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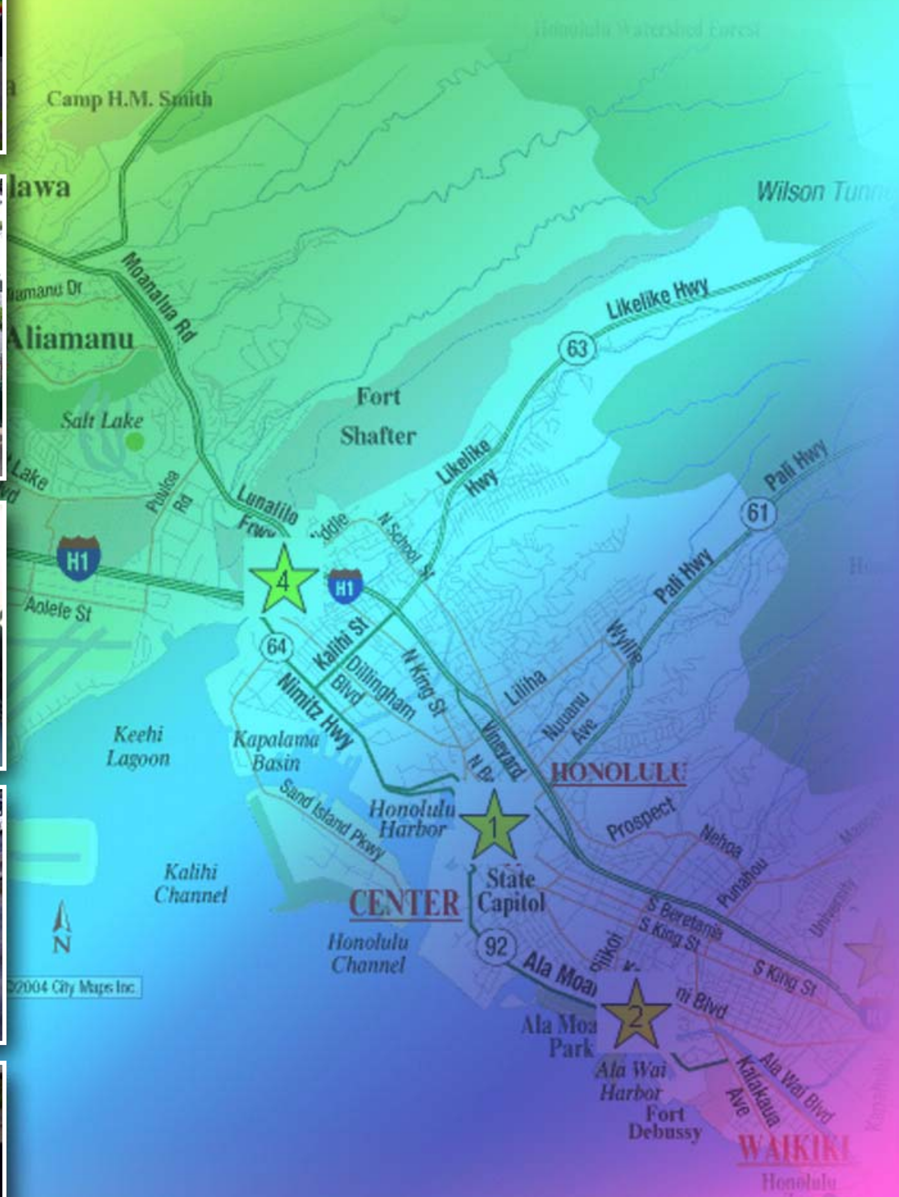
Honolulu
Bus Rapid Transit (BRT)
Project Evaluation
Final Report





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This reference document was prepared for the Office of Research, Demonstration and Innovation of the Federal Transit Administration (FTA). This case study evaluation of the Honolulu bus rapid transit project is intended to support FTA's ongoing research on bus rapid transit (BRT) project planning, development and implementation. This report presents a comprehensive assessment of the applications of BRT elements in Honolulu, per the evaluation framework outlined in the Characteristics of Bus Rapid Transit (CBRT) report. Information is presented on a broad range of applications of key elements of BRT – running ways, stations, vehicles, fare collection, intelligent transportation systems (ITS), and service and operating plans. This evaluation also investigates system performance in several key areas, including reducing travel time, improving reliability, providing identity and a quality image, improving safety and security, and increasing capacity. The evaluation concludes with an assessment of important system benefits, including transportation system benefits (increasing ridership, and improving capital cost effectiveness and operating efficiency) and community benefits (transit-supportive development and environmental quality).

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

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1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

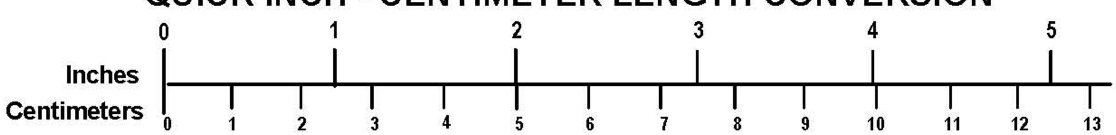
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures.
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Updated 6/17/98

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LIST OF EXHIBITS

LIST OF ACRONYMS

APTS	Automated Public Transportation Systems
AVL	Automatic Vehicle Location
BRT	Bus Rapid Transit
CAD	Computer Aided Dispatch
CBD	Central Business District
CBRT	Characteristics of Bus Rapid Transit
DTS	Department of Transportation Services
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
GPS	Global Positioning System
HOV	High-Occupancy Vehicle
IOS	Initial Operating Segment
ITS	Intelligent Transportation Systems
LPA	Locally Preferred Alternative
MIS	Major Investment Study
OMPO	Oahu Metropolitan Planning Organization
OTS	Oahu Transit Services, Inc.
SDEIS	Supplemental Draft Environmental Impact Statement
SDOT	State Department of Transportation
TVM	Ticket Vending Machine

EXECUTIVE SUMMARY

The Honolulu BRT system is a case study of the benefits and costs of a limited BRT deployment in a city of about 900,000 inhabitants. With minimal capital investment, the current three routes of the Honolulu BRT system (Routes A, B, and C) have primarily served to reduce travel times (as much as one-third) and improve services for existing and new riders, most of whom switched from local routes to BRT routes. Route E was implemented in November 2004 as part of the BRT system, but discontinued in June 2005 due to poor performance. Moreover, the corridors served by BRT were better able to maintain or slightly increase ridership levels despite systemwide decreases in ridership. The findings from the evaluation illustrate the positive benefits from a BRT system of limited investment.

The features of this BRT system are limited compared to typical BRT characteristics, but have key attributes that distinguish the system over local routes:

- While Routes A and B (and E before being discontinued) run primarily on mixed-flow conditions (i.e., no dedicated lane), Route C has a non-stop express segment of about 17.5 miles on the H-1 Freeway, where the buses run on a HOV lane or contra-flow lane called Zipper Lane during the peak periods. This gives Route C an advantage of higher speeds and reduced travel time over its comparable local routes.
- Station stop distance for BRT routes has been one of the primary drivers in decreasing travel times compared to local routes. Though stop distance for Route B is short compared to typical BRT (one third of a mile compared to the average three quarters to one mile stop spacing), all of the routes have an average stop distance greater than their comparable local routes.
- Improved stop shelters were constructed on the now discontinued Route E. Ten hybrid-diesel buses were bought for Route E but are now being used on Route A.
- ITS technologies such as traffic signal priority and real-time information systems were tested on BRT routes to provide higher-quality service over local routes, but were never fully implemented, with only automatic vehicle location technology being used.

Aside from decreasing travel times by increasing station stop distances and the frequency of services on certain corridors, the Honolulu BRT routes have had mixed performance in terms of efficiency and reliability of operations when compared to local routes.

The BRT routes achieved some minor cost decreases from the increase in operating speeds and comparable cost increases from the use of articulated vehicles with their higher maintenance and fuel costs. The differences in operating costs were driven at least in part by the vehicle size and types in use and the alignment of the routes, with the articulated buses on Routes A and C being more costly to operate than standard 40' buses used primarily used on local routes. Route B was on average slightly less costly than Routes 2/13.

The capital costs of the BRT routes were relatively small, although cost data was only provided for Route E. The total Route E capital costs include a design contract of $4 million for the Iwilei to Waikiki alignment and construction costs of approximately $23 million, although a breakdown of these costs was not available. The total Route E capital cost of approximately $27 million equates to $4.5 million per mile based on a length of 6 miles. This is slightly higher than typical BRT projects with little or no investments in running way segregation or grade separation. The capital investment for Routes B and C, though not provided in detail, were also small but consistent with BRT projects of minimal running way segregation and/or grade separation.

Greater benefits in terms of improving ridership, customer satisfaction, capital and operating cost effectiveness, transit supportive land use, and environmental quality may be possible with more significant investments in dedicated running ways, advanced vehicles, stations, ITS elements, and fare collection.

1.0 INTRODUCTION

This research study is supported through the Federal Transit Administration (FTA) Bus Rapid Transit (BRT) Initiative, which investigates the technologies and advanced operational capabilities of BRT systems and facilitates the implementation of successful BRT projects throughout the United States. The specific objectives of FTA's BRT Initiative are to examine:

- The improvements in bus speeds and schedule adherence
- The ridership impacts as a result of improved quality of service
- The impacts of each of the components of BRT on bus speed and other traffic
- The benefits of Intelligent Transportation Systems (ITS) and Automated Public Transportation Systems (APTS) applications
- The effects of BRT systems on land use and development.

This study presents a detailed evaluation of the BRT services in Honolulu, Hawaii. The Honolulu BRT evaluation activities began on March 10-11, 2005 with a project kick-off meeting, and were then followed by a July 28-29 project status update meeting. The data presented in this evaluation were collected according to the Honolulu BRT Evaluation Data Collection Plan dated April 19, 2005.

In accordance with the evaluation framework outlined in the Characteristics of Bus Rapid Transit for Decision-Making (CBRT) report, this evaluation is organized into the following sections:

- Section II: Project Description
- Section III: Planning, Design and Implementation
- Section IV: System Performance
- Section V: System Benefits and Costs
- Section VI: Conclusions

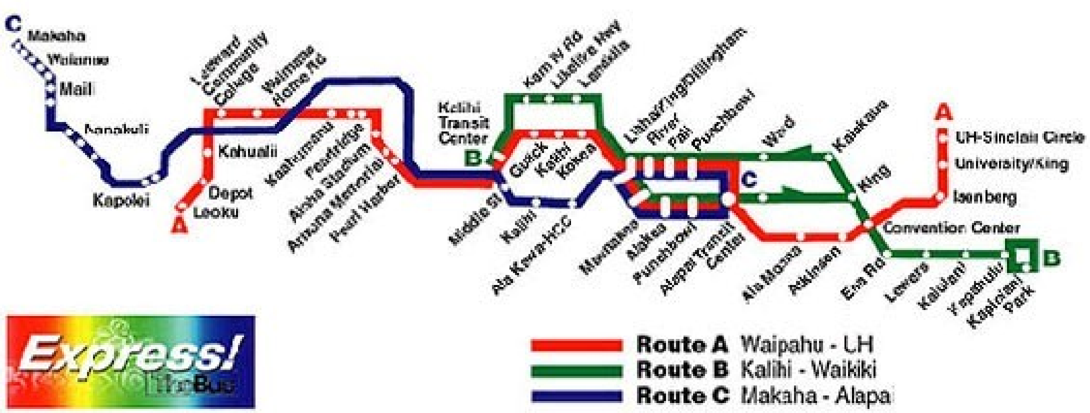
2.0 PROJECT DESCRIPTION

The City and County of Honolulu in Hawaii has a population of approximately 900,000. TheBus is the fixed route transit system for the City and County of Honolulu. The City's Department of Transportation Services (DTS) provides management and oversight for TheBus. Since 1992, the City has contracted with Oahu Transit Services, Inc. (OTS) for operations of TheBus. OTS is a non-profit corporation that was established as an entity of the City.

