Fare Policy Modeling Study: Ridership & Fare Revenue Impacts

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Completed by:

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1.0 Introduction

In 2013, the City and County of Honolulu Department of Transportation Services (DTS) commissioned a Multimodal Fare Collection Study to develop a plan for implementation of a new electronic fare payment system. A project steering committee was formed to review the current fare collection system and help inform the design of the future system. The Multimodal Fare Collection Study: Fare Structure Recommendations report was one component of the study, and was delivered in August 2014, outlining recommended elements that should be included in the design of the electronic fare collection system.

Building on the initial 2014 Fare Structure Recommendations report, HART contracted with CH2M in 2016 to undertake more detailed fare structure implementation options, including estimated ridership and fare revenue impacts.

The purpose of this report is to provide the results of the initial fare model development and baseline results as well as outline the FARES model set up which will provide for the evaluation of alternative fare structure implementation options, including ridership and fare revenue impacts. The alternatives under consideration will be evaluated based on five key preliminary goals: promote simplicity, increase ridership, increase fare revenue, increase equity among customer groups, and decrease fare collection costs. Further description of the fare policy goals is undertaken in Section 1.3

1.1 Study Description

The core objective of this study is to evaluate alternative fare structure/fare policy options, including estimation of ridership and fare revenue impacts for each alternative. Ridership and fare revenue estimates focus on HART Rail and TheBus; ridership and fare revenue impacts for TheHandiVan is beyond the scope of this study.

In order to deliver this study, two different modeling tools were utilized. The TransCAD regional travel model was used to estimate the initial ridership expected prior to rail opening in 2012 and 2019, and from bus and rail in the partial-opening year (2020) and the full-opening year (2025). With initial ridership estimates in 2012, 2019, 2020 & 2025, CH2M utilized the FARES model to estimate ridership and fare revenue by year, from 2017 through 2029. The FARES model will also be used to estimate the ridership and fare revenue impacts of alternative fare structures, including changes to fare products, fare rates and transfer policies.

1.2 Participating Stakeholders

Due to the multimodal nature of this study, stakeholders from several agencies have been working in active collaboration to review assumptions and inputs. Honolulu Authority for Rapid Transit (HART) has commissioned this study, and has involved representatives from the City and County of Honolulu, Department of Transportation and its transit management services contractor, Oahu Transit Services (OTS). The Oahu Metropolitan Planning Organization (OahuMPO) has also provided funding for the study and direction on regional modeling inputs and assumptions.

1.3 Study Goals and Principles

While this study was first initiated by the HART fare policy permitted interaction group in order to help develop fare revenue recovery recommendations for the HART board, changes in the HART Board
composition and recent Charter Amendment propositions have resulted in a need to clarify the goals and objectives for the study. The goals for the initial analysis remain those listed below as best practices/principles for fare studies. Exact goals for the Honolulu fare system are not anticipated to be available until early 2017.

Until such time that goals are adopted by HART, the study will rely on fare policy goals that reflect best practices/principles for fare studies. The specific goals are described in detail below, in Table 1-1.

**Table 1-1: Preliminary HART Fare Policy Goals**

<table>
<thead>
<tr>
<th>Goal</th>
<th>Fare Policy Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplicity</td>
<td>With base functionality in place, effectively use the electronic fare collection system to simplify the fare structure and make fares easy to understand and pay</td>
</tr>
<tr>
<td>Ridership</td>
<td>Use fare system data to strengthen service planning and fare policy decisions</td>
</tr>
<tr>
<td></td>
<td>Benefit society by encouraging transit use and increasing transit’s share of the region’s transportation market</td>
</tr>
<tr>
<td>Revenue</td>
<td>Link fares to the value of the service to customers, considering trip length, service quality and market demand</td>
</tr>
<tr>
<td></td>
<td>Implement regular fare policy reviews and periodic fare adjustments, to generate sufficient fare revenue</td>
</tr>
<tr>
<td></td>
<td>Define sustainable group discount programs that attract riders</td>
</tr>
<tr>
<td>Equity</td>
<td>Offer equitable fares that recognize the needs and ability to pay of passengers who depend on transit for their mobility needs</td>
</tr>
<tr>
<td>Cost Control</td>
<td>Quickly migrate customer fare payment to electronic fare collection system</td>
</tr>
</tbody>
</table>
2.0 Current Fare Payment System

2.1 Current Fare Structure

TheBus, operated by Oahu Transit Services (OTS) under contract with DTS, provides bus and paratransit service across the island of Oahu. As of 2012, OTS provides approximately 74 million fixed-route trips annually, generating $55M annually in fare revenue.

The Honolulu rail system, being constructed by HART, is a 20-mile elevated rail line featuring 21 stations. The system will connect West Oahu with the Honolulu International Airport, continuing through downtown Honolulu with a final stop at Ala Moana Center. The western portion of the rail system (from East Kapolei to Aloha Stadium) is planned to open in 2020, with the full line (East Kapolei to Ala Moana Center) opening expected in 2025.

Current fare pricing is structured to make transit affordable to transit dependent and frequent riders by providing low-cost monthly & annual passes. As a result, 77 percent of transit customers pay using a pass.

<table>
<thead>
<tr>
<th>Key Metrics</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>TheBus Ridership/Revenue</td>
<td>71M/$55M Annual</td>
</tr>
<tr>
<td>Operating Budget</td>
<td>$215M Annually</td>
</tr>
<tr>
<td>Fare Media Options</td>
<td>Paper Products, Cash</td>
</tr>
<tr>
<td>Fare Media Usage</td>
<td>77% Pass, 23% Cash</td>
</tr>
<tr>
<td>Ridership Composition</td>
<td>94% Locals, 6% Visitors</td>
</tr>
</tbody>
</table>

2.1.1 Fare Media

TheBus accepts cash and paper fare products. For cash customers, TheBus operators also provide paper transfers. Farebox data, cash collection, and pass sales data are combined to estimate ridership and revenue.

2.1.2 Fare Products

Available fare products and pricing vary by customer category. Customer categories are listed in Table 2-2. A special ID or application/registration process is required to receive a reduced fare.

<table>
<thead>
<tr>
<th>Customer Category</th>
<th>Cost of ID</th>
<th>Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>N/A</td>
<td>Person age 18-64</td>
</tr>
<tr>
<td>Customer Category</td>
<td>Cost of ID</td>
<td>Qualification</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Youth</td>
<td>Student ID</td>
<td>Person age 6-17 or in high school qualifies for reduced fare passes and cash fare with valid ID</td>
</tr>
<tr>
<td>Child</td>
<td>N/A</td>
<td>Person age 5 and under rides free with fare-paying customer</td>
</tr>
<tr>
<td>Senior</td>
<td>$10</td>
<td>Person age 65 and over qualifies for reduced fare passes and cash fare with OTS-issued senior citizen ID (valid for 4 years) Revised Ordinances of Honolulu (ROH) Section 13-2.3</td>
</tr>
<tr>
<td>Disabled</td>
<td>$10</td>
<td>Person with certified disability qualifies for reduced fare passes and cash fare with OTS-issued disability ID (valid for up to 2 years) ROH Section 13-2.2</td>
</tr>
<tr>
<td>Medicare</td>
<td>Medicare ID</td>
<td>Person with Medicare ID qualifies for reduced cash fare with valid Medicare ID</td>
</tr>
<tr>
<td>Low Income</td>
<td>N/A</td>
<td>Person certified as low-income qualifies for discounted monthly pass ROH Section 13-2.10</td>
</tr>
</tbody>
</table>

TheBus has a flat fare structure for one-way cash fares. Products available for fixed route services are 4-day, monthly, annual, and two-year passes. Pricing and availability vary by customer category.

