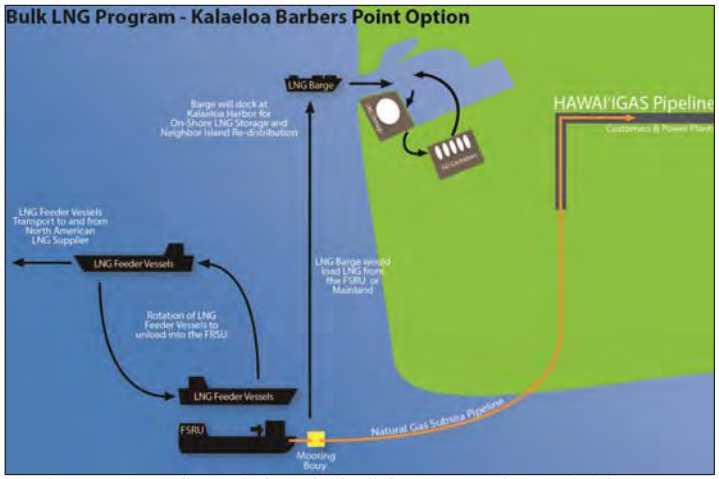


Figure 4 - LNG Bulk Terminal – Hybrid Off-shore FSRU and KBPH Liquid Storage
(Source: Hawai'iGAS Presentation, April 2014)

In this scenario, multiple special purpose Articulated Tug-Barges (ATBs) or dedicated LNG tank ships of approximately 470 feet length overall (LOA) would deliver 30,000 cubic meters of LNG at a time to the Fuel Pier for transfer to storage facilities at KBPH from the FSRU ship. The ATBs will be able to maneuver within the harbor basin, versus the use of larger LNG feeder vessels. ATBs would enter KBPH under multi-tug assist and would berth at Pier 3 of the new Fuel Pier. LNG transfer hoses would be attached to the vessel and LNG would be offloaded at a rate of between 3,000 and 6,000 gallons per minute. Depending on the offloading rate, the LNG transfer process could take between 24 and 48 hours. From the projected demand for LNG on the Neighbor Islands, it is anticipated that an LNG carrier would need to deliver the bulk cargo to KBPH every 10 days.

Delivered LNG would be transferred into a cryogenic storage tank, estimated by Hawai'iGAS at 15 million gallons, depending on the final assessment of requirements. Standard dimensions for a tank of this size would be 170 feet in diameter by 90 feet high with a built-in secondary containment. According to NFPA 59A Section 2.2.4, the minimum distance (beginning from the edge of the impoundment system) to buildings and property lines would be approximately 120 feet. LNG would be dispensed from the storage tank into 40 foot long ISO-container units through a truck loading facility. LNG ISO-containers are standardized containers certified by the International Standards Organization (ISO), subject to PHMSA transportation regulations. Up to six truck-loading stations may be required to fill the approximately 75 ISO-containers needed per day to serve projected Neighbor Island demand. Filled ISO-containers could be staged in the Bulk B storage area, and empty ISO-containers waiting to be filled could be staged nearby.

The tenant will have to resolve the issue of length of storage as the ISO-containers cannot be left for extended periods due to gas pressure buildup as the product warms. The estimated storage life of an ISO-container filled with LNG is between 45 and 60 days before the pressure within the container has to be relieved.

ISO-container filling would be a continuous activity. Based on the projected demand for LNG on the Neighbor Islands, it is anticipated that a barge would need to deliver ISO-containers from Piers 5 or 6 every 10 days (approximately six days per month total time).

The bulk LNG terminal would also include administration, maintenance, and control buildings and would be enclosed by security fencing. An emergency plan and a security plan will be developed for any new bulk LNG terminal, following industry standards for safety and fire control. Hawai'iGAS anticipates the current LPG receiving and storage facilities at Pier 1 will remain operational even with the development of the bulk LNG terminal.

Based on studies prepared by Hawai'iGAS, Pier 3 of the new Fuel Pier could possibly be used by other vessels when the LNG vessel is not occupying it. It is also possible that Pier 4 of the new Fuel Pier could be used by other fuel barges while the LNG vessel is at Pier 3 unloading. This determination would be made in conjunction with USCG COTP as part of the review process under 33 CFR 127. However, there are no provisions to exclude other dock uses as long as the safety and security measures can be maintained through operational protocols. Since both piers 3 and 4 might be handling flammable materials, the same general safety precautions would be in place. Regulations covering LNG facilities and facilities transferring oil in bulk are 33 CFR 127 and 33 CFR 154, respectively. The requirements in 33 CFR 154 also applies to LNG transfers.

5.1 Potential Protection Distances within KBPH

Hawai'iGAS prepared a Concept Plan for a bulk LNG storage terminal at Pier 1 and the Pier 3 area *(Figure 5)* in accordance with NFPA and PHMSA regulations. Facility exclusion zones were estimated based on piping sizes, pumps capacity, and flow rates of LNG into and out of the storage tank. This plan shows two possible exclusion zones based on the different transfer rates from the LNG vessel to the storage tank. Under one scenario, LNG would be transferred at a rate of approximately 6,000 gallons per minute. This rate would allow the LNG vessel's cargo to be transferred in 24 hours. Based on this flow rate through the transfer line from the vessel, Hawai'iGAS states a 700 foot wide radius vapor-dispersion exclusion zone from the transfer connection point would be necessary. Assuming this zone is correctly calculated, all property within this 700 foot zone would need to be under the control of the facility operator. If the transfer rate were reduced to 3,000 gallons per minute by using smaller piping, the exclusion zone could be reduced to approximately 500 feet. This would require approximately 48 hours for the LNG vessel unloading. Additional time for both scenarios at the berth would be needed for connecting and disconnecting the transfer equipment.