TheBus system includes a family of express bus services known as "Express!" designed to improve travel times for several major intracity and interregional transit routes:

- **Route A: CityExpress!** – a 19-mile urban route connecting Waipahu, Pearl City, Downtown Honolulu, and the main University of Hawaii (UH) campus in Manoa. Route A was the first of the four BRT routes to begin operations, in March 1999.
- **Route B: CityExpress!** – an 8-mile urban route connecting Kalihi, Downtown Honolulu, and Waikiki. Route B began operations in August 2000.
- **Route C: CountryExpress!** – a 39-mile suburban route connecting the Leeward coast (Makaha, Nanakuli), the "Second City of Kapolei", and Downtown Honolulu. Route C began operations in May 2000.
- **Route E: TheTransit** – a 6-mile urban route connecting Downtown Honolulu, Ala Moana, and Waikiki. Route E began operations in November 2004 but was discontinued on June 12, 2005 due to poor performance.

The map below shows the layout and the major stops along the three routes currently in operation (not to scale). The image also shows the "Express!" logo used to promote the BRT services.



These routes can be classified as Bus Rapid Transit (BRT), or an integrated package of rapid rubber-tire transit elements that, taken together, create an improved service that is distinct from a local bus service. Routes A, B, and C (also the discontinued Route E) possess several key elements typical of BRT systems, and the basic service package reflects a strategic desire on the part of DTS to create a transit product distinct from more conventional local bus service. With new growth in outlying areas of coastal Oahu and the expansion of the Honolulu metropolitan area, DTS identified growing demand for high-quality express routes serving longer distance trips along the southern Oahu coast. In the future, DTS is planning to introduce Intelligent Transportation System (ITS) and other BRT elements to these routes to enhance overall system performance. At the time of this report, DTS had suspended the implementation of off-vehicle fare collection as part of the BRT program.

Route A, B and C make use of existing TheBus shelters and stop locations, with a few minor station enhancements designed into the routes. For example, curb heights at several Route E stop locations were modified to allow for more level boardings with low-floor vehicles. Routes A and C are operated primarily with 60’ articulated buses, with 40’ buses used as replacements. Route B is operated using conventional 40’ transit buses from the Oahu Transit Services fleet. Most of the buses assigned to the express routes are low-floor vehicles, and are assigned to both conventional local bus service.

Exhibit 1 summarizes the routes and project elements that comprise the Honolulu BRT services. A description of each element is then provided.

Exhibit 1: Honolulu BRT Project Elements

	Route A: City Express!	Route B: City Express!	Route C: Country Express!	Route E: TheTransit (discontinued)
Running Ways	19 miles in mainly mixed traffic	8 miles in mainly mixed traffic	39 miles in HOV freeway lane +	6 miles in mainly mixed traffic
Stations	shelters, benches	shelters, benches	shelters, benches	shelters, benches
Vehicles	Mainly 60’ Diesel and hybrid articulated (reallocated buses from discontinued Route E), some 40’ diesel	Mainly conventional 40’ high-floor bus, some low-floor, 60’ articulated diesel buses if available	Mainly 60’ Diesel articulated buses	10 New hybrid-electric 60’ articulated Silver buses, some standard 40’ high-floor buses
Fare Collection	farebox: cash, pass, transfer	farebox: cash, pass, transfer	farebox: cash, pass, transfer	farebox: cash, pass, transfer
Intelligent Transportation Systems **Installed**	Automated Vehicle Location (AVL)	Automated Vehicle Location (AVL)	Automated Vehicle Location (AVL)	Automated Vehicle Location (AVL)
Planned	Real-time information (not yet available)	Real-time information (not yet available)	Real-time information (not yet available)	Real-time information (tested but not available)
Service & Operations Plan	Limited stops; 7 to 15 min headways	Limited stops; 15 min headways	Limited stops; 30 min headways	Limited stops; 10 to 15 min headways (headway-based schedule)
Marketing & Branding	Kick-off events; website; logo and signs; system map	Website; logo and signs; system map	Website; logo and signs; system map	Kick-off events; website; special bus livery; logo and signs; system map

The following sections provide a more detailed description of Honolulu's express bus service by major BRT element:

- Running Ways
- Station
- Vehicles
- Fare Collection
- Intelligent Transportation Systems (ITS)
- Service and Operations Plans
- Marketing and Branding

2.1 RUNNING WAYS

Running ways refer to the space within which a transit service operates. BRT vehicles are rubber-tired and can operate on standard mixed traffic street and highway lanes. BRT running ways may (not in Honolulu) include segments of grade separated lanes and/or exclusive lanes. BRT vehicles need not operate in a single type of running way for the entire route length. Running ways are often one of the most critical elements in determining the speed and reliability of a BRT service.

One of the biggest challenges facing the deployment of BRT in Honolulu was the absence of roadway space that could be used as a dedicated transit running way. Early in the planning process, DTS and city officials expressed a desire to investigate dedicated transit lanes. Plans to investigate dedicated transit lanes, however, were scrapped in response to public concerns about the impacts on traffic congestion and vehicular mobility. The road system in Honolulu metropolitan area suffers from recurring peak traffic congestion, which has become a more visible quality of life issue. Plans to take away existing roadway space for transit purposes did not generate support from the community. Routes A, B and C operate on a small number of heavily traveled mixed traffic streets and highways.

Exhibits 2 through 5 provide more detailed maps of these services. The routes run mostly in general purpose on-street traffic lanes, with Route C being the major exception. Route C has a non-stop express segment of about 17.5 miles on the H-1 Freeway (from Makakilo, past the airport, to Dillingham Boulevard). During the weekday AM peak period, Route C vehicles use a Zipper Lane (explanation follows). During the weekday AM and PM peak periods, Route C vehicles may also use a high-occupancy vehicle (HOV) lane on the H-1 Freeway.

On weekday mornings from 5:30 am to 8:30 am, one westbound (non-peak flow) lane on the H-1 Freeway is reversed to the eastbound (peak flow) direction and is made available to buses, vanpools, and 3+ occupancy carpools. This lane, called the **H-1 Freeway Zipper Lane**, is facilitated through the use of a “Zipper Machine” that moves a string of concrete barriers to its proper position. **Exhibits 6 through 8** provide diagrams of the Zipper Lane and the Zipper Machine. **Appendix A** describes the impacts of the Zipper Lane on travel speeds.

For most of the day, the number of H-1 Freeway lanes in each direction is typically four eastbound and four westbound (exact number of lanes varies by segment). When the Zipper Lane is in operation, the number of lanes change to five eastbound and three westbound. During weekday mornings from 5:30 am - 8:00 am and afternoons from 3:30 pm to 6:00 pm, an HOV lane is open in peak-flow directions of travel on the H-1 Freeway for use by buses, vanpools and 2+ occupancy carpools.

While Route A also uses the H-1 Freeway for a shorter non-stop segment of about 3.5 miles, the route is not conducive to the Zipper lane. Route A vehicles do not use the HOV lane due to the need for the operator to enter and exit the freeway in a relatively short period of time.