**Table 2-3: Fare Structure**

<table>
<thead>
<tr>
<th>Customer Category</th>
<th>One-Way Fare</th>
<th>4-Day Pass</th>
<th>Monthly Pass</th>
<th>Annual Pass</th>
<th>2 Year Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>$2.50</td>
<td>$35.00</td>
<td>$60.00</td>
<td>$660.00</td>
<td>-</td>
</tr>
<tr>
<td>Youth</td>
<td>$1.25</td>
<td>-</td>
<td>$30.00</td>
<td>$330.00</td>
<td>-</td>
</tr>
<tr>
<td>Senior</td>
<td>$1.00</td>
<td>-</td>
<td>$5.00</td>
<td>$30.00</td>
<td>$60.00</td>
</tr>
<tr>
<td>Disabled</td>
<td>$1.00</td>
<td>-</td>
<td>$5.00</td>
<td>$30.00</td>
<td>$60.00</td>
</tr>
<tr>
<td>Medicare</td>
<td>$1.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Medicare recipients may also be eligible for reduced price products as senior citizens or as persons with disabilities.
2.1.3 Transfer Policy

Under the current fare policy for TheBus, cash paying customers may request a free paper transfer upon fare payment. The transfer is valid for two transfers in the same direction of travel within two hours. Round tripping is not allowed, however, the policy is difficult to enforce with paper media.

Bus operators issue transfers by tearing paper transfer slips at a time of two hours from the transfer request. When customers board with a transfer, operators visually validate the transfer slip and collect the transfer at expiration.

In July 2014, the operator began collecting the coupon at the bottom of the paper transfer on the first connection. TheBus operator then collects the entire transfer on the second connection. Instituting the transfer receipt with a detachable coupon helps enforce the two transfer policy.

The current process to manually issue and enforce transfer policies is susceptible to fraud and impacts bus operation and customer dwell time. Paper transfers can be reused, resold, or used beyond their intended validity period. While resale or sharing of transfers is not permitted, enforcement is difficult. These symptoms are typical of a paper-based transfer system, and can lead to revenue loss due to fare evasion, also known as revenue leakage. Transitioning transfers to electronic fare media can help reduce fraud and revenue leakage by enforcing transfer policies automatically. In addition to considerable fraud potential, current paper transfers will not work in the future gated rail stations that require the use of electronic fare media for entry.

2.2 Current Fare Usage

Ridership survey data was used to identify fare payment methods of current customers. Based on the Honolulu 2012 On-Board Transit Survey conducted by HART, the vast majority of TheBus customers pay using prepaid pass products (77 percent of ridership), while only a quarter of customers pay using cash or paper transfer (23 percent of ridership).
2.2.1 Product Usage by Customer Category

As discussed in Section 2.1.2, the prices and availability of products vary by customer category. Based on the available discounts, TheBus customers will usually choose the fare product that provides the best value and convenience. Over half of senior citizens, disabled customers, and Medicare recipients purchase annual passes, which are priced at the cost of 30 one-way fares, or 6 reduced fare monthly passes. The high usage of annual and two-year passes is due to the higher discount that the products offer when compared to monthly passes, and the added convenience of only needing to visit TheBus Pass Office at the Kalihi Transit Center once a year or biennially. Only senior products may be renewed at Satellite City Hall locations and through the pass-by-mail program.

Figure 2-3: Fare Payment Method by Fare Discount Category

Source: HART Honolulu 2012 On-Board Transit Survey (2013)

\(^1\) TheBus provides only a cash discount to Medicare recipients. Respondents that listed their fare discount category as Medicare are also likely eligible for reduced price products as senior citizens or as persons with disabilities.
Visitors are a small but important customer group in Honolulu. While this group only represents 6% of total ridership, they account for substantial portions of Cash and 4-Day Pass usage. Visitors account for 20% of all Cash trips on the system (or 4.3% of system ridership), and 95% of 4-Day Pass usage (accounting for 0.5% of system ridership). These two products account for 84% of Visitor trips on the system.

2.2.2 Product Usage by Household Income

The affordability of fare products is important to measure the effectiveness of a fare structure for lower income customers. Populations living in low-income households are more likely to ride transit.

Figure 2-4: Ridership by Household Income

![Ridership by Household Income graph](image)

Source: HART Honolulu 2012 On-Board Transit Survey (2013)

Lower income customers are most likely to use passes (e.g., monthly pass, annual pass, U-Pass), and high income customers are likely to pay using cash. Any fare structure and policy considerations should take into account the impacts on low-income customers of changes to the affordability and accessibility of transit.

Figure 2-5: Fare Payment Method by Household Income

![Fare Payment Method by Household Income chart](chart)

Source: HART Honolulu 2012 On-Board Transit Survey (2013)
Youth and Disabled customers are a substantial portion of the very low income customer population. Consideration should be given to pricing for these customer categories, particularly the pricing of the Youth U-Pass & Disabled Annual pass products. The share of Senior customers is fairly even distributed across household income, suggesting some alternative pricing options for Seniors may be viable.

**Figure 2-6: Customer Category by Household Income**

Source: HART Honolulu 2012 On-Board Transit Survey (2013)

### 2.2.3 Transfer Usage

Approximately one-fifth of customers (18 percent of linked trips) transfer between bus lines to complete their trip. The majority of these customers transfer only once.

#### Table 2-4: Transfer Rates

<table>
<thead>
<tr>
<th>Number of Transfers</th>
<th>% of Linked Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>82%</td>
</tr>
<tr>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>3+</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Source: HART Honolulu 2012 On-Board Transit Survey (2013)

Most customers that transfer use a pass product, primarily the monthly pass. Only 6% of boardings are paid with cash and require a paper transfer to complete their trips. However, a higher percentage of transfers are requested and issued.

While relatively few customers require paper transfers to complete their trips, it is important to understand the demographics of the cash customers who require paper transfers. Transit provides an important means of travel for low-income customers to reach their jobs and for unemployed job seekers.
to reach prospective job locations. Understanding who these customers are can help in developing an outreach strategy to migrate them to electronic fare media.

Based on the Honolulu 2012 On-Board Transit Survey:

- Majority (90%) of customers that required a cash transfer are adults.
- One-tenth (10%) of customers that required a cash transfer receive a senior/disabled/Medicare reduced fare.
- Almost half (45%) of customers that required a cash transfer had a household income of less than $40,000. A third (33%) of customers that required a cash transfer had a household income of less than $15,000.
- One-quarter (23%) of customers that required a cash transfer lived in a household without any vehicles.
- One-tenth (10%) of customers that required a cash transfer were unemployed and seeking work.
- One-eighth (13%) of customers that required a cash transfers were tourists.
3.0 Future Fare Payment System – Recommended Structure & Technical Specifications

3.1 Fare Structure Study Recommendations

In the 2014 Fare Structure Recommendations study, a number of fare policies were recommended for inclusion in the Technical Specifications for the Honolulu Fare Collection System, with the potential for implementation on the system. The recommendations aimed to maintain the simplicity built into the current structure, with a suggested fare policy that largely mirrors the existing one. It was also recommended that the system be designed to enable additional fare policy configuration options in the future. Table 3-1 summarizes the 2014 Fare Structure study fare media and fare policy recommendations.