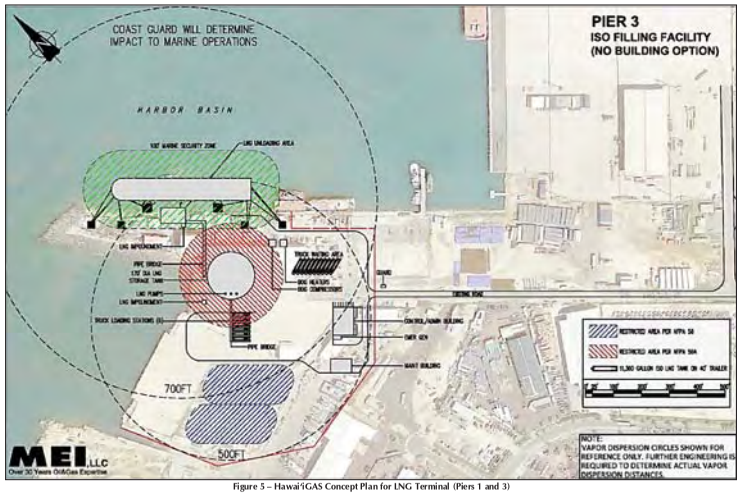


Figure 5 – Hawai'iGAS Concept Plan for LNG Terminal (Piers 1 and 3)

An additional 500 foot radius exclusion zone would be established at the transfer connection point for the loading of LNG from the storage tank into the ISO-containers at the truck loading stations (see *Figure 5)*. This exclusion zone would have a smaller size because the truck/ISO-container loading rate would be less than the rate from the LNG vessel.

The plan drawings also identify a red-hatched area with a radius of 100 feet around the storage tank. This is the radiated heat flux limit for pool fires established in NFPA 59A, Section 5.3.3.2 (also referred to as the thermal radiation exclusion zone in CFR 193). These limits are based upon data supplied by the potential applicant and are case specific (tankage, piping, and impoundment design). Uses within the heat flux zone would be restricted to facility-related occasionally occupied buildings (e.g., pump houses, transformer stations, etc.), and any ignition sources would be prohibited from this zone. Hawai'iGAS determined that other port-related activities would be permitted outside of the radiated heat flux area but within the 500 foot exclusion zone.

LNG transfer operations and its associated exclusion zones at Pier 3 may infringe on private lands. To satisfy 49 CFR 193 requirements where thermal radiation and flammable vapor-dispersion exclusion zones are required within the facility site or on adjacent property controlled by the operator, it is possible that Hawai'iGAS (or DOT-H) would have to acquire approximately eight acres of the privately-owned lands or control them through a lease.

6.0 Opinions and Recommendations of KBPH 2040 Master Plan

The *2040 Master Plan* recommends optimizing harbor operational efficiencies by separating liquid- from dry-bulk cargo operations. It recommends consolidating the transfer of all liquid-bulk cargo operations to the new Fuel Pier and Terminal area (i.e., the Piers 1, 3 and 4 area). The *2040 Master Plan* also recommends use of Piers 5, 6 and 7 be reserved for dry-bulk cargo operations, and that fuel transfer at these locations be de-prioritized but available as backup for the Fuel Pier in the event that fuel berths are not available. The *2040 Master Plan* further recommends that once the Fuel Pier is completed, all fuel tenants connect their pipelines from these piers to their current pipeline and storage facilities off-site to ensure that harbor operational efficiencies are preserved. Fuel transfer operations would then be conducted primarily at the Fuel Pier and only use Piers 5 and 6 as a backup.

6.1 LNG Pier Operations

Several potential locations were analyzed for siting a bulk LNG terminal at KBPH based on safety, operational performance, and impact on other harbor operations and landside activities. While further evaluation would need to be conducted through more detailed engineering and design studies in collaboration with FERC, USCG, DOT-H and other harbor users, the preliminary assessment is that an LNG terminal could be established at Pier 3 in concert with the redevelopment of the Piers 3 and 4 area as part of the Fuel Pier.

Table 11 – LNG Pier Options at KBPH

Pier	Pros	Cons
Pier 1	• Within Fuel/Energy Terminal • Adjacent to HG property	• Berth too small for LNG ships • Seasonal wave/surge conditions
Pier 3	• Pier 3 LNG transfer may not restrict Pier 4 operations • Piers 1 and 2 basin fill could add 5 acres fast land for terminal	• Tenant may need to purchase private land in Kenai Industrial Park to have evacuation control and satisfy FERC requirements. • Requires Fuel Piers 3 & 4 built in one phase • Filling in Piers 1 and 2 would affect marine life/corals at Pier 2 • Protection distances may impact other fuel pier operations.
Pier 4	• Within Fuel/Energy Terminal	• Tenant may need to purchase private land in Kenai Industrial Park to have evacuation control and satisfy FERC requirements. • Requires Fuel Piers 3 & 4 built in one phase • Protection distances may impact other fuel pier operations.
Pier 6	• Ability to control safety evacuation zone within State Harbors property	• Liquid-bulk mixed with dry-bulk operations reduces harbor efficiency • Removes cargo yard for dry bulk operations • Protection distances may impact other harbor operations.

Table 11 – LNG Pier Options at KBPH (continued)

Pier	Pros	Cons
Pier 7	• Ability to control safety evacuation zone within State Harbors property	• Liquid-bulk mixed with dry-bulk operations reduces harbor efficiency • Across from shipyard, with open flame/hot repair • Protection distances may impact other harbor operations.
Pier 8	• Minimal impacts to current and future users	• Dedicated Pier 8 constrains Pier 7 build-out • LNG vessel size limitations to 600' ATB • Difficult to berth ship in this location. • Upwind of Pier 9 shipyard operations • Displaces planned pier for layberth identified as a high priority in the Master Plan
Pier 9	• More isolated location • Other users will not transit site	• LNG facility precludes opportunity for ship yard operations nearby • LNG facility displaces dry-dock which has no reasonable alternate locations to operate • Closer to neighboring resorts and proposed residential uses.
Pier 10	• Isolated harbor location presents few Harbor conflicts • Pier 10 is currently undeveloped.	• Proximity to Pier 9 Marine Support Services may not be feasible • Significant seasonal wave/surge impacts • May receive opposition from Neighboring Ko Olina Resort due to proximity • LNG vessel berth in direct alignment with inbound transit channel may cause safety issues (USCG issue)

6.2 LPG Terminal Siting

LPG is currently distributed via gas barges to the Neighbor Islands from Pier 1. The gas barges also occasionally accept imports from LPG ships located offshore via lightering or transfer operations. Both Hawai'iGAS and AmeriGAS have expressed interest in expanding the capacity for LPG terminal operations at KBPH. Hawai'iGAS operates an LPG storage yard adjacent to Pier 1. It has proposed an expansion of their existing LPG operations to include a new high-pressure gas pipeline from Pier 5 connecting to their storage yard next to Pier 1. AmeriGAS is interested in installing an LPG pipeline at Pier 7 to transport LPG through pipelines to their current O'ahu gas facility in James Campbell Industrial Park, or a new location in neighboring Kapolei Harborside.

Hawai'iGAS barges (approximately 250 feet LOA) currently call at KBPH every three weeks, requiring 12 hours of discharge operations. Expansion of their LPG storage facility located near the Pier 1 Yard will be accomplished via additional storage tanks installed at their terminal, or by the acquisition of a new parcel close to the existing location to accommodate additional storage capacity.