Exhibit 2: Honolulu Route A

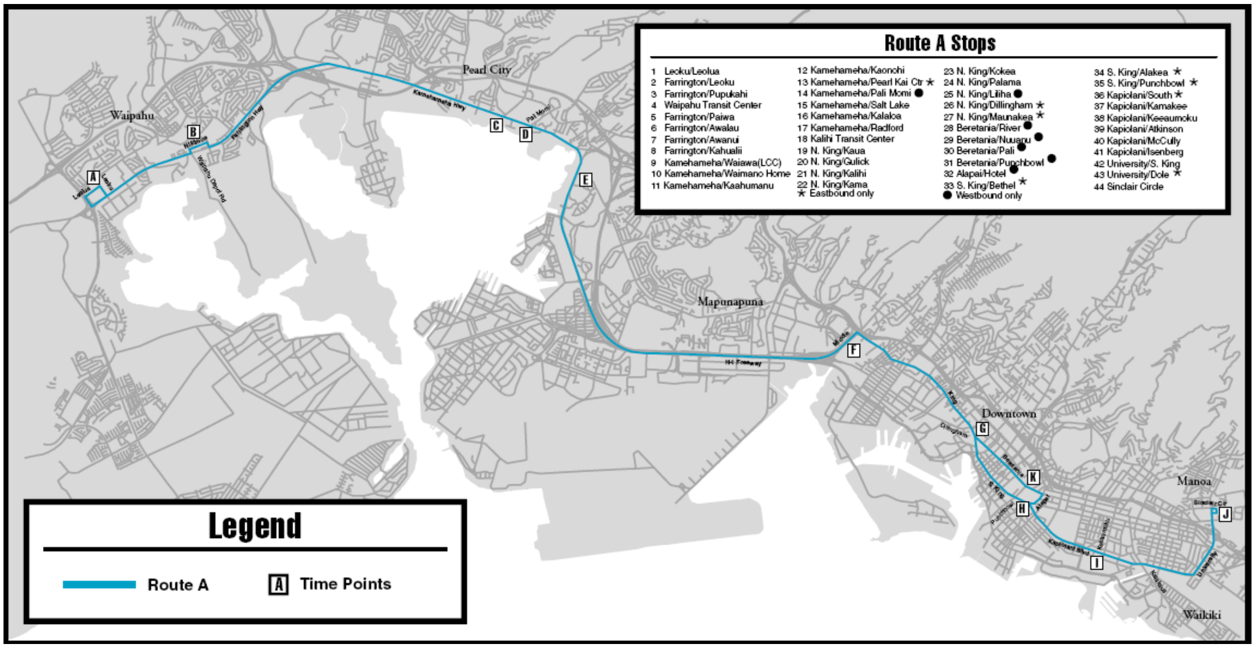


Exhibit 3: Honolulu Route B

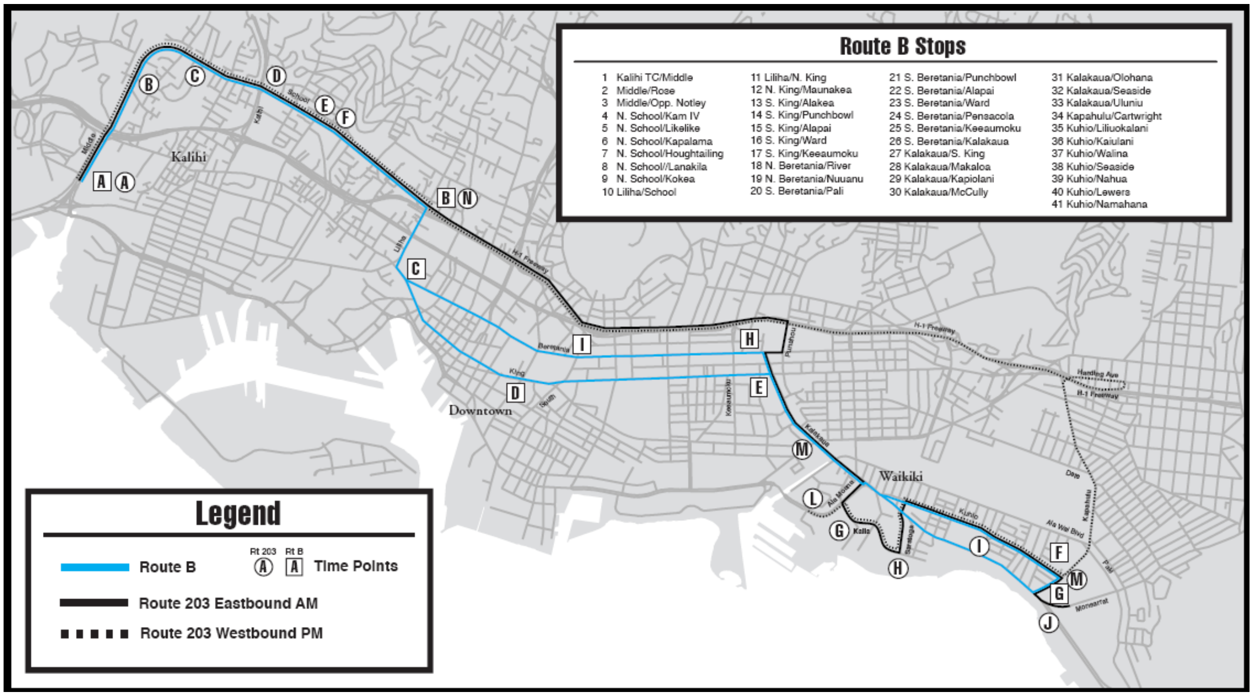


Exhibit 4: Honolulu Route C

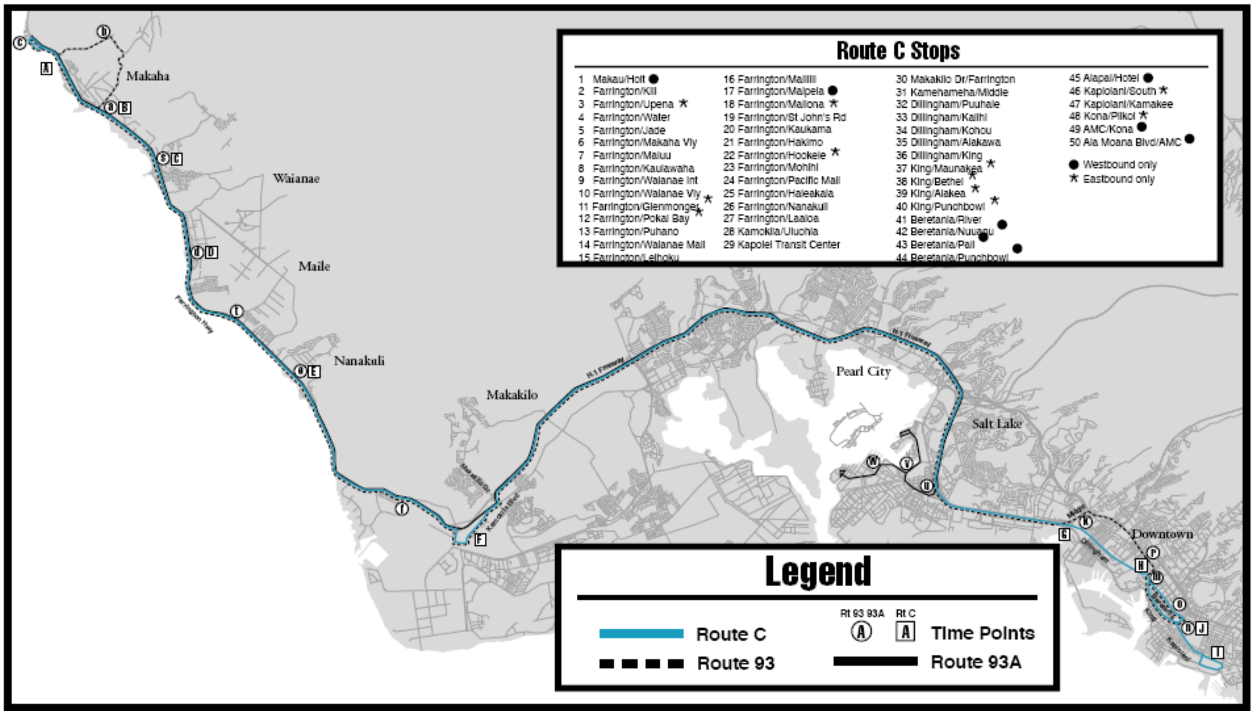


Exhibit 5: Honolulu Route E

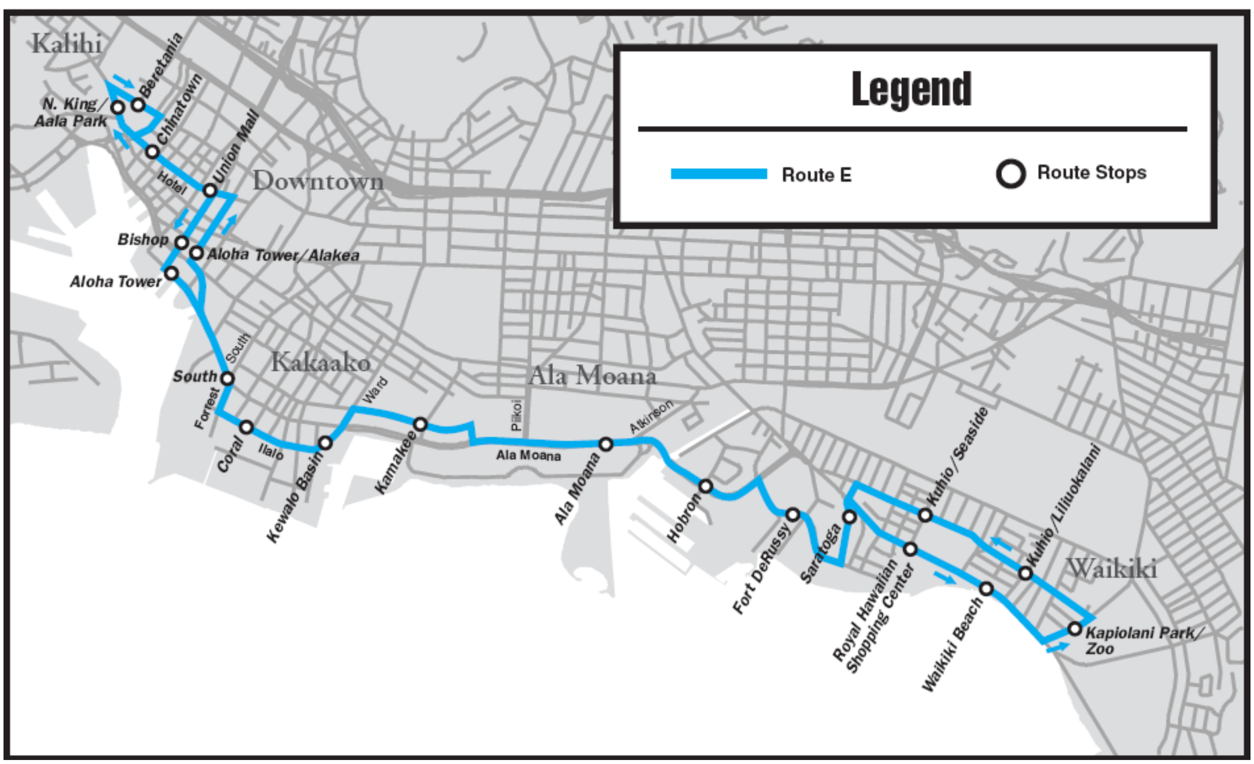


Exhibit 6: H-1 Freeway Zipper Lane Location

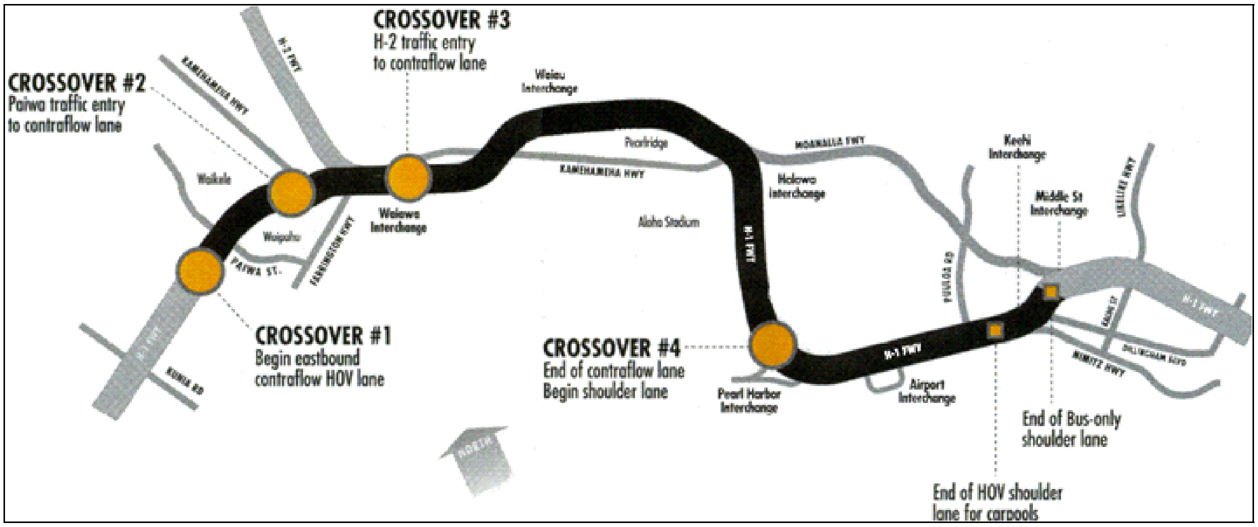


Exhibit 7: H-1 Freeway Zipper Lane Schematic

Exhibit 8: Zipper Machine

2.2 STATIONS

For Routes A, B and C, DTS did not construct enhanced express bus stations. For the most part, DTS used existing bus stops and shelters for express route pick-up locations. Signage at each station stop provides customer information on the location of express bus stops. Six enhanced transit stops were constructed along Route E with high curbs for use by wheelchair ramps of low-floor articulated buses.

Exhibit 9 identifies some of the major locations that are served by the BRT routes. These locations include:

1. Honolulu Central Business District (CBD): Honolulu's CBD, or Primary Urban Center, includes the Financial District, the Civic Center, and Chinatown.
2. Ala Moana Shopping Center: Honolulu's principal shopping center and transit center, served by more than 20 bus routes.
3. Pearlridge Shopping Center: The second largest shopping center in Honolulu, adjacent to Pearl Harbor to the west of the Honolulu CBD.
4. Kalihi Transit Center: Serves as a transfer point for some of the line haul bus routes with the highest ridership in the system.
5. Pearl Harbor Naval Base: One of the largest employers in Hawaii.
6. Hawaii Convention Center: Honolulu's convention center, same location on map as #2.
7. University of Hawaii at Manoa: Flagship university for the state of Hawaii.
8. Aloha Stadium: Multi-use sports stadium, especially University of Hawaii football games.
9. Arizona Memorial: One of the most popular tourist attractions in Hawaii.

Exhibit 10 provides a picture of a representative Honolulu BRT station. **Exhibits 11 and 12** provide pictures of a typical raised curb. **Exhibit 13** provides a picture of a typical wheelchair ramp.

Exhibit 9: Honolulu BRT Major Locations Served

Exhibit 10: Representative Station

Exhibit 11: Raised Curb

Exhibit 12: Raised Curb

Exhibit 13: Representative Ramp

2.3 VEHICLES

Vehicles for a transit service are characterized by factors that include the size, floor height, body type, propulsion system, seating and door arrangements, and aesthetics. Vehicles have a direct and significant impact on BRT service speed, capacity, comfort, and image.

The express routes are operated using a combination of standard and articulated buses assigned from TheBus total fleet. The OTS bus specifications dated June 1, 2005 indicate a total fleet of 525 motorbuses, which is composed of:

- 416 standard 40-foot motorbuses, with an average maximum capacity of 45 seated passengers and 23 standing passengers (total capacity of about 68).
- 72 articulated 60-foot motorbuses (30 year 2000 New Flyers; 16 year 2002 New Flyers; 16 year 2003 New Flyers; and 10 year 2004 hybrid electric New Flyers). These vehicles each have a maximum person capacity of 58 seated and 72 standing, for a total capacity of 130.
- 37 smaller 30- or 35-foot motorbuses.