Table 3-1: Fare Media and Policy Recommendations

<table>
<thead>
<tr>
<th>Topic</th>
<th>Recommendation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fare Structure</td>
<td>Flat Fare</td>
<td>One fare for both bus and rail</td>
</tr>
<tr>
<td></td>
<td>Tap on Entry</td>
<td>Tap upon boarding a bus or entering rail</td>
</tr>
<tr>
<td>Fare Media</td>
<td>Extended-Use Cards</td>
<td>Offer only durable electronic cards</td>
</tr>
<tr>
<td></td>
<td>Nominal Card Fee</td>
<td>Small card fee (e.g., $1) to promote reuse</td>
</tr>
<tr>
<td>Passes</td>
<td>Migrate Existing</td>
<td>Make existing passes good on both bus and rail</td>
</tr>
<tr>
<td></td>
<td>Require Card</td>
<td>Offer passes only on electronic media</td>
</tr>
<tr>
<td>Transfers</td>
<td>Free Bus/Rail</td>
<td>Free transfers between bus and rail</td>
</tr>
<tr>
<td></td>
<td>Require Card</td>
<td>Transfers only on electronic media</td>
</tr>
<tr>
<td>Reduced Fares</td>
<td>Require Card</td>
<td>Reduced fares require a reduced fare card</td>
</tr>
<tr>
<td></td>
<td>Pre-Registration Req.</td>
<td>Reduced fare on rail requires pre-registration</td>
</tr>
</tbody>
</table>

The following options were recommended for inclusion in the system design:

- Mode specific passes: ability to have bus-only passes, rail-only passes, and joint bus/rail passes, each with unique pricing;
- Fare differential: ability to price fares lower for electronic card users;
- Location-based fares: ability to price fares higher at certain locations (e.g., airport);
- Service-based fares: ability to price fares higher for premium services (e.g., express bus, rail);
- Resident Fares: ability to price fares lower for locals who qualify and register.

3.2 Honolulu Fare Collection System, Technical Specifications

The Technical Specifications for the Honolulu Fare Collection System encompasses the full range of specifications that the selected System Integrator is expected to support. To facilitate transition to the smart card system, every effort will be made to ensure that the fare policy options under consideration conform to the fare system Technical Specifications.
The Technical Specifications captured all of the fare structure elements recommended in Section 3.1, plus some additional technical requirements relevant to potential fare policy alternatives. The additional requirements noted below are not required in future fare policies; rather, they are technical specifications that may provide fare policy flexibility:

- **Peak/Off-Peak Pricing**: ability to price fares based on the time of day and day of week (e.g., peak and off-peak fares). (Req. #8.2-6)

- **Bonus Rides**: ability to support fare incentives whereby the customer is granted a free number of rides after a certain number of rides have been paid for using stored value or a trip-based pass. (Req. #8.3-9)

- **The system has been designed to support ‘dual-tap’ operations (Req. #9.6.4.6) for data collection purposes. This requirement may have some implications for fare system design elements such as location-based fares.**
4.0 Ridership & Fare Revenue Modeling Approach

4.1 Modeling Approach Overview

The evaluation of fare policy alternatives, and namely the estimation of ridership and fare revenue, relies on two separate models and a validation tool to develop detailed ridership & fare revenue estimates. Figure 4-1 outlines the high-level modeling framework. The modeling begins with the use of the OahuMPO regional travel demand forecasting model (TDFM) for the island of Oahu. The regional TDFM uses land use and population data to estimate transit system usage at different horizon years. Key outputs from the TDFM include average weekday boardings/linked trips, and customer transfer rates. With these outputs, a validation tool is used to estimate base year ridership and revenue by fare category and by fare product. In addition to data from the TDFM, the validation tool relies on customer data from the 2012 On-Board Survey. Key outputs from the validation tool include base-year boardings and linked trips, and product usage rates by fare category and by fare product. The base-year estimates are then incorporated into a second model called FARES. The FARES model distributes the transit ridership into different customer categories and fare products by year, enabling the evaluation of alternative fare product pricing and structures. With several additional inputs, annual ridership and fare revenue estimates are then developed for the years 2017 through 2029. Additional detail on the two models (TDFM & FARES) and the validation tool are provided later in Section 4.

Figure 4-1: HART Fare Modeling Framework

4.2 Regional Travel Demand Forecasting Approach

The TDFM estimates future, island-wide vehicular traffic flows and transit ridership based on land use, employment, population characteristics, and an underlying transportation network. The OahuMPO uses the TDFM during long-range planning efforts to assess and compare the performance of different transportation projects relative to a baseline scenario.

The current OahuMPO TDFM is a tour-based, micro-simulation model system that uses the TransCAD 6.0 software package. The model uses a synthetic population and land use forecast to simulate and track the travel patterns of each individual or household in future years. The tour-based model simulates individual daily travel patterns as a series of linked trips or tours which begin or end at home or work. Trips are simulated as one of seven different tour purposes, such as work, school, or non-mandatory trips. The tour-based framework allows consistency across trip mode choice decisions. Someone who takes a bus to work, for example, would not be able to use a car for a trip during lunch because he or she would not have a car available to make the trip. The simulation results are then aggregated and
assigned to a transportation network (highway or transit service). Simulation results are also supplemented by forecasts of tourists, airport passengers, and commercial vehicle traffic.

4.2.1 Major Inputs / Assumptions

Major inputs into the OahuMPO TDFM include long-range socioeconomic forecasts prepared by the Department of Planning and Permitting in 2015 for the Oahu Regional Transportation Plan. Long-range population, housing, and employment forecasts for 2040 were linearly interpolated to develop intermediate forecasts for 2020 and 2030. A Monte Carlo simulation was used to fit a synthetic population to these targets. Overall, the land use inputs included about 3.4% fewer residents in 2030 than previous projections, or a total of 1.08 million people.

Other model inputs include data from the 2010 U.S. Census, as well as travel behavior surveys of 4,000 households and 950 visitors conducted in 2012. An onboard survey of 26,300 bus riders in 2012-2013 was also incorporated into the model. These surveys were used to calibrate the travel mode choice components of the model----e.g. how the model predicts that the synthetic travelers will chose to ride transit or drive an automobile.

Another major input into the TDFM is the underlying roadway and transit projects that are assumed to be in place at the time of the forecast year. This fare modeling study includes the committed short-range highway and transit projects included in the 2040 Oahu Regional Transportation Plan that was adopted in April, 2016. Proposed mid- and long-range highway projects through 2029 and 2040, respectively, are not included in the fare model study due to their implementation horizons.

The TDFM also includes an underlying bus route network in order to simulate how travelers will use the transit system. Although the City and County Department of Transportation Services is developing the bus service plans that will be implemented when the rail system opens, this fare study uses two scenarios for analytical purposes:

- **Interim Opening Bus Network**: The base and interim forecasts assume that the current (2012) existing bus network is unchanged, except for the addition of a new all-day express route that would operate from Pearl City through the interim Aloha Stadium rail terminus to Downtown Honolulu. This “53X” would be a modification of an existing route that would provide additional service to rail passengers. Rail passengers from West Oahu could also transfer to existing regional bus routes at either the Pearlridge or Aloha Stadium stations.

- **Long-Range Bus Network**: The full-opening forecast assumes the comprehensive long-term restructuring of the bus network that was described in the Honolulu Rail Transit Project Final EIS. This conceptual long-term bus network includes the addition of new high-frequency community circulators, truncation of regional and peak-period express routes, and a modest expansion in the bus fleet. Overall, the 2030 bus network included a roughly 20% increase in bus service hours over 2011 levels and an increase in the peak bus fleet of 474 vehicles (about a 10% increase).