AmeriGAS has discussed the importation of enough bulk LPG to satisfy approximately 10 to 12 months of product demand. This operation would require approximately 15 acres to accommodate four one million gallon facilities *(Figure 6)*. This is based on a diameter of 250 feet per storage facility, with a distance of 125 feet between storage facilities, including an estimated 400 foot radius minimum distance to buildings (based on NFPA 58 (2004) Table 6.3.1). The diameter of the storage facilities and separation distances requires approximately 12.5 acres of area, with another 2.5 acres for operational facilities. The frequency of AmeriGAS LPG vessel calls would be two to three times per year. These ships have a pressurized tank cargo system and product is pumped to shore terminals. Special flexible cargo hoses would connect from the vessel to the manifold on the dock, with a pump system to provide adequate pressures to transfer the product. Additional booster pumps may be needed to provide additional pressure to properly transfer the product to a more remote terminal storage area.

Figure 6 - Preliminary Plans for LPG Storage at KBPH

A bulk LPG storage terminal sited within the Bulk B area would be compatible with the risk designation of the area (see *2040 Master Plan, Section 5.1)*. The AmeriGAS bulk storage facility is anticipated to require approximately four gas delivery trucks each day to transfer the product, which may increase with additional LPG demand. A *Safety and Fire Safety Plan* must be developed by the tenant for any new LPG facility, following industry standards for safety and fire control.

6.2.1 LPG Pier Operations

Several potential locations were also analyzed for siting a bulk LPG terminal at KBPH based on safety, operational performance, and impact on other harbor operations and landside activities. LPG delivery may be prioritized at Piers 1 and 3 for regular shipments, but Piers 5 and 7 may be used as back up. An LPG vessel will follow the same protocols as LNG according to 33 CFR 165 and outlined in *Section 3.1 LHG Vessel Security Zones*. It is expected that there will not be significant disruption to other marine traffic or harbor operations during the berthing of an LPG vessel. *Table 12* summarizes the pros and cons for siting considerations of LPG berthing and storage at KBPH.

Table 12 – LPG Pier Options at KBPH

Pier	Pros	Cons
Pier 1	• Existing use by one LPG distributor	• Seasonal high surf/surge limit operations • Too small/congested for propane ships
Pier 3	• Potential for new pipelines to Pier 1 and Bulk B storage • Allows larger LPG tankers and barges • Support Pier 1 during surge periods	• Safety distances may impact other fuel pier operations.
Pier 5A	• Closest proximity to Bulk B storage • New LPG pipeline adds flexibility	• Need to ensure dry-bulk priority at Pier 5A • Berthing subject to vessel size • Requires new pipeline expansion under concrete hardstand
Pier 5	• Allows for large vessel berthing	• Need to ensure dry-bulk priority at Pier 5 • Dry-bulk cargo berth utilization is already at capacity • Requires new pipeline expansion under concrete hardstand
Pier 6	• Allows for large vessel berthing	• Need to ensure dry-bulk priority at Pier 6 • Dry-bulk berth utilization is already at capacity • Requires new pipeline expansion under concrete hardstand
Pier 7	• Harbor area is underutilized at Pier 7 • Pier extension adds berthing options • Pipeline to off-site storage possible • Close to new Kalaeloa Harbor Access Road	• Dry-bulk priority may extend to this pier (especially w/ cement ship calls) • Requires pier-side/cargo yard upgrade • Located furthest from Bulk B • Above-ground piping/storage conflicts with pier support activities

7.0 References

Alaska Natural Gas Transportation Projects. n.d. *Alaska LNG Project.* [URL: http://www.arcticgas.gov/alaska-lng-project] Accessed 1/15/15

Congressional Research Service. 2004. *Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation.* CRS Report for Congress, Order Code RL32205.

Facts Global Energy. 2014. *Fuels Market in Hawaii: Current Situation and Future Prospects.*

Federal Energy Regulatory Commission. n.d. *A Guide To LNG Liquefied Natural Gas What All Citizens Should Know.* [URL: http://www.cheniere.com/resources/citz-guide-lng.pdf] Accessed 1/16/15

Federal Energy Regulatory Commission. October 2014. *Corpus Christi LNG Project Final Environmental Impact Statement.* Docket Nos. CP12-507-000, CP12-508-000, DOE FE 12-97-LNG, FERC/EIS-0252F.

Hansen, Michael. September 6, 2014. *Hawai'i LNG Shipping Options.* Hawai'i Free Press. [URL: http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/13469/Hawaii-LNG-Shipping-Options.aspx?utm_source=September+7%2C+2014+News+from+Hawaii+Free+Press&utm_campaign=September+7%2C+2014+Email&utm_medium=ema] Accessed 1/15/15

Meyer, Ernst Andre, et al. January 2006. *US Coast Guard redefines LNG terminal permitting process.* Oil & Gas Journal's LNG Observer. [URL: http://www.sutherland.com/portalresource/lookup/poid/Z1tOI9NPluKPtDNIqLMRV56Pab6TfzcRXncKbDtRr9tObDdEv43Ds0!/fileUpload.name=/LNGObserver0106.pdf] Accessed 2/18/15

Mykleseth, Kathryn. January 20, 2015. *Hawaii Gas firm on LNG supply plan.* StarAdvertiser.com. [URL: http://www.staradvertiser.com/businesspremium/20150120_Hawaii_Gas_firm_on_LNG_supply_plan.html?id=289118091] Accessed 1/20/15

Oregon Department of Energy. July 2013. *Proposed Liquefied Natural Gas Terminals in Oregon.* [URL: http://www.oregon.gov/energy/Siting/docs/LNG/Final%20LNG%20Proposals %20in%20Oregon-Background.pdf] Accessed 1/15/15

Quarterman, Cynthia L. June 29, 2010. *Written Statement of Cynthia L. Quarterman, Administrator, Pipeline and Hazardous Materials Safety Administration, US Department of Transportation.* [URL: http://phmsa.dot.gov/pv_obj_cache/pv_obj_id_CA601F6D5F8FC73BEED6D0DA0A9B883B324D1B00/filename/House_TI%20Regulated_vs_Unregulated%20Haz_Liq_Pipes_Testimony.pdf] Accessed 2/12/15

Sandia National Laboratories, 2004. *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water.* SAND2004-6258. [URL: http://futureofhowesound.org/wp-content/uploads/2014/06/2004-12_SANDIA-DOE_RISK_ANALYSIS.pdf] Accessed 2/18/15