OTS does not dedicate buses to a particular route. Current vehicle assignments typically vary on a day-to-day basis, within some general parameters:

- Articulated 60-foot motorbuses are used on Routes A and C.
- Standard 40-foot motorbuses are used on Route B.
- Route E primarily used the articulated, hybrid 60-foot motorbuses, prior to the route being discontinued.

Most of the buses are diesel-powered only. The ten 2004 hybrid-electric articulated buses went into service in November 2004, but were all temporarily pulled from service in October 2005 following three engine fires. Details of these incidents were not available for this report.

Exhibits 14 through 16 provide pictures of an articulated bus. Articulated 60-foot low-floor buses (diesel and hybrid-electric) have three doors and wheelchair ramps.

Exhibit 17 provides a picture of a conventional bus. Conventional 40-foot diesel buses have two doors and wheelchair lifts.

Exhibit 14: Articulated Bus (Diesel)

Exhibit 15: Articulated Bus (Diesel)

Exhibit 16: Articulated Bus (Hybrid-Electric)

Exhibit 17: Standard Bus (Diesel)

2.4 FARE COLLECTION

The Honolulu express services have the same fare collection procedures as the fixed route system – operator-enforced with electronic registering fareboxes used to collect cash fares. The services have the same fares ($2.00 adult cash fare; $1.00 for qualifying riders) as other fixed routes. More than 80% of Honolulu BRT riders board with a pass or transfer validated by the driver, as opposed to paying with cash. This high percentage, which helps speed up average boarding times, is achieved in part through deep discounts on the monthly passes ($40.00 for adults; $20.00 for youth; $5.00 for senior/disabled riders). **Exhibit 18** shows a typical on-board farebox.

Exhibit 18: Farebox

2.5 INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) include a variety of advanced transportation technologies that are typically applied to improve transportation operational efficiency or to provide riders with enhanced travel information. ITS applications are often integral to BRT operations and enhancing benefits.

The Honolulu BRT services feature the following ITS technologies:

- **An Automated Vehicle Location system**, using Siemens Global Positioning System (GPS) technology on-board the buses, became fully operational in April of 2005. Testing during the operation of Route E was inconclusive and the transit control center features were not fully implemented at the time of the test. Since then, the GPS feature has been implemented and used for route adherence, schedule adherence and headway management.
- **Automatic next-stop bus arrival information** on-board the vehicle and route announcements exterior to the vehicle, which also provide the date and time of day, were not fully operational during the initial analysis. All of the buses have been upgraded for this technology. The GPS network (for next-stop information) is available islandwide and results of an initial trial were good. Implementation of this feature throughout the system was completed in April 2005. **Exhibit 19** shows a picture of a typical on-bus information display.
- **Travel information display systems** were constructed at Route E stations, but were never fully operational with real-time bus arrival information. The initial next-bus display trial was inconclusive. Currently a two sign trial is underway and initial results look favorable. It is planned to deploy up to an additional 43 signs in 2006. The signs are designed to display scheduled and real-time vehicle arrival and departure times for multiple routes at a given location. The display system is also designed to provide ad hoc traveler bulletins. **Exhibit 20** shows a picture of a station information display.

In addition, the City utilizes a state-of-the-art **traffic management center**, equipped with an area-wide surveillance system that operates through closed circuit television cameras that are installed at select intersections and roadways within the Primary Urban Center. This technology helps monitor transit system reliability and to alert bus operators to traffic problems.

Exhibit 19: On-bus Information Display

Exhibit 20: Station Information Display

2.6 SERVICE AND OPERATIONS PLANS

The service and operations plan of a transit service refers to route length and alignment, station spacing, service span (hours of service provided by day of week), and service frequency (by time of day; by day of week). The service and operations plan determines the amount of operating resources invested in a particular service, and impacts the value of the service to its customers. BRT services often have fewer stops and higher frequencies than local services. BRT and local services can be used to serve the same corridor in a complementary fashion – the BRT service to provide high-speed service between major origins and destinations; the local service to provide local coverage.

Exhibit 21 provides the service spans and approximate headways of the four BRT routes (A, B, C & E), as compared to select local bus services that run along some of the same or parallel segments. The comparable local services were identified and validated with the help of DTS. The information provided for Route E corresponds to its service provision prior to its discontinuation in June 2005.

Exhibit 21: Headways by Route – BRT and Comparable Local Services

Route	Route Length	Avg. Stop Spacing (miles)	Weekday Span of Service	Weekday Headway (6am-6pm)	Saturday Span of Service	Saturday Headway (8am-6pm)	Sunday Span of Service	Sunday Headway (8am-6pm)
A	**19 miles**	**0.55**	**4:30am-10:30pm**	**15 min**	**5:00am-10:45pm**	**30 min**	**5:30am-9:30pm**	**30 min**
1	9 miles	0.14	4:00am-1:45am	8 min	4:15am-1:00am	10 min	5:00am-1:00am	15 min
3	14 miles	0.16	4:15am-1:30am	20 min	4:30am-1:15am	20 min	5:00am-1:00am	30 min
B	**8 miles**	**0.29**	**5:00am-11:00pm**	**15 min**	**5:00am-10:45pm**	**15 min**	**5:00am-10:45pm**	**15 min**
2/13	9 miles	0.15	4:15am-1:45am	6.5 min	4:30am-1:30am	6.5 min	5:00am-1:30am	7.5 min
C	**39 miles**	**0.98**	**3:45am-10:00pm**	**30 min**	**3:45am-10:00pm**	**30 min**	**3:45am-10:00pm**	**30 min**
40	39 miles	0.27	24-hour service	30 min	24-hour service	30 min	24-hour service	30 min
E	**6 miles**	**0.40**	**5:00am-12:00am**	**10 min**	**5:30am-12:00am**	**10 min**	**6:00am-12:00am**	**10 min**
19	17 miles	0.21	4:15am-1:45am	40 min	4:45am-1:45am	50 min	4:45am-1:45am	50 min
20	17 miles	0.23	5:15am-7:30pm	40 min	5:45am-6:45pm	50 min	5:45am-6:45pm	50 min
42	26 miles	0.24	4:15am-12:45am	30 min	4:30am-12:45am	30 min	4:45am-12:45am	30 min

Information provided is approximate based on posted schedules and milepost data.

Route A headways shown are based on trips that cover the full route alignment. There are also additional partial alignment trips (about 7 miles) that are not reflected in the table.

Route 2/13 headways shown are based on the common segment covered by both routes. Additional peak hour trips for Routes 2/13 and 19 are not reflected in the table.

Route E information provided is prior to the route's discontinuation in June 2005.

Common BRT routes station stop distance is between three quarters and a mile. Route A station stop spacing has lower-than-average station distances, averaging approximately one half a mile. However, this is greater than its comparable Routes 1 and 3, which have an average stop spacing of around 0.15 of a mile. Route B stop spacing was even lower, at under 1/3 of a mile, yet it is greater than the 0.15 of a mile average stop spacing of the comparable Route 2. Route C was more typical with common BRT station spacing, with average spacing at just under a mile. This is significantly greater than its comparable Route 40, which has an average stop spacing of 0.27 of a mile. Route E had an average stop spacing of 0.40 of a mile, which is almost double the average spacing of 0.22 of a mile of its comparable local service routes.

The weekday headways and number of stops by direction for each BRT route are as follows:

- **Route A: CityExpress!** – 15 minute headways (7 minute peak period headways on a partial alignment); 35 westbound stops along 18.7 miles; 34 eastbound stops along 19.5 miles.
- **Route B: CityExpress!** – 15 minute headways; 28 westbound stops along 8.0 miles; 29 eastbound stops along 8.5 miles.
- **Route C: CountryExpress!** – 30 minute headways; 39 westbound stops along 37.4 miles; 42 eastbound stops along 40.1 miles.
- **Route E: TheTransit** – (prior to discontinuation) 10 minute headways (headway-based schedule); 15 westbound stops along 5.5 miles; 15 eastbound stops along 6.1 miles.

A comparison of the BRT headways and average stop spacing with those of local routes is provided in Section IV: System Performance.

2.7 MARKETING AND BRANDING

The City of Honolulu took a proactive approach to marketing and branding during the implementation of the first BRT service, Route A, which was also marketed using a "CityExpress!" logo on maps and schedules:

- **Presentations** were made to numerous community and business organizations, neighborhood boards, and the University of Hawaii. Individual members of the City Council were briefed on the project.
- **Schedule and route information cards** were mailed to over 35,000 residents along and adjacent to the route.
- The **OTS "Ask Me" Program**, which uses employees returning to work from injuries, was used to provide schedule information to passengers at bus stops along the route.
- **Businesses along the route** were asked to promote the BRT service in their advertisements. For example, Zippy's Restaurant promoted the service by distributing 10,000 two-for-one breakfast coupons for Route A riders.
- **Opening ceremonies** were held at the Kalihi Transit Terminal, Chinatown, the Civic Center, and the University of Hawaii. Remarks were made by the Mayor, City Council members, and community representatives.
- An extension to Route A was also promoted with the fare being waived for the first week.

There was no additional marketing done for Routes B and C other than the standard signage, system map, and schedule information published on the website and on paper materials. Route B and C were also marketed using the "CityExpress!" and "CountryExpress!" logos, respectively, on maps, schedules and on the system website.

For Route E, ten new hybrid-electric buses were purchased and painted a special two-tone silver color. The only similarity to TheBus standard livery was a rainbow color scheme along the roofline. Route E was also marketed as "TheTransit" using the same marketing channels used by the other BRT services. In addition, a press event included an opening ceremony and remarks by the Mayor, City Council members, and community representatives.

3.0 PLANNING, DESIGN AND IMPLEMENTATION

3.1 INSTITUTIONAL SETTING

The City and County of Honolulu took control over the bus transit system in 1971 under Mayor Frank Fasi. The Department of Transportation Services (DTS) is a government department of the City and County of Honolulu. Its director is a mayoral political appointee who must be approved by the City Council. As a direct political appointee, the director serves at the pleasure of the mayor.

TheBus operates over 18 million vehicle service miles and carries more than 68 million passenger trips. This places TheBus among the top twenty most utilized bus systems nationwide. A one-month strike, in September 2003, by the bus workers resulted in a dip in ridership numbers. Current year projections return to previous levels. Since 1992, TheBus has been operated by Oahu Transit Services, which operates under a contract with DTS. It is a non-profit corporation established as an instrumentality of the city.

3.2 PROJECT PLANNING AND DESIGN

The BRT system planned for Oahu was one feature of a strategic transit service plan developed in the late 1990s by DTS to reconfigure the transit network to changing travel patterns and continued growth. DTS replaced the “radial” transit network with a “hub-and-spoke” system, which emphasized tiered services – local circulators, local routes and longer-distance express routes focused around the downtown Honolulu hub – to better meet the needs of the transit market. Under this new service paradigm, DTS designated transit centers as centralized hubs that connected both express and local circulator routes as major transfer locations.

DTS introduced the Leeward Oahu “hub-and-spoke” services in 2000, with gradual implementation of new routes throughout 2001 and 2002. DTS reports that the new services, which are comprised of local circulators, local bus routes and express services, more than doubled mid-day service levels in Leeward Oahu.

Outreach

The decision to investigate the feasibility of bus rapid transit for the Honolulu metropolitan area originated from an extensive public participation process in 1998 that led to the emergence of the hub-and-spoke service restructuring efforts. This process, formally known as “Oahu Trans 2K”, involved more than one hundred public meetings and included over a thousand Oahu residents and commuter members.

Based on the mass transit concepts identified through this process, County and City of Honolulu and the DTS completed a Major Investment Study (MIS) in August 2000, which recommended BRT for further study. In November 2000, BRT was selected by the Honolulu City Council as the Locally Preferred Alternative (LPA) and included in the Oahu Metropolitan Planning Organization (OMPO) Regional Plan.