4.2.2 Model Scenarios

The TDFM was used to estimate ridership in four different forecast years, reflecting local conditions in 2012, the year before the partial-opening of the rail system (2019), the first year of rail partial-opening (2020), and the first year of full rail operations (2025). The following assumptions were made for each scenario:

- **2012 Scenario (for calibration purposes)**: The purpose of developing the 2012 TDFM TransCAD model is to calibrate the modeled results against observed 2012 ridership.
Major model inputs and assumptions include:

- 2012 Roadway Network
- 2012 Bus Transit Network
- 2012 (Department of Planning and Permitting) DPP Land Use Data

Having confirmed that the TransCAD model assumptions and results compare favorably against the previously developed MINUTP estimates, the TransCAD model was setup to run the scenarios described below. Further details on the calibration and validation can be found in Appendix A.

b. **2019 HART Rail Pre-Opening Scenario**: The development of this 2019 pre-opening model with no rail services and existing bus network will be used to compare to the next scenario below, the partial-opening model.

   Major model inputs and assumptions include:
   - 2020 Roadway Network (based on current Oahu RTP using the short-range project lists (2011-2018))
   - 2012 Bus Transit Network
   - 2020 DPP Land Use Scenario

c. **2020 HART Rail Partial-Opening Scenario**: This partial-opening model scenario assumes that HART rail service is in operation between East Kapolei and Aloha Stadium. It assumes a slightly modified 2012 bus transit network with the inclusion of the 53X service.

   Major model inputs and assumptions include:
   - 2020 Roadway Network (based on current Oahu RTP using the short-range project lists (2011-2018))
   - 2012 Bus Transit Network, with addition of route 53X express service
   - HART rail, East Kapolei to Aloha Stadium
   - 2020 DPP Land Use Scenario

d. **2025 HART Rail Full-Opening & Revised Bus Network Scenario**: The full-opening model scenario assumes that HART rail extends to Ala Moana Center and that the supporting bus network will reflect the 2030 FEIS bus transit network.

   Major model inputs and assumptions include:
   - 2020 Roadway Network (based on current Oahu RTP using the short-range project lists (2011-2018))
   - 2030 FEIS Bus Transit Network
   - HART rail, East Kapolei to Ala Moana Center
   - 2020 DPP Land Use Scenario

### 4.3 Base-Year Validation & FARES Model Approach

With initial ridership estimates for select years from the TDFM model, a two-step process is applied to generate detailed ridership estimates in FARES. First, the average weekday boarding estimates from the TDFM model are converted to annual ridership and fare revenue estimates by customer category and by product for the base-year, in this case 2012. Data from the TDFM 2012 model run was used so that the modeled estimates could be validated against observed, FY2012 ridership and fare revenue results.

Once the aggregate 2012 annual ridership and fare revenue is estimated with the Baseline fare structure, additional inputs and assumptions are applied to convert the single-year estimate into
detailed ridership and fare revenue estimates for 2017 through 2029. Since the single-year (2012) estimate is validated based on Funding Year data from TheBus, the modeled results also represent Funding Year estimates. Data used to support the FARES model setup included the 2012 On-board Transit Survey, historic DTS ridership/revenue/pass sales data, and TDFM modeled ridership forecasts.

With the establishment of the Baseline scenario, alternative fare structures and fare pricing can be evaluated. The FARES model considers the impacts of external growth factors, service changes, and fare policy changes. The external growth factors include changes to population and employment, which may increase overall demand for transit. The service changes include the increased demand from HART rail opening. The FARES model also considers the higher transfer rates that occur through realignment of TheBus’ network to support the HART rail service. Most importantly, FARES allows for the evaluation of changes to fare products as well as changes to fare prices. The model also considers customer elasticity/price sensitivity, in order to predict customer response to changes to fare levels.

The remaining sections will discuss the base-year validation & FARES model approaches and key assumptions in greater detail. Alternative fare structures for further consideration will be discussed in Section 5.

4.3.1 Estimating & Validating 2012 Annual Ridership/Fare Revenue, from TDFM model results

A number of steps were undertaken to transform the TDFM ridership outputs into aggregate 2012 annual ridership and fare revenue by customer category and by product. The steps involved in the conversion include:

1. Application of an annualization factor to convert weekday estimates to an annual estimate,
2. Application of product and customer category shares, based on data from the 2012 On-Board Transit Survey, to sub allocate ridership into product and customer categories,
3. Apply observed product sales by customer category to estimate average product usage rates (validate the implied usage rates against GFI reports and historic ranges)
4. Apply current fare rates by product and customer category against product sales to estimate fare revenue by product and customer category (validate against reported revenue)
5. Apply seasonal factors to estimate approx. monthly ridership and fare revenue (validate against reported monthly ridership and revenue)

Each of these steps involved key assumptions and is outlined in greater detail in the following section. Figure 4-2 outlines the base-year validation approach. A similar process flow diagram is included in Section 4.3.2 for the FARES model framework.
Figure 4-2: Base-Year Validation Approach

1. **Application of Annualization Factor to TDFM Average Weekday Boardings**
   The first step in the development of a detailed annual estimate was to convert TDFM average weekday boardings to annual boardings. For 2012, an annualization factor of 321 was applied in order for estimated 2012 ridership to match actual, observed TheBus boardings in FY2012. An annualization factor of 321 is slightly higher than typically applied in regional modeling activities when converting weekday estimates to an annual estimate, but it reflects the multiplier required to match 2012 weekday estimates to FY2012 observations.

2. **Estimation of Customer Category & Product Shares, based on 2012 On-Board Survey**
   With an annual boardings estimate, the next step was to sub-allocate total ridership into customer categories and products. To do this, the unadjusted ridership shares reported in the 2012 On-Board Transit Survey were applied against total estimated boardings. With detailed boardings by customer category and by product, known product sales statistics from 2012 could then be applied to generate inferred product usage rates for validation purposes.

3. **Apply observed Product Sales, Inferred Product Usage Rates for Validation**
   The use of the unadjusted 2012 On-Board Survey results generated some inferred product shares that were unlikely to exist among TheBus customers. For example, the survey and ridership data suggested that Senior Monthly Pass usage rates were ~170 boardings/month; more typical monthly pass usage rates range from 40-55. The results also suggested that Annual Pass usage for Adult and Youth customers averaged 1,600 to 2,000 boardings/year, or 135 to 165 boardings/month. These usage rates were higher than anticipated. As such, some adjustments were made to the 2012 On-Board Survey results to better align estimated ridership against product sales and usage rates.

   At a high level, the adjusted 2012 survey results assumed a higher proportion of ridership generated from Annual Pass products, and less from Cash fares and Monthly passes. The adjustment also assumed a higher proportion of Youth and Senior ridership, and a lower proportion of Adult ridership. This higher share on discounted customer categories was supported by data from TheBus GFI farebox reports, which indicated higher proportions of Youth and Senior ridership. Figure 4-3 compares the unadjusted and adjusted On-Board Survey shares.
The adjusted 2012 On-Board Survey shares lined up well against usage rates generated by the GFI farebox reports, and against traditional product usage ranges. The 4-Day Pass is assumed to be used for ~12 boardings which aligns well with the GFI reports which suggest ~10 boardings. The Monthly Passes were assumed to have usage rates ranging from 45-60 boardings/month. This is higher than the GFI usage rates (~30-45 boardings/month) and typical monthly pass ranges (~40-55 boardings/month), but significantly more reasonable than the unadjusted values. The Annual Passes were assumed to have usage rates ranging from 350-600 boardings/year, which is generally in line with typical annual pass ranges of 400-550 boardings/year.