Sandia National Laboratories, 2008. *Breach and Safety Analysis of Spills Over Water from Large Liquefied Natural Gas Carriers*. SAND2008-3153. [URL: http://www.lngfacts.org/resources/SANDIA_2008_Report_-_Large_LNG_Vessel_Sa.pdf] Accessed 2/18/15

US Coast Guard. 2011. Navigation and Vessel Inspection Circular (NVIC) No. 01-2011. *Guidance Related to Waterfront Liquefied Natural Gas (LNG) Facilities*. [URL: http://www.uscg.mil/hq/cg5/nvic/pdf/2011/NVIC%2001-2011%20Final.pdf] Accessed 1/26/14

US Department of Transportation Pipeline and Hazardous Materials Safety Administration. December 15, 2014. *LNG Facility Siting Application Requirements: Frequently Asked Questions*. [URL: http://primis.phmsa.dot.gov/lng/faqs.htm] Accessed 1/21/15

US Government Publishing Office. January 16, 2015. *Electronic Code of Federal Regulations*. [URL: http://www.ecfr.gov/cgi-bin/ECFR?SID=e2b0232a873d804228a0450faaa07588&page=browse] Accessed 1/21/15

Appendix H

Rough Order of Magnitude Cost Estimate
(Rider Levett Bucknall)

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R2-110314

Summary with Margins Distributed

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A1	Storage Yards S-7, Multi-Purpose Yard and Maritime Support Services: Coral Stockpile Removal	10,620,439
A2	Northern Harbor (Piers 7, 8, 9 10): Utilities Infrastructure	3,101,614
A3	Relocate Perimeter Road	10,190,602
A4	Pier 9: Improvements	Excl.
A5	Pier 7: Pier Extension and Cargo Yard Expansion	39,892,987
A6	Piers 3&4: Fuel Pier Construction Phase I	43,020,722
A7	Fuel Terminal: Fuel Terminal Construction	22,532,381
A8	Pier 8: Layberth and Multi-Purpose Yard	73,938,621
A9	Pier 4B: Finger Pier Removal and Fuel Pier Construction Phase II	20,278,561
A10	Storage Yards S-7, Multi-Purpose Yard and Martime Support Services: Install Underground Power Lines	3,755,737
A11	Kalaeloa Harbor Access Road: Construction on Property	794,028
A12	Pier 10: Layberth	1,357,122
A13	Dredging/Flaring Harbor Entrance and Dredging KBPH Basin (USACE)	80,000,232
	A - MAJOR PROJECTS	***$309,483,046***
B MINOR PROJECTS		
B1	Pier 6: Bollard Installation	111,240
B2	Piers 5 and 6: Pier Improvements - Deleted	
B3	Finger Pier and T-Pier: Minor Improvements	27,661
B4	Pier 10: Emergency Access Connection to Ko Olina	14,090
B5	Bulk Storage Areas S-A1, A2, B: Coral Stockpile Removal	6,466,951
B6	Ko Olina Mole: Perimeter Lighting Improvements	35,597
B7	Piers 5/6 and 7: Personnel Shelter Construction	2,589,522
B8	Harbor Office Relocation	12,823,766
B9	Piers 4/5, 8 and 10: Personnel Shelter Construction	2,992,681
B10	Landscaping	148,320
	B - MINOR PROJECTS	***$25,209,828***
C NON-DOT-HARBORS PROJECTS		
C1	Marisco Relcoation (Marisco)	Excl.
C2	Nagivational Aids (USCG)	
C3	Installation of Fuel Pipelines (tenants)	
C4	Dredging/Flaring Harbor Entrance and Dredging KBPH Basin (USACE) - moved to A13	
C5	Kalaeloa Harbor Access Road: Construction Off Property (DOT-Highways, Kapolei Properties)	

RLB | Rider Levett Bucknall

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R2-110314

Summary with Margins Distributed

Rates Current At December 2014

Location		Total Cost
C6	Weigh Station (DOT-Highways)	
	C - NON-DOT-HARBORS PROJECTS	***Excl.***
	ESTIMATED NET COST	**$334,692,874**
MARGINS & ADJUSTMENTS		
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$334,692,874**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A1 Storage Yards S-7, Multi-Purpose Yard and Maritime Support Services: Coral Stockpile Removal		7,227,438
A - MAJOR PROJECTS		***$7,227,438***
ESTIMATED NET COST		**$7,227,438**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$722,744
Bond & Insurance	2.0 %	$159,004
Overhead and Profit	7.0 %	$567,643
General Excise Tax	2.0 %	$173,537
Estimating Contingency	20.0 %	$1,770,073
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$10,620,439**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A1 Storage Yards S-7, Multi-Purpose Yard and Maritime Support Services: Coral Stockpile Removal

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1010 Site Clearing				
1 Remove coral stockpile - volume based on assumed average height of 5' - by others	CY	246,481.60		Excl.
Site Clearing				***Excl.***
G1030 Site Earthwork				
2 Mass grading	SF	2,890,975.00	0.50	1,445,488
Site Earthwork				***$1,445,488***
G3030 Storm Sewer				
3 Drainage improvements	SF	2,890,975.00	2.00	5,781,950
Storm Sewer				***$5,781,950***
STORAGE YARDS S-7, MULTI-PURPOSE YARD AND MARITIME SUPPORT SERVICES: CORAL STOCKPILE REMOVAL				***$7,227,438***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A2 Northern Harbor (Piers 7, 8, 9 10): Utilities Infrastructure		2,000,250
A - MAJOR PROJECTS		***$2,000,250***
ESTIMATED NET COST		**$2,000,250**
MARGINS & ADJUSTMENTS		
General Conditions	15.0 %	$300,038
Bond & Insurance	2.0 %	$46,006
Overhead and Profit	8.0 %	$187,704
General Excise Tax	2.0 %	$50,680
Estimating Contingency	20.0 %	$516,936
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$3,101,614**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A2 Northern Harbor (Piers 7, 8, 9 10): Utilities Infrastructure