On January 29, 1999, the City Council of the City and County of Honolulu passed Resolution 99-18 authorizing the City to submit an application to the FTA for participation in the FTA BRT Demonstration Program. The application was submitted in February 1999, and provided extensive information about the BRT project that included a system description, research and analysis plan, management plan, and financial plan.

Over the next two years, DTS spearheaded the environmental review process. On March 13, 2002, the County and City of Honolulu and DTS released the Supplemental Draft Environmental Impact Statement (SDEIS) for the Primary Corridor Transportation Project, which identified a new bus rapid transit system for the Honolulu metropolitan area. Throughout the environmental review process, DTS continued to gather public input through a working group process consisting of a broad cross-section of community stakeholders.

The working groups recommended three changes to the alignment of the BRT system:

- Kakaako Makai branch – extend to Halekauwila and Pohukaina streets to serve developments along the waterfront area, including the UH Medical School and cruise ship terminals along Ilalo Street.

- Pensacola Street branch – replace Ward Avenue in the alignment with the UH-Manoa branch of the in-town BRT.
- Puapele Drive access ramp – add BRT access ramp into the H-1 at Luapele Drive; the new ramp replaces the ramps originally planned for Kaonohi Street and Radford Drive.

Copies of the Environmental Impact Statement (EIS) documents were made available on the project website, www.oahutrans2k.com, and at all state libraries on Oahu. The public comment period for the SDEIS was for 30 days to May 7, 2002, with a public hearing on the SDEIS held on April 20 at the Hawaii Convention Center. The alignment modifications described above were incorporated into the Final Environmental Impact Statement (FEIS), which was released on August 8, 2003. The State FEIS was accepted by Governor Cayetano in November 2002.

3.3 PROJECT IMPLEMENTATION

In 1999 and 2000, DTS introduced the CityExpress! and CountryExpress! services in a phased implementation approach. Route A: CityExpress!, the first Honolulu BRT route to go into service, was implemented in three phases:

- Phase I (implemented in March 1999) – limited stop service running about 7 miles between the Kalihi-Palama Bus Terminal and the University of Hawaii.
- Phase II (implemented in August 1999) – 6.0 mile extension to the Pearlridge Shopping Center.
- Phase III (implemented in June 2000) – 6.0 mile extension to Waipahu.

Route A: CityExpress! provides service to the Manoa campus of the University of Hawaii.

The three other BRT routes were implemented in May 2000 (Route C), August 2000 (Route B), and November 2004 (Route E). Route E was discontinued in June 2005. Route B links the residential neighborhoods of Kalihi with employment, education and shopping opportunities in Honolulu and Waikiki.

Route C, also known as CountryExpress!, serves the rural/residential areas of western Oahu, linking many individuals to jobs, schools, and shopping in Honolulu and Waikiki. This route services Honolulu's second city of Kapolei, a primarily residential community anticipated to mature into a major employment center.

Route E: TheTransit, before being discontinued in June 2005, provided frequent service between downtown Honolulu and Waikiki. The route, according to press release literature, "improves the mix of services available to riders along this travel area."

3.4 IMPLEMENTATION CHALLENGES

The implementation of the express bus system differed to some degree from what was originally envisioned in the conceptual design stages of the planning process. The objective of this section is to identify the major issues and challenges faced by DTS in implementing the BRT system described in the DEIS and describe the response by DTS to address stakeholder concerns raised before, during and after the FEIS public comment period.

Concerns over Exclusive Lanes

The Initial Operating Segment (IOS) of Route A: CityExpress! was designed to operate on exclusive, semi-exclusive and mixed traffic lanes, with an exclusive segment along Kalaimoku Street in Waikiki and semi-exclusive lanes along Auahi Street and Sarasota Road.

With the release of the FEIS, the State Department of Transportation (SDOT) and community members expressed concerns about the BRT system design. One of the main concerns raised was the recommendation to dedicate exclusive lanes for operation of the In-Town BRT on Kapiolani Boulevard between Pensacola Street and Aktinson Drive. In response to concerns about losing the existing peak-period contraflow operation on Kapiolani Boulevard, DTS decided to defer the implementation of exclusive transit lanes indefinitely.

The Primary Corridor Transportation Project also proposed transit exclusive lanes for Dillingham Boulevard. However, the City has decided not to pursue this project. As a result, there are currently no exclusive lanes planned for Dillingham Boulevard.

Direct BRT Access Ramps to H-1

The plan for the IOS of Route A, referred to informally as the “In-Town” segment, also called for a series of BRT access ramps onto H-1. SDOT expressed concerns about the costs of building direct BRT access ramps to H-1 at three locations. Because SDOT had already planned interchanges at these locations, DTS decided to remove direct BRT ramps estimated at $166 million from the FEIS in 2002.

Vehicle Technology

The SDEIS explored several options for BRT vehicle technology, including Embedded Plate Technology and Hybrid-Electric vehicles. Embedded Plate Technology involves powering vehicles by means of a power strip embedded in the roadway or installed in a track along the running way. Because DTS considered Embedded Plate Technology unproven, DTS decided to defer a decision about automated guidance capabilities until such technologies were more advanced and tested. As a result, the FEIS states that DTS will defer the decision on BRT vehicle technology until 2008. In the meantime, DTS chose to operate the express services using buses from the existing OTS fleet.

DTS procured ten hybrid-electric articulated buses in 2004 and assigned these vehicles for use on Route E as a dedicated fleet. Due to operational considerations (with respect to turning radii), these buses were instead shifted largely to Route A operations when Route E ceased operation.

Route E

The now discontinued Route E was intended as a true rapid transit corridor between the CBD and the Waikiki resort area. It was implemented in 2004, despite city council timeline concerns and the rescinding of federal funding, with many changes. Some of the BRT features originally planned for Route E, such as dedicated lanes with traffic signal priority and real-time passenger information, were cut due to the changing funding situation and public resistance over the potential impact to traffic in the corridor. The route was discontinued by the DTS Director in June 2005 due to poor performance, which is further discussed in the next two section of this report.

Fare Collection at BRT Stations

One of the signature BRT design features identified in the DEIS was multiple-door boarding for passholders and transferring passengers. This design feature, which is intended to lower station dwell times by eliminating cash payments at the farebox, is typical of BRT systems with high-load points. To facilitate multiple entry vehicles, such systems typically provide off-vehicle fare collection methods. For example, the MAX system in Las Vegas, NV has ticket vending machines (TVMs) at MAX stations. The MAX vehicle has multiple-door entry, and all passengers are required to have valid fare prior to entering the vehicle.

After further study, DTS chose not to allow multiple door entry in order to maintain a single fare collection interface across all fixed routes. DTS had planned to implement a smart card system for the entire fixed route system. Preliminary testing and pilot phase were conducted in 2004. However, because a feasibility study was not conducted prior to implementation and operational costs were not considered, the smart card project was terminated due to lack of funding.

Intelligent Transportation Systems

With the goal of implementing a real-time travel information system jointly developed by the City of Honolulu and the University of Hawaii, the City investigated the feasibility of installing a computer aided dispatch/automated vehicle location (CAD/AVL) system in late 2002. This system became operational in 2003, but the real-time passenger information system enabled by CAD/AVL has not been fully implemented. Real-time traveler information using “On-street” signs, originally planned and tested on Route E, experienced data integration and technical issues. A field trial of two station signs is currently being completed along with an operational plan that will consider up to 43 additional station signs deployed in 2006. The implementation delays were in part a result of an effort to quickly deploy the display signs without coordination with the CAD/AVL project plan. Technical delays related to the CAD/AVL project were not factored into the traveler information project.

The City also explored the feasibility of a “corridor signal prioritization system” that would extend the green signal time at major intersections to expedite bus movement through the corridor. After extensive review and technical difficulties with integration, the City determined that implementing signal prioritization would negatively impact traffic along the corridor and, therefore, has not done so.

4.0 SYSTEM PERFORMANCE

The analysis of system performance for each of the BRT routes needs to be carefully defined according to two primary dimensions: the time period for the specific analysis and the geographic extent.

Time Period

The analysis of each BRT route examines system performance one year prior to the service beginning operation until the most recently available data to the degree that adequate data are available. In general, the analysis period ends in June 2005, but some additional data were collected after that. This comparison is intended to determine the specific impacts of each service on overall system performance, and how the performance has changed over time. **Exhibit 22** shows the start date and approximate analysis time period of each BRT service.

Exhibit 22: BRT Analysis Time Periods

BRT Route	Start Date	Analysis Period
Route A	Mar 1999	Mar 1998 – Jun 2005
Route B	Aug 2000	Aug 1999 – Jun 2005
Route C	May 2000	May 1999 - Jun 2005
Route E	Nov 2004	Nov 2003 – Jun 2005

Geographic Extent

The analysis of each BRT route requires the identification of comparable local routes that provide or provided service in the same corridor. Each of the four Honolulu BRT routes follows a unique alignment. As such, there is no local route that exactly duplicates the alignment of the Honolulu BRT routes. However, there are local route segments that partially overlap or are parallel with the BRT routes.

Exhibit 23 shows a list of the comparable segments by route that will be used for this analysis, as determined by Booz Allen with the concurrence of DTS and OTS. The amount of overlap varies significantly from route to route.

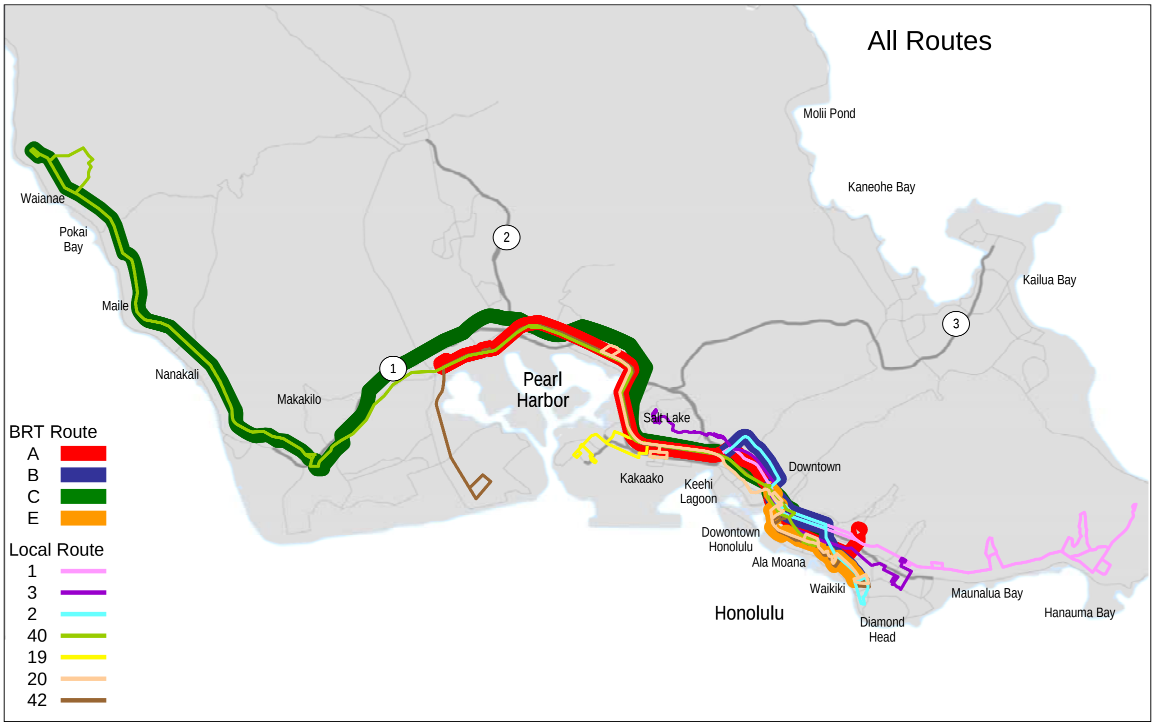
Exhibit 23: Comparable Segments - BRT and Local Routes