4. **Apply Fare Rates against Product Sales to Estimate Fare Revenue**
   With adjusted product shares estimated, fare rates were applied against product sales and cash usage rates to estimate total annual revenue. For 2012, estimated revenue was $55,175,445, which was +0.5% higher than reported revenue of $54,889,622. This was closer than originally anticipated, and provides some additional support for the adjusted product shares.

5. **Apply Seasonal Factors to Estimate Monthly Ridership & Fare Revenue Shares**
   The final step in the process was to apply monthly factors to the annual ridership and fare revenue estimates, to account for seasonality in ridership. Monthly shares were applied across all fare products and categories equally, with the exception of U-Pass customers. U-Pass ridership and revenue was distributed to align with the academic calendar, with significantly higher shares of ridership in the August to May timeframe.

### 4.3.2 Development of 2017-2029 Baseline Scenario

Having successfully estimated 2012 annual ridership and fare revenue by customer category and product, the FARES model is now used to expand the estimate out for each year from 2017 through 2029. The FARES model relies on information from the validation efforts, as well as additional...
parameters/assumptions specific to each fare scenario. Figure 4-4 outlines the FARES modeling framework.

**Figure 4-4: FARES Modeling Framework**

In order to develop a 2017 initial year estimate, ridership, revenue and product sales data for FY2016 was gathered and the same adjusted 2012 On-Board survey shares were applied. The 2016 results were increased by +0.64% (the approximate annual growth assumed in the 2012 TDFM land use scenario), in order to establish a 2017 initial year estimate. At this point, several additional assumptions were added to the analysis to forecast ridership and revenue through 2029. These assumptions generally fall into two categories; universal assumptions that remain consistent across scenarios, and variable assumptions that are likely to change between scenarios.

Universal assumptions within the model include:

- **Market-driven Growth**: Market-driven growth is meant to reflect changes in population, employment and land use that results in additional demand for transit services. This is typically an exogenous factor, outside of transit agency control. Growth assumed in the 2020 land use scenario (an input to the 2020 & 2025 TDFM models) was approximately +0.83%/year. For consistency, this same rate was used in the FARES modeling as the market-driven growth rate.

- **Service-driven Growth**: Service-driven growth reflects changes in transit service provision that are likely to impact ridership. In this study, the HART rail partial-opening and full-opening are the two major service-driven growth events that are foreseen. Based on the TDFM ridership forecast for 2020, it is projected that ridership will increase by approximately 8.0% from 2019 to 2020. Given the population density and higher transit usage at station locations in the full-opening segment, the increase in ridership due to the full-opening is anticipated to be substantially greater than for the partial-opening. Based on the TDFM model output, it is projected that ridership in 2025 will be 55% higher than it was in 2020. These two percentage growth rates were incorporated as service-driven growth factors.

- **Elasticity Rates**: Customer response to price changes are taken into account in the form of elasticity rate assumptions. Fare elasticities measure the percentage change in ridership resulting from a one percent increase in fare price. CH2M performed a literature review in order to determine the most applicable elasticities for HART, as historical elasticity data for TheBus was not available.
elasticities were recommended for adult, senior/disabled/Medicare, youth, and tourist customer categories. As part of a sensitivity analysis, CH2M provided both moderate and high sensitivity elasticities. A CH2M technical memo (included as Appendix B) provides additional detail. For the Baseline scenario, there are no assumed fare changes, so elasticity impacts are not taken into account, however, elasticity will be a consideration in future fare scenarios where prices are adjusted. Table 4-1 outlines the current elasticity assumptions in the FARES model.

<table>
<thead>
<tr>
<th>Customer Category</th>
<th>Moderate Sensitivity Elasticity</th>
<th>High Sensitivity Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>-0.30</td>
<td>-0.38</td>
</tr>
<tr>
<td>Senior/Disabled/Medicare</td>
<td>-0.21</td>
<td>-0.26</td>
</tr>
<tr>
<td>Youth</td>
<td>-0.26</td>
<td>-0.32</td>
</tr>
<tr>
<td>Tourist</td>
<td>-0.42</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

• **Transfer Rates:** Transfer rates are used to convert boardings into linked trips, and linked trips form the basis for fare revenue estimation. Transfer rates typically remain relatively consistent over time, unless substantial service changes are introduced. In both 2020 & 2025, TheBus’ network will be reorganized to various degrees to support the partial and full rail openings. Some routes that duplicate rail service are likely to be re-routed to feed customers to rail. These types of service changes will increase system wide transfer rates. Specific transfer rates were taken as an output from the TDFM model. For years 2017 through 2019, a transfer rate of 1.17 is assumed. This rate implies that for every 100 linked trips, approximately 117 boardings would be taken. An alternate way of interpreting this rate is that approximately 17% of trips involve a transfer. This value is very close to the transfer rate of 1.18 estimated from the 2012 On-Board Survey. During the partial rail opening years, from 2020 to 2024, the transfer rate will increase to 1.20. Given the greater population density and higher transit usage at stations in the full-opening segment, a larger increase in transfer rate to 1.40 is expected in 2025.

Major changes in transfer rates are anticipated in 2020 and 2025. Estimated transfer rates are one of the outputs from the TDFM regional model.

• **Product Usage Rates:** Product usage rates allow for the conversion of linked trips into estimated product sales. One of the key assumptions of the FARES modeling methodology is that product usage rates (in terms of linked trips/product) remain relatively consistent over time. As such, the adjusted 2012 product usage rates developed in the earlier model validation effort are applied to all years from 2017 through 2029.

Variable assumptions that are assumed to change across scenarios include:

• **Fare Rates & Products:** Future structure scenarios will be developed in Section 5, with estimated ridership and fare revenue impacts estimated. For the Baseline scenario, the fares and products in place in 2016 are anticipated to remain in place through 2029.

• **Customer Migration between Products:** The FARES model includes a feature that allows customers to migrate, or shift, between products. This typically occurs when fare pricing (and hence trip multiples) change between products. Some of these migrations may be ridership and revenue neutral (e.g.: customers migrating between similarly priced Cash and Stored Value) and some may have ridership/revenue impacts (e.g.: customers taking advantage of a lower priced product when a competing product price increases).
5.0 Analysis of Fare Structure Alternatives

This section discusses the proposed fare structure alternatives, including major assumptions. Ridership and fare revenue results are summarized, along with any key observations that should be considered. Currently, the modeling assumes that partial HART rail launch is Jun-2020 (beginning of FY2021) and full HART rail launch is Dec-2025 (part way through FY2026).

5.1 Scenario 1 – Baseline Scenario

The Baseline scenario is a status quo scenario; it assumes that the existing fare structure and pricing remains in place through 2029 with minimal changes. All existing retail and institutional products remain in place and pricing is held to 2016 rates. Appendix C outlines the product and fare rate assumptions for the Baseline Scenario.