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1030 Site Earthwork				
2 Mass grading	SF	61,700.00	0.50	30,850
Site Earthwork				***$30,850***
G3010 Water Supply				
4 Water & fire protection infrastructure lines & fire hydrants to piers 7-10 and 3 personnel shelters	LF	2,870.00	200.00	574,000
Water Supply				***$574,000***
G3030 Storm Sewer				
3 Drainage improvements	SF	61,700.00	2.00	123,400
Storm Sewer				***$123,400***
G4010 Electrical Distribution				
5 Temporary overhead power lines, telecommunication lines to piers 7-10 and 3 personnel shelters	LF	5,300.00	240.00	1,272,000
Electrical Distribution				***$1,272,000***
NORTHERN HARBOR (PIERS 7, 8, 9 10): UTILITIES INFRASTRUCTURE				***$2,000,250***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A3 Relocate Perimeter Road		6,934,925
	A - MAJOR PROJECTS	***$6,934,925***
	ESTIMATED NET COST	**$6,934,925**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$693,493
Bond & Insurance	2.0 %	$152,568
Overhead and Profit	7.0 %	$544,669
General Excise Tax	2.0 %	$166,513
Estimating Contingency	20.0 %	$1,698,434
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$10,190,602**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A3 Relocate Perimeter Road

Rates Current At December 2014

Description		Unit	Qty	Rate	Total
G1030 Site Earthwork					
2 Mass grading		SF	1,931,170.00	0.50	965,585
	Site Earthwork				***$965,585***
G2010 Roadways					
7 New roadway, including AC paving & gutter		SF	103,200.00	12.00	1,238,400
	Roadways				***$1,238,400***
G3010 Water Supply					
10 Water system to Marisco, including meters, hydrants, backflow preventers, etc.		LF	2,000.00		Excl.
	Water Supply				***Excl.***
G3020 Sanitary Water					
11 Sewer system to Marisco, including manholes		LF	2,000.00		Excl.
	Sanitary Water				***Excl.***
G3030 Storm Sewer					
3 Drainage improvements		SF	1,827,970.00	2.00	3,655,940
9 Roadway drainage		LF	4,300.00	50.00	215,000
	Storm Sewer				***$3,870,940***
G4020 Site Lighting					
8 Roadway lighting		LF	4,300.00	200.00	860,000
	Site Lighting				***$860,000***
	RELOCATE PERIMETER ROAD				***$6,934,925***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location	Total Cost
A MAJOR PROJECTS	
A4 Pier 9: Improvements	Excl.
A - MAJOR PROJECTS	***Excl.***
ESTIMATED NET COST	**Excl.**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A4 Pier 9: Improvements

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2040 Site Development				
15 Pier 9 - by tenant	LF	950.00		Excl.
Site Development				***Excl.***
G3010 Water Supply				
16 Pier 9 improvements (water, sewer, power, lighting) by tenants	LS	1.00		Excl.
Water Supply				***Excl.***
PIER 9: IMPROVEMENTS				***Excl.***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A5 Pier 7: Pier Extension and Cargo Yard Expansion		27,911,640
	A - MAJOR PROJECTS	***$27,911,640***
	ESTIMATED NET COST	**$27,911,640**
MARGINS & ADJUSTMENTS		
General Conditions	8.0 %	$2,232,931
Bond & Insurance	2.0 %	$602,891
Overhead and Profit	6.0 %	$1,844,848
General Excise Tax	2.0 %	$651,846
Estimating Contingency	20.0 %	$6,648,831
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$39,892,987**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A5 Pier 7: Pier Extension and Cargo Yard Expansion

Rates Current At December 2014

Description		Unit	Qty	Rate	Total
E2010 Fixed Furnishings					
26 First aid station		EA	1.00	400.00	400
	Fixed Furnishings				***$400***
G2040 Site Development					
55 Vehicle gates		EA	1.00	5,000.00	5,000
17 Pier 7 extension (continuous wharf)		LF	200.00	43,400.00	8,680,000
21 Concrete hardstand		SF	566,280.00	25.00	14,157,000
24 Fencing		LF	3,100.00	105.00	325,500
54 Gates		Pr	1.00	1,500.00	1,500
	Site Development				***$23,169,000***
G3010 Water Supply					
19 Spigot, wash/first aid station		LS	1.00	10,000.00	10,000
	Water Supply				***$10,000***
G4010 Electrical Distribution					
43 Underground power lines		LF	400.00	500.00	200,000
	Electrical Distribution				***$200,000***
G4020 Site Lighting					
23 Site lighting		SF	566,280.00	8.00	4,530,240
	Site Lighting				***$4,530,240***
G4030 Site Communications & Security					
25 Emergency communication		LS	1.00	2,000.00	2,000
	Site Communications & Security				***$2,000***
	PIER 7: PIER EXTENSION AND CARGO YARD EXPANSION				***$27,911,640***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A6 Piers 3&4: Fuel Pier Construction Phase I		30,100,000
	A - MAJOR PROJECTS	***$30,100,000***
	ESTIMATED NET COST	**$30,100,000**
MARGINS & ADJUSTMENTS		
General Conditions	8.0 %	$2,408,000
Bond & Insurance	2.0 %	$650,160
Overhead and Profit	6.0 %	$1,989,490
General Excise Tax	2.0 %	$702,953
Estimating Contingency	20.0 %	$7,170,121
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$43,020,724**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A6 Piers 3&4: Fuel Pier Construction Phase I

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2040 Site Development				
27 Pier 3 & 4 (segmented)	LF	1,000.00	30,100.00	30,100,000
Site Development				***$30,100,000***
PIERS 3&4: FUEL PIER CONSTRUCTION PHASE I				***$30,100,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A7 Fuel Terminal: Fuel Terminal Construction		15,333,774
	A - MAJOR PROJECTS	***$15,333,774***
	ESTIMATED NET COST	**$15,333,774**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$1,533,377
Bond & Insurance	2.0 %	$337,343
Overhead and Profit	7.0 %	$1,204,315
General Excise Tax	2.0 %	$368,176
Estimating Contingency	20.0 %	$3,755,397
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$22,532,382**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A7 Fuel Terminal: Fuel Terminal Construction