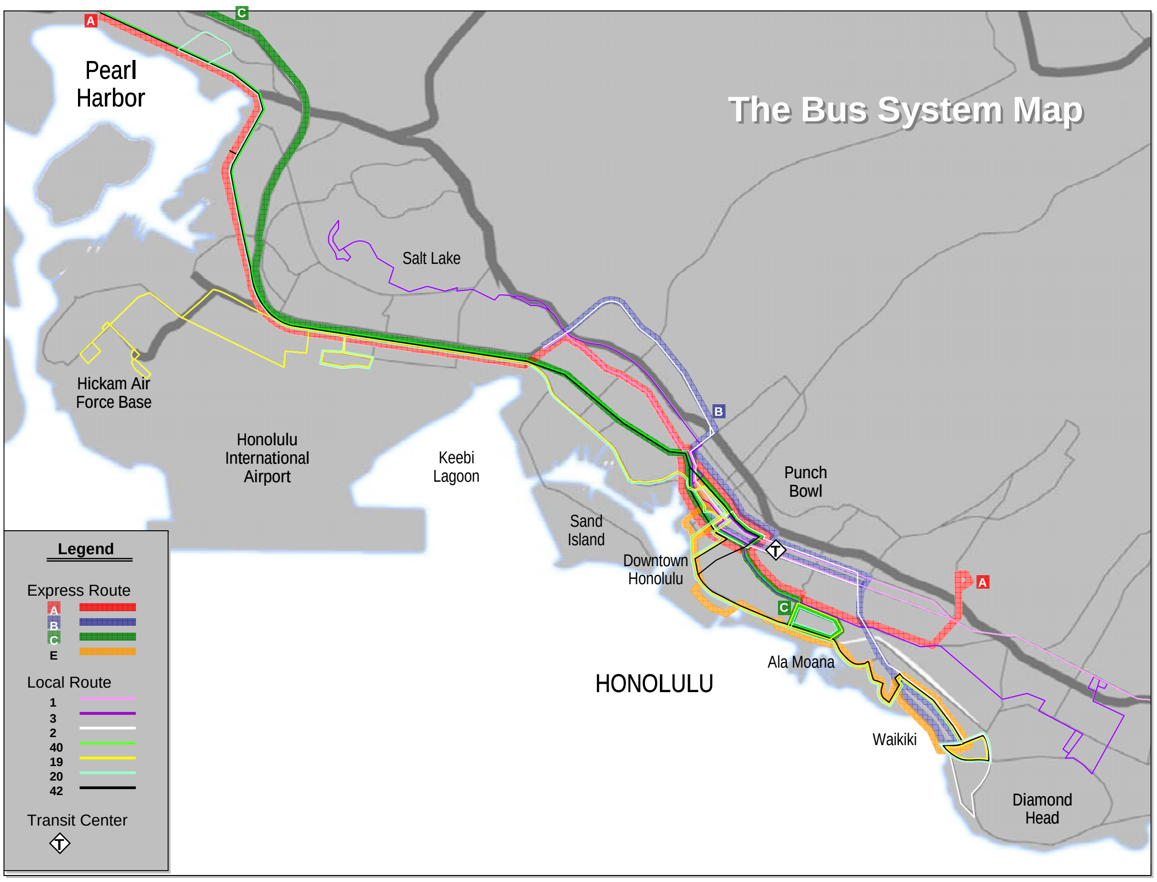
BRT Route	Local Route	Overlapping Segment	Segment Length
Route A	Route 1 Route 3	Kalihi Transit Center – King/Dillingham (Liliha) King (Beretania)/Punchbowl – Kapiolani/Isenberg	2.1 miles 2.5 miles
Route B	Route 2	Kalihi Transit Center – Kapahulu/Kalakaua (Kuhio)	7.8 miles
Route C	Route 40	Farrington/Makaha Valley – Ala Moana Center	36.8 miles
Route E	Rtes 19, 20, 42	Hotel/River – Kuhio/Liliuokalani	5.4 miles

Segment length shown is approximate based on an average by route and by direction.

Exhibit 24 provides graphics of the BRT routes and the overlapping services.

Exhibit 24: Graphic of Main Overlapping BRT and Local Route Segments





Within the time periods and geographic extents previously described, this section evaluates the Honolulu BRT system based on five attributes that comprise BRT system performance: 1) travel time, 2) reliability, 3) image and identity, 4) safety and security, and 5) system capacity.

4.1 TRAVEL TIME

One of the main advantages of Bus Rapid Transit is typically higher operating speeds as a result of specific design elements. The overall travel time is one of the most important performance attributes of a BRT service and consists of four components:

- Running Time: Time spent in the vehicle traveling from stop to stop.
- Dwell Time: Time spent in the vehicle stopped at a station.
- Wait Time: Time spent by passengers initially waiting to board a transit service.
- Transfer Time: Time spent by passengers to transfer from one vehicle to another vehicle in order to complete his/her trip.

It is expected that longer average stop spacing (as compared to local routes) in Honolulu is the primary contributor to any travel time savings. Route C, which uses the H-1 Freeway (and HOV lanes during weekday peak periods) for part of its route alignment, is expected to generate additional travel time savings when compared to the local route that travels on local streets for that part of the alignment.

The focus of the analysis provided in this section is **in-vehicle travel time**, which is inclusive of both running time and dwell time. There are three primary sources of data that were used to establish what the route-by-route in-vehicle travel times are:

- Scheduled Travel Times: Scheduled location-to-location travel times, as provided in the "routes & timetables" section of the website for TheBus.
- Actual Travel Times from AVL Data: Actual location-to-location travel times, as provided by the Automated Vehicle Location system. The AVL travel time data used for this analysis were collected during a total of 107 days between December 5, 2004 and April 29, 2005. This dataset includes weekday, Saturday, and Sunday data and was collected during many different times of day.
- Actual Travel Times from Ridechecks: Actual location-to-location travel times, as provided by ridecheck data, was collected during a total of 222 days between February 25, 2003 and June 30, 2005.

None of these datasets separate out dwell time specifically from running time, and therefore, no actual dwell time data are available. This analysis covers in-vehicle travel time from location to location and does not provide a dwell time analysis separately from running time. A discussion of scheduled travel times is provided first, followed by an analysis of actual travel times.

Scheduled Travel Times

The main purpose of documenting the scheduled travel time savings is to provide context. **Exhibit 25** shows a comparison of scheduled travel times along segments that are common to both a BRT route and a local route.

Exhibit 25: Travel Times from Schedules

Rt	Overlapping Segment	Dir	Segment Length (miles)	No. of Stops	Stop Spacing (miles)	Weekday AM Peak (minutes)	Weekday Midday (minutes)	Weekday PM Peak (minutes)
A	**Kalihi Transit Center – King/Dillingham**	**E**	**1.99**	**7**	**0.28**	**13**	**11**	**13**
1	Kalihi Transit Center – King/Beretania	E	2.16	16	0.14	16	16	17
	% Scheduled Travel Time Savings	E				19%	31%	24%
A	**King/Dillingham – Kalihi Transit Center**	**W**	**2.25**	**7**	**0.32**	**11**	**13**	**13**
1	King/Beretania – Kalihi Transit Center	W	2.44	15	0.16	12	13	13
	% Scheduled Travel Time Savings	W				8%	0%	0%
A	**King/Punchbowl – Kapiolani/Keeaumoku**	**E**	**1.33**	**3**	**0.44**	**8**	**7**	**8**
3	Kapiolani/South – Kapiolani/Kalakaua	E	1.64	14	0.12	11	11	11
	% Scheduled Travel Time Savings	E				27%	36%	27%
A	**Kapiolani/Keeaumoku – Beretania/Punchbowl**	**W**	**1.66**	**3**	**0.55**	**10**	**11**	**12**
3	Kapiolani/Kalakaua – Alapai/Hotel	W	1.71	14	0.12	11	11	11
	% Scheduled Travel Time Savings	W				9%	0%	-9%
B	**Kalihi Transit Center – Kapahulu/Kuhio**	**E**	**7.29**	**26**	**0.28**	**44**	**42**	**42**
2	Kalihi Transit Center – Kapahulu/Kuhio	E	7.54	51	0.15	60	60	60
	% Scheduled Travel Time Savings	E				27%	30%	30%
B	**Kapahulu/Kuhio - Kalihi Transit Center**	**W**	**7.74**	**28**	**0.28**	**39**	**39**	**41**
2	Kapahulu/Kuhio - Kalihi Transit Center	W	7.85	54	0.15	59	59	59
	% Scheduled Travel Time Savings	W				34%	34%	31%
C	**Farrington/Makaha Valley – Ala Moana Center**	**E**	**35.95**	**35**	**1.03**	**89**	**85**	**85**
40	Farrington/Makaha Valley – Ala Moana Center	E	35.07	132	0.27	125	125	118
	% Scheduled Travel Time Savings	E				29%	32%	28%
C	**Ala Moana Center – Farrington/Makaha Valley**	**W**	**37.10**	**36**	**1.03**	**86**	**96**	**96**
40	Ala Moana Center – Farrington/Makaha Valley	W	36.09	133	0.27	130	134	131
	% Scheduled Travel Time Savings	W				34%	28%	27%

Information provided is approximate based on currently posted schedules and milepost data.
Note: AM Peak corresponds to 6 am to 9 am; Midday is from 9 am to 2 pm; PM Peak is from 2 pm to 6 pm.

Findings from this scheduled travel time analysis are as follows:

- Route A: Along the roughly comparable 2 mile segments on Route A and 1, there seems to be a schedule travel time savings of at least 3 minutes eastbound, but little or no saving westbound. This is also true for the comparable 1+ mile segment on Routes A and 3. These segments, however, represent less than one-fifth of the entire Route A alignment thereby limiting the significance of any findings. Data were not available to explain the discrepancy in directional travel times, but have been requested from DTS.
- Route B: Along the roughly 7 miles of overlap with Route 2, Route B provides a scheduled travel time savings of at least 27%.
- Route C: Along the roughly 35 to 37 miles of overlap with Route 40, Route C provides a scheduled travel time savings of at least 27%.
- No comparison for Route E was conducted because of the difficulty in finding timepoints in the headway-based schedule that matched with local routes.

Scheduled travel times for any of the routes do not vary significantly by time of day.

Actual Travel Times, AVL Data

The AVL dataset is the most substantial available for conducting an analysis of actual travel times. While the number of days for which AVL data were collected is less than for ridechecks (107 days for AVL vs. 222 for ridechecks), the total number of vehicle trips recorded is much higher. **Exhibit 26** provides a comparison of size between the two datasets. Adequate AVL data were not available for Route E.

Exhibit 26: Number of Vehicle Trips Recorded – AVL and Ridechecks

Route	Direction	AVL Data	Ridecheck Data
Route A	Eastbound	6,978	49
	Westbound	6,215	63
Route B	Eastbound	6,941	93
	Westbound	6,986	90
Route C	Eastbound	4,066	28
	Westbound	4,280	27
Route E	Eastbound	-	37
	Westbound	-	36

An AVL analysis for Route E was not prepared due to the difficulty in finding matching timepoints with local routes.

Exhibit 27 provides the comparison of actual average travel times from the AVL dataset with the scheduled travel times, for the same common segments by time period identified previously.