The introduction of electronic payment options in 2020, with the opening of HART rail, does introduce additional product options and could create some changes to the ways in which transfers are treated. Several assumptions have been made regarding changes to the fare structure beginning in 2020:

- Beginning in Jun-2020, it is assumed that cash will still be accepted, but that 100% of pass products (4-Day Pass, Monthly Pass, Annual Pass, Two-Year Pass, U-Pass, Other Institutional Passes) will be migrated to the electronic fare payment system and be vended on smartcard media exclusively. Since there are no price changes assumed, this results in no financial changes.
- Beginning in Jun-2020, Stored Value on smartcard would be introduced as a new product offering. It would be priced identically to Cash fares.
- Beginning in Jun-2020, transfers of any kind (bus-to-bus, bus-to-rail, rail-to-bus, rail-to-rail) will only be possible using smartcard fare media; cash fares will no longer entitle a customer to free transfers. For any pass customers, their experience is identical and no impacts are expected. For cash paying customers that relied on a transfer, it is assumed that 100% would migrate to Stored Value in order to take advantage of transfers. Some portion of cash paying customers that only make a single boarding would remain paying cash. Because Cash and Stored Value are priced identically, and because it is assumed that 100% of Cash customers requiring a transfer will migrate, this assumption results in no financial changes.

5.1.1 Ridership Forecasts

System wide boardings increase from 73.6M in 2017 to 125.8M in 2029. This represents a 70.8% increase in boardings over a 12-year period.

It is worth noting that when comparing ridership results from the Baseline scenario against historic, observed ridership, a gap has developed between 2012 and 2016. The development of estimates for 2012 were reasonably accurate, but the moderate growth assumed between 2012 and 2017 in the model has not occurred on the system. Beginning in 2014, the observed boarding and model estimates began to diverge. There are a number of factors that may have contributed to this situation, but the decreasing price of fuel beginning in May-2014 is likely a contributor. The result is that the model is currently estimating approximately 6M more boardings than are occurring on the system. If this is left as

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2 Historic, observed results reflect unaudited ridership and fare revenue data for FY2010 through FY2015, as provided by TheBus.
is, the model will over-estimate boardings over the 12-year period. Figure 5-1 compares historic, observed boardings against the estimates from the Baseline scenario.

**Figure 5-1: Comparison of Historic, Observed Boardings against Baseline scenario Boardings**

![Comparison of Historic vs. Forecast (Baseline) Boardings](image)

5.1.2 **Fare Revenue Forecasts**

System wide fare revenue increases from $58.8M in 2017 to $86.9M in 2029. This represents a 47.8% increase in fare revenue over a 12-year period.

As with the ridership forecast, the fare revenue forecast suffers from a similar gap between reported and estimated FY2016 revenue. The model is currently estimating approximately $4.4M more fare revenue than what is currently being reported system wide. If this is left as is, the model will over-estimate fare revenue over the 12-year period. Figure 5-2 compares historic, reported fare revenue against the estimates from the Baseline scenario.
5.2 Scenario 2 – ‘Cost of Living’ Scenario

The second scenario considered was a ‘cost of living’ scenario, whereby fare prices increase annually by a consistent percentage. All other assumptions in this scenario match the Baseline scenario.

Based on data from the US Department of Labor, Bureau of Labor Statistics, the Honolulu Consumer Price Index for all items (CPI, All Items) averaged +2.8%/year from 2006 to 2015. This +2.8% increase was applied to all products annually, beginning in 2018. Fares were rounded to the nearest $0.05. Appendix D outlines the product and fare rate assumptions for the Cost of Living Scenario.

5.2.1 Ridership Forecasts

System wide boardings increase from 73.6M in 2017 to 111.4M in 2029. This represents a 51.2% increase in boardings over a 12-year period. Figure 5-3 compares Baseline scenario boardings against Cost of Living scenario boardings.
5.2.1 Fare Revenue Forecasts

System wide fare revenue increases from $58.8M in 2017 to $105.6M in 2029. This represents a 79.7% increase in fare revenue over a 12-year period. Figure 5-4 compares Baseline scenario fare revenue against Cost of Living scenario fare revenue.

Figure 5-4: Comparison of Baseline scenario vs. Cost of Living scenario Fare Revenue
5.3 Potential Fare Policy Structures/Attributes for Further Evaluation

As further fare policy alternatives are developed, several policy structures/attributes may be worthy of consideration. This section describes some of the policy structures/attributes in greater detail.

5.3.1 Fare Policy Structures

Two major fare policy structures are suggested for further analysis:

Flat Fare Structure – A flat fare structure assumes that products/fares will allow customers to board both bus and rail with no incremental charges. Essentially it treats bus and rail as an integrated system and supports it with an integrated fare structure. A flat fare structure would support greater integration between bus and rail networks, without necessarily imposing cost increases on customers.

Mode-specific Fare Structure – A mode-specific fare structure would maintain a flat-fare structure, however it assumes that rail is a premium service with a slightly higher fare. This structure would have different prices for bus and rail, for each customer category. It is likely that two unique Monthly/Annual passes per customer category would also be introduced; bus-only and bus & rail. Transfers between modes, with associated upcharges, would need to be considered carefully. A mode-specific structure might alter how TheBus structures their route network to connect with HART rail services. This structure is likely to result in higher fares for some portion of customers.

5.3.2 Product/Pricing Adjustments

In addition to the overarching fares structures outlined above, a number of product/pricing adjustments are presented for consideration. None of the product/pricing adjustments outlined below are mutually exclusive with the structures above; they can be combined in various ways.

Consolidate Annual & Two-Year Pass for Senior/Disabled Categories – The Annual and Two-Year passes for Seniors and customers with Disabilities both offer deep discounts for frequent use, and are priced similarly, but there is little demand for the Two-Year Pass. Currently, Two-Year passes are believed to account for <2% of system wide ridership. In a smartcard fare payment environment, features such as autoload (where an annual pass can be remotely loaded once a year) largely replicate the benefits of an entire separate, two-year product.

Consolidate Medicare Customer Eligibility into the Disabled Category – Transit operators receiving FTA Section 5307 funds for fixed route transit services are required to provide fares at half the price of the Adult fare for elderly customers, customers with disabilities and Medicare card holders. While the regulation is clear regarding discounts, it provides flexibility as to how agencies structure their fare categories. Some agencies have combined Senior, Disabled and Medicare customers into a single category (e.g.: Portland TriMet, Seattle ORCA), while others offer a distinct Senior category, but a combined Disabled/Medicare category (e.g.: Los Angeles Metrolink) for ease of eligibility confirmation. By definition, Medicare recipients must be either 65+ years old, or under 65 but with a disability, including end stage renal disease. With consolidated fare categories, some customers presenting a Medicare card would be eligible for Senior fare products (identical to the current situation, whereby Medicare customers 65+ are already eligible for Senior products), while the remainder would fall under a consolidated Disabled/Medicare category.

Re-evaluate Senior Cash, Monthly and/or Annual pass prices – The pricing for Senior customers, particularly the Monthly and Annual Passes, offers significant discounts over similarly priced Adult products. Currently, Senior Monthly Passes are 8% of the price of an Adult Monthly Pass. As noted in
Section 2.2.2, Senior customers have a fairly even income distribution, suggesting some opportunity to adjust pricing, independent of the Disabled & Medicare categories. Care should be taken to ensure that Senior pricing continues to abide by FTA guidelines.

As a starting point for evaluating alternative prices, it may be valuable to evaluate a Monthly Pass priced at 10% - 25% of the relevant Adult Monthly Pass price\(^3\). This would imply an increase to $6 to $15/month, and would imply a breakeven of ~6 to 15 trips per month, still well below the trip rate of 32-35 boardings/month indicated by historic GFI reports. Assuming a similar multiple of 6X the Monthly Pass price, the Annual Pass would increase to $35 to $90/year. In addition to ridership and fare revenue implications with this alternative, the political implications should be weighed carefully.