Rates Current At December 2014

Description		Unit	Qty	Rate	Total
F1010 Special Structures					
33 Fuel building - size assumed		SF	1,000.00	1,000.00	1,000,000
37 Security shack		EA	1.00	50,000.00	50,000
	Special Structures				***$1,050,000***
G1020 Site Demolition and Relocations					
28 Miscellaneous demolition		SF	518,364.00	3.00	1,555,092
	Site Demolition and Relocations				***$1,555,092***
G1030 Site Earthwork					
2 Mass grading		SF	518,364.00	0.50	259,182
	Site Earthwork				***$259,182***
G2020 Parking Lots					
34 AC paving		SF	517,300.00	10.00	5,173,000
	Parking Lots				***$5,173,000***
G2040 Site Development					
55 Vehicle gates		EA	1.00	5,000.00	5,000
24 Fencing		LF	2,300.00	105.00	241,500
36 Security fencing & video monitoring @ secondary containment		LF	1.00	300.00	300
39 Navigation (signage)		LS	1.00	50,000.00	50,000
54 Gates		Pr	1.00	1,500.00	1,500
	Site Development				***$298,300***
G3010 Water Supply					
18 Water & fire protection lines & fire hydrants to piers		LF	2,000.00	200.00	400,000
30 Potable water for vessels		LS	1.00	100,000.00	100,000
32 Upgrade fire suppression system		LS	1.00	250,000.00	250,000
	Water Supply				***$750,000***
G3020 Sanitary Water					
11 Sewer system to Marisco, including manholes		LF	1.00		Excl.
31 Upgraded individual wastewater system (IWS)		LS	1.00	300,000.00	300,000
	Sanitary Water				***$300,000***
G3060 Fuel Distribution					
35 Pipeline rack (Arcadis less markups)		LS	1.00	1,527,800.00	1,527,800
	Fuel Distribution				***$1,527,800***
G4010 Electrical Distribution					
29 Shore based electrical power for vessels		LS	1.00	80,000.00	80,000
	Electrical Distribution				***$80,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A7 Fuel Terminal: Fuel Terminal Construction (continued)

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G4020 Site Lighting				
23 Site lighting	SF	517,300.00	8.00	4,138,400
Site Lighting				***$4,138,400***
G4030 Site Communications & Security				
25 Emergency communication	LS	1.00	2,000.00	2,000
38 Cameras, video	LS	1.00	200,000.00	200,000
Site Communications & Security				***$202,000***
FUEL TERMINAL: FUEL TERMINAL CONSTRUCTION				***$15,333,774***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A8 Pier 8: Layberth and Multi-Purpose Yard		53,721,800
A - MAJOR PROJECTS		***$53,721,800***
ESTIMATED NET COST		**$53,721,800**
MARGINS & ADJUSTMENTS		
General Conditions	6.0 %	$3,223,308
Bond & Insurance	2.0 %	$1,138,902
Overhead and Profit	4.0 %	$2,323,360
General Excise Tax	2.0 %	$1,208,147
Estimating Contingency	20.0 %	$12,323,103
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$73,938,620**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A8 Pier 8: Layberth and Multi-Purpose Yard

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
E2010 Fixed Furnishings				
26 First aid station	EA	1.00	400.00	400
Fixed Furnishings				***$400***
G2040 Site Development				
55 Vehicle gates	EA	1.00	5,000.00	5,000
40 Pier 8 (heavy duty floating dock)	LF	410.00	15,000.00	6,150,000
21 Concrete hardstand	SF	1,416,800.00	25.00	35,420,000
24 Fencing	LF	3,700.00	105.00	388,500
54 Gates	Pr	1.00	1,500.00	1,500
Site Development				***$41,965,000***
G3010 Water Supply				
19 Spigot, wash/first aid station	LS	1.00	10,000.00	10,000
Water Supply				***$10,000***
G4010 Electrical Distribution				
43 Underground power lines	LF	820.00	500.00	410,000
Electrical Distribution				***$410,000***
G4020 Site Lighting				
23 Site lighting	SF	1,416,800.00	8.00	11,334,400
Site Lighting				***$11,334,400***
G4030 Site Communications & Security				
25 Emergency communication	LS	1.00	2,000.00	2,000
Site Communications & Security				***$2,000***
PIER 8: LAYBERTH AND MULTI-PURPOSE YARD				***$53,721,800***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A9 Pier 4B: Finger Pier Removal and Fuel Pier Construction Phase II		13,800,000
A - MAJOR PROJECTS		***$13,800,000***
ESTIMATED NET COST		**$13,800,000**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$1,380,000
Bond & Insurance	2.0 %	$303,600
Overhead and Profit	7.0 %	$1,083,852
General Excise Tax	2.0 %	$331,349
Estimating Contingency	20.0 %	$3,379,760
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$20,278,561**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A9 Pier 4B: Finger Pier Removal and Fuel Pier Construction Phase II — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1020 Site Demolition and Relocations				
42 Finger pier removal	LF	170.00	500.00	85,000
Site Demolition and Relocations				***$85,000***
G2040 Site Development				
41 Pier 4B (continuous wharf)	LF	325.00	42,200.00	13,715,000
Site Development				***$13,715,000***
PIER 4B: FINGER PIER REMOVAL AND FUEL PIER CONSTRUCTION PHASE II				***$13,800,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A10 Storage Yards S-7, Multi-Purpose Yard and Martime Support Services: Install Underground Power Lines		2,422,100
A - MAJOR PROJECTS		***$2,422,100***
ESTIMATED NET COST		**$2,422,100**
MARGINS & ADJUSTMENTS		
General Conditions	15.0 %	$363,315
Bond & Insurance	2.0 %	$55,708
Overhead and Profit	8.0 %	$227,290
General Excise Tax	2.0 %	$61,368
Estimating Contingency	20.0 %	$625,956
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$3,755,737**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A10 Storage Yards S-7, Multi-Purpose Yard and Martime Support Services: Install Underground Power Lines

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1020 Site Demolition and Relocations				
44 Remove temporary overhead power lines	LF	4,570.00	30.00	137,100
Site Demolition and Relocations				***$137,100***
G4010 Electrical Distribution				
43 Underground power lines	LF	4,570.00	500.00	2,285,000
Electrical Distribution				***$2,285,000***
STORAGE YARDS S-7, MULTI-PURPOSE YARD AND MARTIME SUPPORT SERVICES: INSTALL UNDERGROUND POWER LINES				***$2,422,100***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A11 Kalaeloa Harbor Access Road: Construction on Property		535,350
A - MAJOR PROJECTS		***$535,350***
ESTIMATED NET COST		**$535,350**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$53,535
Bond & Insurance	2.0 %	$11,778
Overhead and Profit	8.0 %	$48,053
General Excise Tax	2.0 %	$12,974
Estimating Contingency	20.0 %	$132,338
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$794,028**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A11 Kalaeloa Harbor Access Road: Construction on Property — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1020 Site Demolition and Relocations				
28 Miscellaneous demolition	SF	27,200.00	3.00	81,600
Site Demolition and Relocations				***$81,600***
G1030 Site Earthwork				
2 Mass grading	SF	27,200.00	0.50	13,600
Site Earthwork				***$13,600***
G2010 Roadways				
7 New roadway, including AC paving & gutter	SF	27,200.00	12.00	326,400
Roadways				***$326,400***
G3030 Storm Sewer				
9 Roadway drainage	LF	455.00	50.00	22,750
Storm Sewer				***$22,750***
G4020 Site Lighting				
8 Roadway lighting	LF	455.00	200.00	91,000
Site Lighting				***$91,000***
KALAELOA HARBOR ACCESS ROAD: CONSTRUCTION ON PROPERTY				***$535,350***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A12 Pier 10: Layberth		915,000
	A - MAJOR PROJECTS	***$915,000***
	ESTIMATED NET COST	**$915,000**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$91,500
Bond & Insurance	2.0 %	$20,130
Overhead and Profit	8.0 %	$82,130
General Excise Tax	2.0 %	$22,175
Estimating Contingency	20.0 %	$226,187
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$1,357,122**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A12 Pier 10: Layberth