Exhibit 27: Actual Travel Times (AVL Data)

Rt	Overlapping Segment	Dir	Scheduled Travel Time			Actual Travel Time (average)		
			Weekday AM Peak (minutes)	Weekday Midday (minutes)	Weekday PM Peak (minutes)	Weekday AM Peak (minutes)	Weekday Midday (minutes)	Weekday PM Peak (minutes)
A	**Kalihi Transit Center – King/Dillingham**	**E**	**13**	**11**	**13**	**14.1**	**12.8**	**14.0**
1	Kalihi Transit Center – King/Beretania	E	16	16	17	16.9	16.1	17.1
	% Travel Time Savings	E	19%	31%	24%	17%	21%	18%
A	**King/Dillingham – Kalihi Transit Center**	**W**	**11**	**13**	**13**	**11.7**	**12.7**	**13.5**
1	King/Beretania – Kalihi Transit Center	W	12	13	13	14.7	16.0	17.0
	% Scheduled Travel Time Savings	W	8%	0%	0%	20%	21%	21%
A	**King/Punchbowl – Kapiolani/Keeaumoku**	**E**	**8**	**7**	**8**	**6.4**	**7.3**	**7.3**
3	Kapiolani/South – Kapiolani/Kalakaua	E	11	11	11	10.5	12.6	12.1
	% Scheduled Travel Time Savings	E	27%	36%	27%	39%	42%	40%
A	**Kapiolani/Keeaumoku – Beretania/Punchbowl**	**W**	**10**	**11**	**12**	**8.3**	**9.6**	**12.3**
3	Kapiolani/Kalakaua – Alapai/Hotel	W	11	11	11	10.3	12.6	13.2
	% Scheduled Travel Time Savings	W	9%	0%	-9%	19%	24%	7%
B	**Kalihi Transit Center – Kapahulu/Kuhio**	**E**	**44**	**42**	**42**	**48.0**	**46.5**	**49.4**
2	Kalihi Transit Center – Kapahulu/Kuhio	E	60	60	60	59.0	60.2	61.5
	% Scheduled Travel Time Savings	E	27%	30%	30%	19%	23%	20%
B	**Kapahulu/Kuhio - Kalihi Transit Center**	**W**	**39**	**39**	**41**	**45.2**	**46.9**	**52.8**
2	Kapahulu/Kuhio - Kalihi Transit Center	W	59	59	59	57.4	63.2	69.7
	% Scheduled Travel Time Savings	W	34%	34%	31%	21%	26%	24%
C	**Farrington/Makaha Valley – Ala Moana Center**	**E**	**89**	**85**	**85**	**98.4**	**90.2**	**95.0**
40	Farrington/Makaha Valley – Ala Moana Center	E	125	125	118	139.8	135.5	139.9
	% Scheduled Travel Time Savings	E	29%	32%	28%	30%	33%	32%
C	**Ala Moana Center – Farrington/Makaha Valley**	**W**	**86**	**96**	**96**	**91.3**	**93.5**	**108.5**
40	Ala Moana Center – Farrington/Makaha Valley	W	130	134	131	125.1	137.2	154.8
	% Scheduled Travel Time Savings	W	34%	28%	27%	27%	32%	30%

Each average of the actual travel times is based on between 18 and 2,206 observations, with the exception of B Westbound in the AM Peak (based on 2 observations only)

Note: AM Peak corresponds to 6 am to 9 am; Midday is from 9 am to 2 pm; PM Peak is from 2 pm to 6 pm.

Findings from this actual AVL travel time analysis demonstrated that BRT routes had faster travel times, which are likely primarily due to the increased station spacing. Approximately 80% of BRT riders use a prepayment system, reducing boarding time, which may have also decreased travel times compared with local routes. Data required to make boarding time comparisons were unavailable, but have been requested from DTS. Route specific analyses are as follows:

- Route A: As mentioned, it is difficult to compare the travel time savings because of the relatively short segments and potential mismatch of BRT and local timepoint locations. However, for the segments compared, the travel time savings for Route A may be significant. For the comparable segment between King (Beretania)/Punchbowl and Kapiolani/Keeaumoku, the eastbound average travel time savings is about 39-42% compared to Route 1. The westbound average travel time savings is about 7-24% for the same segment. The finding that the eastbound direction provides greater travel time savings than the westbound direction for this segment is consistent with the scheduled travel times.

- Route B: Along the roughly 7 miles of overlap by direction with Route 2, Route B provides an average travel time savings of about 19-26%. The travel time savings are slightly greater in the Westbound direction than Eastbound, and are slightly greater in the midday period than in the AM or PM peak periods. The actual travel times on Route B are consistently greater than the scheduled travel times, with the difference being greatest in the PM peak, while actual travel times on Route 2 are approximately as scheduled.
- Route C: Along the roughly 35 to 37 miles of overlap by direction with Route 40, Route C provides an average travel time savings of about 27-33%. The travel time savings are slightly greater in the Eastbound direction than Westbound, and are slightly greater in the midday period than in the AM or PM peak periods. The actual travel times on Route C are typically greater than the scheduled travel times, with the difference being greatest in the PM peak, while actual travel times on Route 40 also tend to be greater than scheduled.

The travel time analysis also includes a comparison of AVL travel speed observations for each BRT and local comparison route. **Exhibits B-1** and **B-2** in **Appendix B**: AVL Speed Distributions, provide the distribution of AVL travel speed observations, inclusive of all three time periods (AM Peak, Midday, and PM Peak), for the Eastbound and Westbound direction of each BRT and local comparison route. The 90th percentile means that 10% of observations had a faster speed; 90% had a slower speed. This also applies to the 75th percentile, the 50th percentile, etc.

Findings from the AVL speed distribution analysis are as follows:

- Route A: For the limited comparable local services, the average travel speed of Route A is roughly 10.5 miles per hour, compared to about 8.7 miles per hour for the local services. The second segment of Route A (King (Beretania)/Punchbowl – Kapiolani/Keeaumoku) has a larger speed advantage over the comparable local service than Segment 1 (Kalihi Transit Center – King/Dillingham).
- Route B: Average travel speed for Route B is about 9.4 miles per hour, compared to about 7.5 miles per hour for Route 2 over the comparable segment.
- Route C: Average travel speed for Route C is about 23.2 miles per hour, compared to about 15.4 miles per hour for Route 40.
- In general, the distributions show that speed varies more significantly for Routes A, B, and C than for the comparable local routes over the comparable segments. This may be explained by the fact that the BRT routes stop less often but generally do not have exclusive running ways and are thus subject to congestion as the local bus routes.

Speed distributions were also prepared from the ridecheck data for consistency with the AVL data. The ridecheck speed distributions, provided in **Appendix B**: Ridecheck Speed Distributions, were similar to those from the AVL analysis, although with more variability because the number of observations made by route and by direction were much fewer. Ridecheck data in **Appendix B** includes graphics for the discontinued Route E.

Transfer Time

In the Fall of 2004, DTS conducted a passenger usage and satisfaction survey for Routes A, B, and C. The highest number of responses to a single question, or the approximate number of survey responses received, was 10,931 for Route A; 6,831 for Route B; and 4,427 for Route C (total of 22,189 across the three routes).

Exhibit 28 provides the results of this survey for the number of transfers and average travel time experienced by passengers on the three routes. The results show that the vast majority of BRT riders did not transfer. Specifically, riders were asked how many buses are needed reach their destination (to complete a one-way trip):

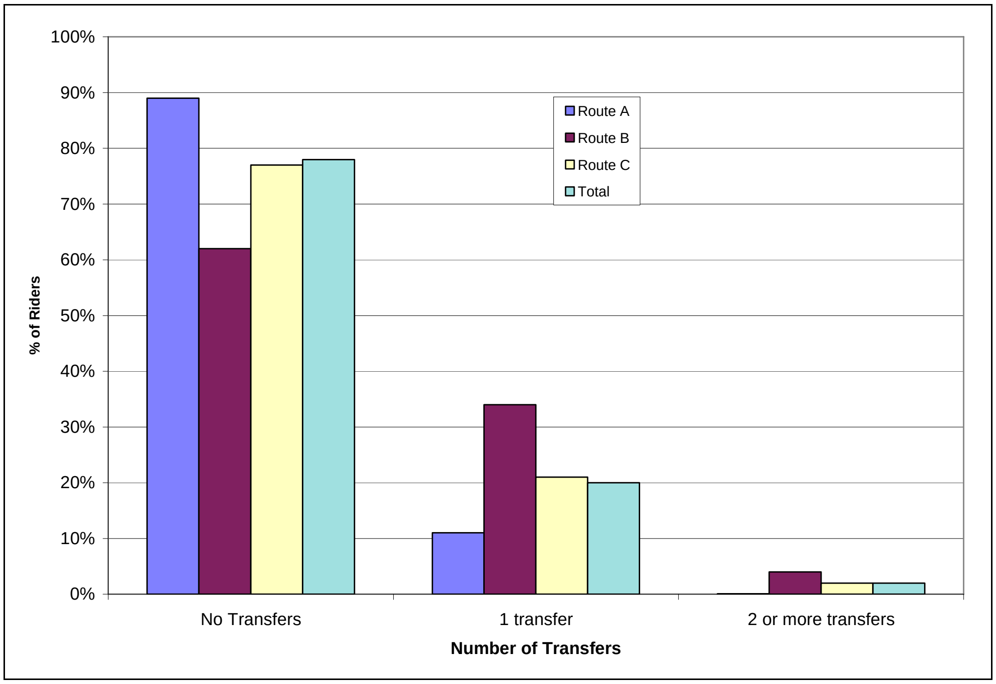
- <u>Route A:</u> 89% of survey respondents did not need to transfer; 11% required one transfer. Less than 1% of Route A riders required two or more transfers.
- <u>Route B:</u> 62% of respondents did not need to transfer; 34% required one transfer; 4% required two or more transfers.
- <u>Route C:</u> 77% did not need to transfer; 21% required one transfer; 2% required two or more transfers.

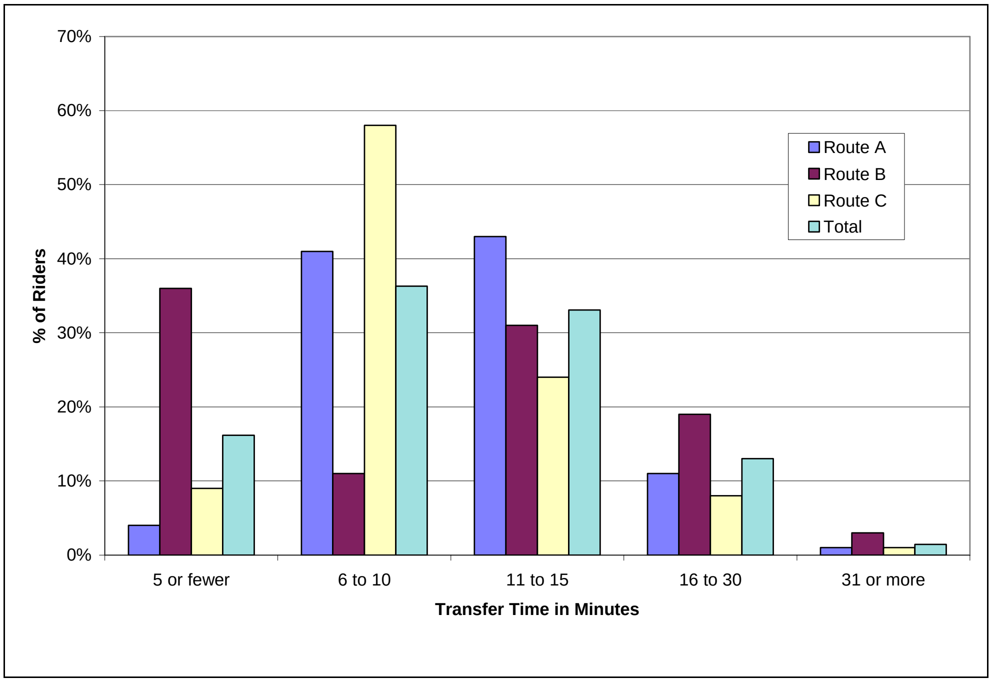
Overall, 78% of BRT riders did not transfer, 20% required one transfer, and 2% required two or more transfers. Survey respondents who indicated they had used another bus (i.e., needed a transfer) were also asked how long they typically waited between buses. The results by route showed that:

- <u>Route A:</u> 4% of respondents waited 5 minutes or less; 85% waited 6-15 minutes; 12% waited 16 minutes or more.
- <u>Route B:</u> 36% waited 5 minutes or less; 42% waited 6-15 minutes; 22% waited 16 minutes or more.
- <u>Route C:</u> 9% waited 5 minutes or less; 82% waited 6-15 minutes; 9% waited 16 minutes or more.