**Re-evaluate 4-Day Pass Pricing** – In late-2013, the price of the 4-Day Pass was increased from $25 to $35, or an increase of +40%. Comparing product sales for the 12-months prior to the increase, vs. product sales for the 12-months after the increase, total product sales decreased by -54%. The observed elasticity, or customer price response, was -1.34. Typically, elasticity rates fall between 0 and -1.0; an observed elasticity rate of -1.34 provides a strong indication that the product has been priced outside the range that customers are willing pay. It is likely that most of these customers would have migrated back to paying individual cash fares. It may be useful to assume 2.0-3.0 trips/day as an initial starting point to evaluate 4-Day Pass pricing; this would imply evaluation of prices in the $20 - $30 range.

**Re-evaluate U-Pass Opt-In Pricing** – Between 2012 and 2016, the price of U-Pass Opt-In semester passes increased from $125 to $225 over three successive increases. Over that same timeframe, U-Pass Opt-In participation has decreased by more than 50%. After the most recent increases in Fall-2015 & Spring-2016, the observed elasticity responses among customers ranged from -0.97 to -1.35, as demonstrated in Table 5-1 below. Similar to the 4-Day Pass pricing situation, the observed elasticity rates provide a strong indication that the product has been priced outside the range that customers are willing pay. As an initial starting point, a Fall/Spring semester rate of $150-$175 may be appropriate.

| Table 5-1: Observed changes in U-Pass Opt-In Pricing & Product Sales |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| U-Pass Opt-In - Quant.          | 5,311     | 4,782        | 4,919     | 4,445         | 4,856     | 4,243         | 4,753     | 4,026         | 2,621     | 2,065         |
| U-Pass Opt-In - Price           | $125.00   | $150.00      | $150.00   | $150.00       | $150.00   | $150.00       | $150.00   | $200.00       | $225.00   |
| Implied Trips/Month            | 10.00     | 12.00        | 12.00     | 12.00         | 12.00     | 12.00         | 12.00     | 12.00         | 16.00     | 18.00         |
| % Chg. in Quant                | -7.4%     | -44.9%       | -48.7%    |               |           |               |           |               |           |
| % Chg. in Price                | 20.0%     |               |           |               |           |               |           |               |           |
| Obs. Elasticity                | (0.37)    |               |           |               |           |               |           |               | (0.97)    |

**Location-based Pricing, for Select Locations** – For locations that are deemed to offer access to special services, or where competing modes offer services at a higher rate, location-based pricing could be considered. In particular, location-based fares for customers departing the Honolulu International Airport may be worth exploring. The location based charge would apply to trips originating at HIA, beginning no earlier than service launch in 2025. Depending on preferences, this price could apply to Stored Value/4-Day Pass exclusively, or across all products.

**Introduction of a Fare Differential between Cash & Stored Value** – A small fare discount for customers choosing to pay with electronic fare media is likely to encourage migration to the electronic payment system upon launch. Among transit agencies that offer a fare differential, the value varies but typically falls between 5% and 20%. Specific consideration of Title VI issues would be needed for this proposal.

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\(^3\) Portland Tri-Met currently offers elderly customers 65+ a $28 Monthly Pass, priced at 28% of the Adult Monthly Pass price ($100).
Appendix A – Calibration & Validation of TDFM Model

The TDFM regional model was updated and calibrated, with support from the OahuMPO, to reflect the modeling needs of this study. The intention of revisiting some of the inputs/calibration results was to ensure that the model reasonably reflects past, observed ridership results while continuing to provide reasonable future forecasts. Several specific updates to the TDFM TransCAD model included increasing local roadway networks in new subdivisions, adjusting the transit walk access link distance to a maximum of one mile, and adjusting the HART rail operating speed to match current operational assumptions.

A first step in the validation of the TransCAD model results was to compare the outputs against those estimated in the MINUTP model. A comparison was necessary because MINUTP was used for the FFGA and post rail implementation results will be compared with this model. In order to compare the models as closely as possible, outputs were compared in three separate years. Model results in 2012 assumed Bus-only transit services; however, both the 2020 and 2030 model results assume that HART rail to Ala Moana Center exists in the respective years. While the timing assumptions may no longer reflect project schedules, making this assumption was essential in order to compare the TransCAD and MINUTP results. Table A-1 compares the model results between MINUTP and TransCAD.

### Table A-1: Validation of TransCAD model against past MINUTP results

<table>
<thead>
<tr>
<th>Year &amp; Model Run</th>
<th>Walk Access Max Distance</th>
<th>Transit Boardings</th>
<th>Rail Boardings</th>
<th>Transit Trips</th>
<th>Transfer Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 Observed</td>
<td>223,871</td>
<td>188,170</td>
<td></td>
<td></td>
<td>1.19</td>
</tr>
<tr>
<td>2012 TransCAD</td>
<td>1</td>
<td>214,299</td>
<td>183,587</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td>2012 MINUTP</td>
<td>2</td>
<td>251,967</td>
<td>185,610</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>2020 TransCAD Half NIA</td>
<td>1</td>
<td>391,424</td>
<td>95,298</td>
<td>279,060</td>
<td>1.40</td>
</tr>
<tr>
<td>2020 MINUTP</td>
<td>2</td>
<td>409,585</td>
<td>101,505</td>
<td>258,073</td>
<td>1.59</td>
</tr>
<tr>
<td>2030 TransCAD Half NIA</td>
<td>1</td>
<td>444,405</td>
<td>119,380</td>
<td>313,112</td>
<td>1.42</td>
</tr>
<tr>
<td>2030 MINUTP</td>
<td>2</td>
<td>461,962</td>
<td>121,939</td>
<td>288,456</td>
<td>1.60</td>
</tr>
</tbody>
</table>

The 2012 TransCAD results line up relatively well against observed values. Both transit boardings and linked trips are within several percentage points of 2012 ridership. In 2020 & 2030, the HART rail boardings are similar between the two models, and the total transit boardings are also reasonably close to one another (within 5%). However, the number of linked trips is higher in the TransCAD model results in both 2020 and 2030, due to a lower transfer rate. This difference in transfer rates is likely due in part to a difference in transit network assumptions between TransCAD and MINUTP; MINUTP assumed a feeder transit network design that encouraged higher transfer rates.

Beyond the transfer rates, there remain some key differences between the TransCAD and MINUTP models, around the land use projections and included highway projects. In general, the TransCAD model assumes a lower population/households forecast, but a higher employment forecast. This may explain the slightly lower boarding forecasts in the TransCAD models. The TransCAD model is also missing several of the 2006 RTP projects that were assumed in the MINUTP model, so network congestion in the TransCAD model is slightly worse, and thus makes transit slightly more attractive than it would be.
otherwise. Table A-2 compares the population, employment and Household assumptions between the TransCAD and MINUTP models.

Table A-2: Comparison of Population, Employment & Households between TransCAD and MINUTP

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Employment</th>
<th>Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020 TransCAD Half NIA</td>
<td>1,010,442</td>
<td>604,221</td>
<td>335,829</td>
</tr>
<tr>
<td>2020 MINUTP</td>
<td>1,037,252</td>
<td>588,030</td>
<td>360,525</td>
</tr>
<tr>
<td>2030 TransCAD Half NIA</td>
<td>1,078,968</td>
<td>645,849</td>
<td>360,602</td>
</tr>
<tr>
<td>2030 MINUTP</td>
<td>1,117,332</td>
<td>632,711</td>
<td>396,925</td>
</tr>
</tbody>
</table>

Specific highway projects missing from the TransCAD model, include:
- Central Mauka Road
- Wahiawa Second Access Road
- Nimitz Flyover (HOV project)
- Waianae Second Access Road
- PM zipper lane
- Kapolei Parkway connection to Koolina
- Kapolei Interchange modification, and Hanua Road Extension from H-1 into Kalaeloa

Having confirmed that the TransCAD model assumptions and results compare favorably against the MINUTP estimates, the TransCAD model was setup to run the four scenarios described previously. Table A-3 shows the results of the TransCAD model with the inputs, assumptions and results for each of the four scenarios.