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2040 Site Development				
45 Pier 10 mooring dolphins and bollards - allow	LS	1.00	390,000.00	390,000
Site Development				***$390,000***
G4010 Electrical Distribution				
43 Underground power lines	LF	1,050.00	500.00	525,000
Electrical Distribution				***$525,000***
PIER 10: LAYBERTH				***$915,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Summary

Rates Current At December 2014

Location		Total Cost
A MAJOR PROJECTS		
A13 Dredging/Flaring Harbor Entrance and Dredging KBPH Basin (USACE)		58,126,000
A - MAJOR PROJECTS		***$58,126,000***
ESTIMATED NET COST		**$58,126,000**
MARGINS & ADJUSTMENTS		
General Conditions	6.0 %	$3,487,560
Bond & Insurance	2.0 %	$1,232,271
Overhead and Profit	4.0 %	$2,513,833
General Excise Tax	2.0 %	$1,307,193
Estimating Contingency	20.0 %	$13,333,371
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$80,000,228**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

A MAJOR PROJECTS

A13 Dredging/Flaring Harbor Entrance and Dredging KBPH Basin (USACE) — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G9090 Other Site Systems & Equipment				
74 Dredging/flaring harbor entrance and dredging KBPH basin (per 2008 Kalaeloa Deepening Cost Apportionment)	LS	1.00	58,126,000.00	58,126,000
Other Site Systems & Equipment				***$58,126,000***
DREDGING/FLARING HARBOR ENTRANCE AND DREDGING KBPH BASIN (USACE)				***$58,126,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B1 Pier 6: Bollard Installation		75,000
	B - MINOR PROJECTS	***$75,000***
	ESTIMATED NET COST	**$75,000**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$7,500
Bond & Insurance	2.0 %	$1,650
Overhead and Profit	8.0 %	$6,732
General Excise Tax	2.0 %	$1,818
Estimating Contingency	20.0 %	$18,540
Escalation beyond 2014		Excl.
	ESTIMATED TOTAL COST	**$111,240**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B1 Pier 6: Bollard Installation

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2040 Site Development				
49 Bollard installation at pier 6	LS	1.00	75,000.00	75,000
Site Development				***$75,000***
PIER 6: BOLLARD INSTALLATION				***$75,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B3 Finger Pier and T-Pier: Minor Improvements		18,650
B - MINOR PROJECTS		***$18,650***
ESTIMATED NET COST		**$18,650**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$1,865
Bond & Insurance	2.0 %	$410
Overhead and Profit	8.0 %	$1,674
General Excise Tax	2.0 %	$452
Estimating Contingency	20.0 %	$4,610
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$27,661**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B3 Finger Pier and T-Pier: Minor Improvements

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2040 Site Development				
52 Gated access	LF	110.00	105.00	11,550
54 Gates	Pr	1.00	1,500.00	1,500
Site Development				***$13,050***
G3010 Water Supply				
50 Water spigots	EA	2.00	800.00	1,600
Water Supply				***$1,600***
G4010 Electrical Distribution				
51 Shore side power connection	LS	2.00	2,000.00	4,000
Electrical Distribution				***$4,000***
FINGER PIER AND T-PIER: MINOR IMPROVEMENTS				***$18,650***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B4 Pier 10: Emergency Access Connection to Ko Olina		9,500
B - MINOR PROJECTS		***$9,500***
ESTIMATED NET COST		**$9,500**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$950
Bond & Insurance	2.0 %	$209
Overhead and Profit	8.0 %	$853
General Excise Tax	2.0 %	$230
Estimating Contingency	20.0 %	$2,348
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$14,090**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B4 Pier 10: Emergency Access Connection to Ko Olina — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1010 Site Clearing				
53 Clear for dirt road access	LF	800.00	10.00	8,000
Site Clearing				***$8,000***
G2040 Site Development				
54 Gates	Pr	1.00	1,500.00	1,500
Site Development				***$1,500***
PIER 10: EMERGENCY ACCESS CONNECTION TO KO OLINA				***$9,500***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B5 Bulk Storage Areas S-A1, A2, B: Coral Stockpile Removal		4,400,900
B - MINOR PROJECTS		***$4,400,900***
ESTIMATED NET COST		**$4,400,900**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$440,090
Bond & Insurance	2.0 %	$96,820
Overhead and Profit	7.0 %	$345,647
General Excise Tax	2.0 %	$105,669
Estimating Contingency	20.0 %	$1,077,825
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$6,466,951**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B5 Bulk Storage Areas S-A1, A2, B: Coral Stockpile Removal — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G1010 Site Clearing				
1 Remove coral stockpile - volume based on assumed average height of 5' - by others	CY	121,722.40		Excl.
Site Clearing				***Excl.***
G1030 Site Earthwork				
2 Mass grading	SF	3,961,800.00	0.50	1,980,900
57 Fill existing drainage channel	LF	2,700.00	600.00	1,620,000
Site Earthwork				***$3,600,900***
G3010 Water Supply				
72 Fire line	LF	2,000.00	200.00	400,000
56 Potable water line	LF	2,000.00	200.00	400,000
Water Supply				***$800,000***
G3030 Storm Sewer				
73 Drainage improvements - by tenant	SF	3,961,800.00		Excl.
Storm Sewer				***Excl.***
BULK STORAGE AREAS S-A1, A2, B: CORAL STOCKPILE REMOVAL				***$4,400,900***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B6 Ko Olina Mole: Perimeter Lighting Improvements		24,000
B - MINOR PROJECTS		***$24,000***
ESTIMATED NET COST		**$24,000**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$2,400
Bond & Insurance	2.0 %	$528
Overhead and Profit	8.0 %	$2,154
General Excise Tax	2.0 %	$582
Estimating Contingency	20.0 %	$5,933
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$35,597**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B6 Ko Olina Mole: Perimeter Lighting Improvements — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G4020 Site Lighting				
66 Remove and replace light fixtures with marine-friendly	EA	20.00	1,200.00	24,000
Site Lighting				***$24,000***
KO OLINA MOLE: PERIMETER LIGHTING IMPROVEMENTS				***$24,000***