Table A-3: Comparison of TransCAD inputs, assumptions and results, by scenario

<table>
<thead>
<tr>
<th>Model Scenario</th>
<th>2012 Calibrated Model</th>
<th>2019 Pre-Opening Model</th>
<th>2020 Partial-Opening Model</th>
<th>2025 Full-Opening Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail Transit Network</td>
<td>N/A</td>
<td>N/A</td>
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<td>15 min, all day</td>
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Model Results (Average Weekday Boardings)

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<td>231,069</td>
<td>239,365</td>
<td>296,125</td>
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<td>Rail Boardings</td>
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<td>Transit Boardings</td>
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The results from these four scenarios become the key inputs into the FARES modeling process.
Appendix B – Fare Elasticity Technical Memo

HART Fare Study – Technical Memo for Transit Fare Elasticity Specification

PREPARED FOR: Whitney Birch, HART
PREPARED BY: Andrew Amey and Brian Mitchell, CH2M
DATE: September 28, 2016 (draft 2)

In support of the development of ridership and revenue forecasts, CH2M has prepared the following report outlining transit fare elasticities specified in the CH2M FARES Model.

Introduction

In economic theory, a price elasticity is a measure of the resulting change in a product’s demand given a change in the product’s price. Fare elasticities measure how responsive ridership is to a change in fare price. Formally, fare elasticities show the percentage change in ridership resulting from a one percent increase in fare price.

\[
\text{Fare Elasticity} = \frac{\% \text{ Change in Ridership}}{\% \text{ Change in Price}}
\]

Fare elasticities are typically negative. This implies that an increase in price will lead to a decrease in ridership. Fare elasticities generally range from zero (0) to negative one (-1). This implies that a one percent increase in fare price will lead to a less than one percent decrease in ridership.

Selection Methodology

Many transit agencies estimate fare elasticities by using statistical models. These models analyze historic ridership and fare level data to determine elasticity values. This method requires that fare prices have changed over time. Fare levels for DTS/The Bus have remained constant for several years. Therefore it is not possible to statistically model fare elasticities using DTS/The Bus data.

While it is not possible to directly estimate fare elasticities for this study, considerable research has been done in the field of transit fare elasticity estimation. CH2M performed a literature review in order to determine the most applicable elasticities for HART. In order to provide the most defensible elasticity recommendations, CH2M focused on research papers which used advanced statistical methods and data from a large number of transit agencies.

Researchers have estimated a wide range elasticities for specific scenarios. Fare elasticities have been estimated by mode type, customer category, fare product, time of day, etc. HART has requested that elasticities are differentiated by customer category. Specific elasticity recommendations were made for adult, senior/disabled/Medicare, youth, and tourist customer categories.

As part of a sensitivity analysis, CH2M provided both moderate and high sensitivity elasticities. The moderate elasticities were derived directly from research studies. In order to create the high sensitivity elasticity scenarios, moderate elasticities were increased by 25%. Increasing the elasticities by 25%
implies that customers are 25% more responsive to price changes compared to the moderate elasticity scenario.

Elasticity Recommendations

Descriptions of the recommended elasticities are listed below. The table at the conclusion of the section lists all final recommended elasticities. Sources for the described research papers are listed at the conclusion of Appendix B.

Adult

Adult riders comprise the largest share of riders for most transit agencies. Adult riders are typically a diverse group comprising a wide range of incomes, auto availability, and trip purposes. Research does not typically specify adult customer elasticities as these riders are seen as reflective of overall travel behavior for transit agencies. The Transit Cooperative Research Program (TCRP) commissioned a report documenting transit traveler responses to pricing and fare changes (TCRP Report 95, chapter 12). This report included a summary of prominent fare elasticity research efforts. The report found that the average fare elasticity for cities with populations between 500,000 and 1 million residents was -0.30. This implies that a one percent increase in fares will lead to a 0.30% decrease in ridership. This elasticity rate is appropriate as it corresponds to the current DTS/The Bus service area population. Additionally, this elasticity rate is consistent with values previously estimated and used by CH2M in prior fare studies. The recommended moderate sensitivity adult elasticity is -0.3 and the recommended high sensitivity adult elasticity is -0.38.

Senior/Disabled/Medicare

Reduced fare riders including senior, disabled, and Medicare customers are more likely to be transit dependent than adult customers. Therefore, it is expected that these customers are less responsive to price changes than adult riders. The Transit Cooperative Research Program (TCRP) Report 95 chapter 12 also included a discussion of transit elasticities for reduced fare customers. The report found that the average senior/disabled/Medicare fare elasticity was -0.21. This implies that a one percent increase in fare price will lead to a 0.21% decrease in ridership. This value supports the claim that senior, disabled, and Medicare riders are less sensitive to price changes. The recommended moderate sensitivity senior/disabled/Medicare elasticity is -0.21 and the recommended high sensitivity elasticity is -0.26.

Youth

Fare elasticity rates estimated for youth riders range widely depending on age classifications, time of day, and geographic location. This wide range of elasticity rates makes it difficult to recommend a previously estimated elasticity value for youth riders. Youth riders are considered to be less price responsive than adult riders. Youth riders are typically not of the age to operate vehicles and tend to make a large number of school based trips. However, youth riders in the regions surrounding Honolulu have access to several alternative transportation services. As a result, youth riders are expected to be more price responsive than reduced fare riders. Given these considerations, the youth elasticity rate is calculated as the midpoint between the adult and senior/disabled/Medicare elasticity rates. The recommended moderate sensitivity youth elasticity is -0.26 and the recommended high sensitivity elasticity is -0.32.

Tourist

Tourists are assumed to be less transit dependent than other customer categories. These customers are typically higher income, are making discretionary trips, and have greater transportation alternatives. The
recent rise in popularity in ride sharing services, such as Lyft and Uber, has also had an impact on tourist travel. The addition of these services has provided tourists with more transportation alternatives. This in turn has made tourists even more sensitive to transit price changes. There is currently a lack of research regarding tourist transit price sensitivity. Given that tourists are not transit dependent and are making discretionary trips, it was assumed that tourist travel patterns most closely reflect off-peak travel patterns. The American Public Transit Association (APTA) published the report “Fare Elasticities and Its Application to Forecasting Transit Demand” which used statistical models to estimate elasticities for a wide range of trip types and service types. This report found that off-peak trips typically have an average elasticity of -0.42. This implies that a one percent increase in fare would lead to a 0.42% decrease in ridership for off-peak trips. This elasticity value was much larger than that for adult riders, which implies that tourists are more responsive to price changes than adult riders. The final recommended moderate sensitivity tourist elasticity is -0.42 and the high sensitivity tourist elasticity is -0.53.

Table B-1: Summary of Recommended Elasticities

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<th>High Sensitivity Elasticity</th>
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<td>-0.53</td>
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Research Sources

TCRP Report 95, Chapter 12
APTA “Fare Elasticities and Its Application to Forecasting Transit Demand”
# Appendix C – Baseline Scenario Fare Table

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## Appendix D – Cost of Living Scenario Fare Table

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