RLB | Rider Levett Bucknall

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan
ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B7 Piers 5/6 and 7: Personnel Shelter Construction		1,670,000
B - MINOR PROJECTS		***$1,670,000***
ESTIMATED NET COST		**$1,670,000**
MARGINS & ADJUSTMENTS		
General Conditions	15.0 %	$250,500
Bond & Insurance	2.0 %	$38,410
Overhead and Profit	8.0 %	$156,713
General Excise Tax	2.0 %	$42,312
Estimating Contingency	20.0 %	$431,587
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$2,589,522**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B7 Piers 5/6 and 7: Personnel Shelter Construction — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
F1010 Special Structures				
59 New personnel shelter	SF	3,000.00	500.00	1,500,000
Special Structures				***$1,500,000***
G3010 Water Supply				
61 Water system for new personnel shelter	EA	2.00	25,000.00	50,000
Water Supply				***$50,000***
G3020 Sanitary Water				
60 Septic system for new personnel shelter	EA	2.00	40,000.00	80,000
Sanitary Water				***$80,000***
G4010 Electrical Distribution				
62 Power, telecommunications for new personnel shelter	EA	2.00	20,000.00	40,000
Electrical Distribution				***$40,000***
PIERS 5/6 AND 7: PERSONNEL SHELTER CONSTRUCTION				***$1,670,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B8 Harbor Office Relocation		8,726,850
B - MINOR PROJECTS		***$8,726,850***
ESTIMATED NET COST		**$8,726,850**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$872,685
Bond & Insurance	2.0 %	$191,991
Overhead and Profit	7.0 %	$685,407
General Excise Tax	2.0 %	$209,539
Estimating Contingency	20.0 %	$2,137,294
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$12,823,766**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B8 Harbor Office Relocation

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
F1010 Special Structures				
69 Garage	SF	1,440.00	140.00	201,600
70 Hazardous material shed	EA	1.00	25,000.00	25,000
68 Maintenance Shop	SF	4,620.00	225.00	1,039,500
63 Wash facility (single vehicle car wash)	EA	1.00	35,000.00	35,000
64 Storage warehouse	SF	5,500.00	175.00	962,500
46 Harbor operations building	SF	3,900.00	500.00	1,950,000
Special Structures				***$4,213,600***
G1020 Site Demolition and Relocations				
67 Building demolition (existing Harbor Office)	SF	2,000.00	15.00	30,000
Site Demolition and Relocations				***$30,000***
G1030 Site Earthwork				
2 Mass grading	SF	230,868.00	0.50	115,434
Site Earthwork				***$115,434***
G2020 Parking Lots				
22 AC paving	SF	43,560.00	10.00	435,600
Parking Lots				***$435,600***
G3010 Water Supply				
47 Water system to Harbor Operations building, including meters, hydrants, backflow preventers, etc.	LF	2,600.00	300.00	780,000
Water Supply				***$780,000***
G3020 Sanitary Water				
48 Sewer system to Harbor Operations building, including manholes	LF	2,600.00	400.00	1,040,000
71 Other sewer: effluent ejector system, septic tank (250 gal) & sewer cleanout	LS	1.00	2,000.00	2,000
Sanitary Water				***$1,042,000***
G3030 Storm Sewer				
3 Drainage improvements	SF	230,868.00	2.00	461,736
Storm Sewer				***$461,736***
G4010 Electrical Distribution				
43 Underground power lines	LF	2,600.00	500.00	1,300,000
Electrical Distribution				***$1,300,000***
G4020 Site Lighting				
23 Site lighting	SF	43,560.00	8.00	348,480
Site Lighting				***$348,480***
HARBOR OFFICE RELOCATION				***$8,726,850***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated

Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B9 Piers 4/5, 8 and 10: Personnel Shelter Construction		1,930,000
B - MINOR PROJECTS		***$1,930,000***
ESTIMATED NET COST		**$1,930,000**
MARGINS & ADJUSTMENTS		
General Conditions	15.0 %	$289,500
Bond & Insurance	2.0 %	$44,390
Overhead and Profit	8.0 %	$181,111
General Excise Tax	2.0 %	$48,900
Estimating Contingency	20.0 %	$498,780
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$2,992,681**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B9 Piers 4/5, 8 and 10: Personnel Shelter Construction — Rates Current At December 2014

Description	Unit	Qty	Rate	Total
F1010 Special Structures				
58 Renovate existing personnel shelters	SF	1,300.00	200.00	260,000
59 New personnel shelter	SF	3,000.00	500.00	1,500,000
Special Structures				***$1,760,000***
G3010 Water Supply				
61 Water system for new personnel shelter	EA	2.00	25,000.00	50,000
Water Supply				***$50,000***
G3020 Sanitary Water				
60 Septic system for new personnel shelter	EA	2.00	40,000.00	80,000
Sanitary Water				***$80,000***
G4010 Electrical Distribution				
62 Power, telecommunications for new personnel shelter	EA	2.00	20,000.00	40,000
Electrical Distribution				***$40,000***
PIERS 4/5, 8 AND 10: PERSONNEL SHELTER CONSTRUCTION				***$1,930,000***

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Summary with Margins Separated — Rates Current At December 2014

Location		Total Cost
B MINOR PROJECTS		
B10 Landscaping		100,000
B - MINOR PROJECTS		***$100,000***
ESTIMATED NET COST		**$100,000**
MARGINS & ADJUSTMENTS		
General Conditions	10.0 %	$10,000
Bond & Insurance	2.0 %	$2,200
Overhead and Profit	8.0 %	$8,976
General Excise Tax	2.0 %	$2,424
Estimating Contingency	20.0 %	$24,720
Escalation beyond 2014		Excl.
ESTIMATED TOTAL COST		**$148,320**

DOT-Harbors Kalaeloa Barbers Point Harbor Master Plan

ROM Cost Estimate R5-120114

Location Elements Item

B MINOR PROJECTS

B10 Landscaping

Rates Current At December 2014

Description	Unit	Qty	Rate	Total
G2050 Landscaping				
65 Landcaping - minimal	LS	1.00	100,000.00	100,000
Landscaping				***$100,000***
LANDSCAPING				***$100,000***