Overall, 16% of BRT riders who transferred waited 5 minutes or less, 69% waited 6-15 minutes, and 14% waited 16 minutes or more. It is difficult to analyze average transfer times on the BRT routes because the survey only asked respondents about transfer times in ranges of 5 minutes. However, it can be interpreted from the results that average wait times are between 6-10 minutes, which is reasonable considering the frequencies of the BRT services. Variability in transfer time is the highest for Route B, which also had the greatest number of riders requiring 1 transfer.

Exhibit 28: Number of Transfers and Average Transfer Time (Survey Results)





4.2 RELIABILITY

Service reliability is the ability of transit operators to provide a consistent level of service and maintain operations as scheduled. Customers may consider service unreliable when bus arrival times are not as schedule or when travel times are highly variable and unpredictable. Having reliable service improves customer satisfaction and the perception of high-quality service, which may consequently increase ridership for the transit operator.

Schedule Adherence

Schedule adherence refers to the ability of a transit service to stay on schedule at designated timepoints (generally defined as within 0 to +5 minutes of the schedule). Schedule adherence is a measure of reliability, and the same BRT features that help improve travel times (i.e., dedicated running way, stop spacing, ITS elements) could also help improve schedule adherence by reducing variability in wait times and in-vehicle travel times.

Schedule adherence is intended to measure the systematic occurrence of deviations from schedule, such as the likelihood of buses consistently arriving late at a stop. Traffic accidents and service disruptions, which may affect the schedule adherence of one or more buses during the day of the accident, are evaluated in subsequent sections. The occurrence of these may be random or isolated, and tend to not contribute to any pattern of unreliability. For example, buses on a route may have a low accident rate but regularly run behind schedule due to traffic congestion.

This is important from a customer perspective, who may use fixed schedule information to determine the time that they need to arrive at a station to catch a particular vehicle trip in order to arrive at their destination by a certain time. From an operator perspective, schedule adherence is a measure that buses are operating efficiently and according to plan.

Among the BRT routes and the comparable local routes, most run on fixed schedules with designated timepoints at identified stations throughout the day:

- <u>BRT Routes:</u> Routes A, B, and C all run on fixed schedules. The discontinued Route E ran on a headway-based schedule (based on the temporal and spatial intervals between vehicles).
- <u>Local Routes:</u> Routes 1, 3, and 40 run on fixed schedules. Route 2 runs on a headway-based schedule from roughly 8 am to 4 pm (both weekdays and weekends), and on a fixed schedule during other times of the day.

For the schedule adherence analysis, ridecheck data were used instead of AVL data due to the following reasons:

- The AVL data had a large number of schedule adherence entries that were null (25% null rate for Route A, 42% null rate for Route B, and 48% null rate for Route C). Among the non-null AVL data entries, the percentage of schedule adherence entries that indicated an early arrival (i.e., the actual arrival time was earlier than the scheduled arrival time) was deemed to be unusually high (40% early arrival rate for Route A, 18% for Route B, 30% for Route C).

- Because of the sheer size of the AVL dataset, the data analyzed (for purposes of the travel time analysis) only corresponded to select locations. For schedule adherence, it makes sense to consider the entire route length if possible because the level of schedule adherence could vary along the route length. Examining only limited locations along the route could skew the analysis.

Exhibit 29 provides results from the schedule adherence analysis using ridecheck data for every available measured timepoint at all times of the day (in both directions of travel). This includes results from Route E and its comparable local routes (Routes 19, 20, and 42).

Exhibit 29: Schedule Adherence (Ridecheck Data)

	Route	Avg Stop	# of	Difference Between Scheduled and Actual Arrival Time (in minutes)						
	Length	Spacing	Observ	-6 or less	-1 to -5	0 to 5	6 to 10	11 to 15	16 to 20	21 +
A	**19.1**	**0.55**	**3,161**	**3.8%**	**21.4%**	**47.8%**	**19.2%**	**4.6%**	**1.5%**	**1.7%**
1	8.9	0.14	21,011	2.7%	26.0%	44.7%	17.7%	6.5%	2.0%	0.3%
3	13.6	0.16	9,641	4.1%	24.9%	51.4%	14.5%	2.7%	1.5%	0.8%
B	**8.2**	**0.29**	**5,424**	**1.0%**	**9.9%**	**43.1%**	**21.8%**	**12.1%**	**5.4%**	**6.7%**
2	8.9	0.15	12,183	3.9%	28.3%	46.1%	14.4%	5.1%	1.4%	0.8%
C	**38.7**	**0.98**	**2,169**	**1.8%**	**14.5%**	**53.3%**	**16.5%**	**6.8%**	**3.7%**	**3.4%**
40	38.7	0.27	5,159	4.4%	17.0%	30.9%	19.4%	11.0%	7.5%	9.8%
E	**5.8**	**0.40**	**1,168**	**4.0%**	**18.2%**	**44.3%**	**21.7%**	**8.3%**	**2.0%**	**1.5%**
19	16.5	0.21	2,068	8.2%	24.6%	34.1%	19.9%	8.1%	4.4%	0.7%
20	17.0	0.23	2,771	7.6%	30.1%	39.8%	15.1%	5.0%	1.8%	0.6%
42	25.8	0.24	2,243	2.5%	19.5%	29.4%	23.4%	9.7%	5.9%	9.7%

Route Length is a one-way average of both directions, in miles. Avg Stop Spacing is for the entire route length, in miles. # of Observ shows the total number of individual ridecheck observations that the analysis is based on.

The schedule adherence analysis highlights the following findings:

- Route A: Route A does not appear to have a significant schedule adherence advantage over Routes 1 and 3, with 47.8% of the total observations within 0 to 5 minutes behind the scheduled time (as compared to 44.7% for Route 1 and 51.4% for Route 3).

  On the plus side, Route A was less likely to run early (25.2%, as compared to 28.7% and 29.0% for Routes 1 and 3). However, Route A was more likely to run late by 6 minutes or more (27.0%, as compared to 26.5% and 19.5% for Routes 1 and 3).

- Route B: Route B has lower schedule adherence than Route 2, with 43.1% of the total observations within 0 to 5 minutes behind schedule (compared to 46.1% for Route 2).

  On the plus side, Route B was far less likely to run early (10.9%, compared to 32.2% for Route 2), but was more likely to run late by 6 minutes or more (46.0%, as compared to 21.7% for Route 2).

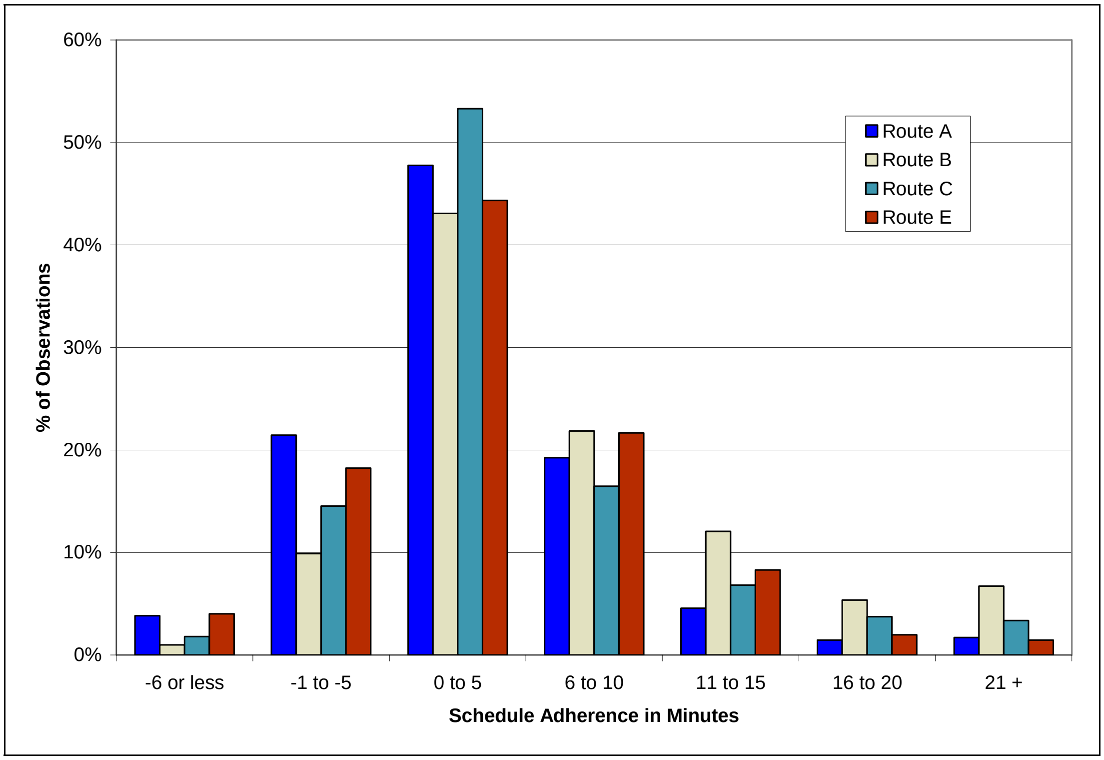
- Route C: Among all of the evaluated routes, Route C had the highest schedule adherence with 53.3% of observations within 0 to 5 minutes behind the scheduled time. About 16.3% of Route C's observations were early, and 30.4% were late by 6 minutes or more.

Route 40, the comparable local route, has nearly four times as many stops per mile than Route C and has much lower schedule adherence at 30.9%. About 21.4% of the Route 40 observations were early and 47.7% were late by 6 minutes or more, compared with Route C with 16.3% and 30.4%, respectively.

- Route E: At 44.3%, Route E had higher schedule adherence than Routes 19, 20, and 42 (at 34.1%, 39.8%, and 29.4%).

Exhibit 30 provides the same schedule adherence for the BRT routes in a bar chart. This highlights that among the BRT services, Route A is the most likely to run early, Route C has the highest on-time performance, and Routes B and E are the most likely to run late.

Exhibit 30: Schedule Adherence Distribution (Ridecheck data)



Service Interruptions

A service interruption is defined by DTS as any maintenance-related problem where it is necessary to do repair on road, change the vehicle, or return bus to base. Service interruptions affect service reliability by introducing unpredictable delays and potential increases in travel times.

Exhibit 31 shows the total number of service interruptions for the BRT routes and the comparable local routes, from Fiscal Year 2002 to FY2005. The Fiscal Year for TheBus runs from July to June (i.e., FY2005 is the period from July 2004 to June 2005). **Exhibit 32** shows the average revenue miles between service interruptions for the BRT routes and the comparable local routes in the same time period.

The overall trend of revenue miles between service interruptions for the BRT services from FY2002 to FY2005 has been mixed. Local and BRT routes experienced large swings in service interruptions over the four years, tending to improve in FY03, worsen in FY04, and improve again in FY05. The poorer performance in FY04 may have been related to the September 2003 strike.

Exhibit 31: Total Service Interruptions

	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
A	**333**	**305**	**395**	**363**	**9.0%**
1	478	489	385	356	-25.5%
3	270	197	232	185	-31.5%
B	**175**	**167**	**224**	**164**	**-6.3%**
2/13	589	492	526	519	-11.9%
C	**234**	**291**	**318**	**164**	**-29.9%**
40	303	247	197	210	-30.7%
E	**n/a**	**n/a**	**n/a**	**128**	**n/a**
19/20	175	115	163	255	45.7%
42	172	152	193	222	29.1%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.
Service interruption data for all TheBus routes was not provided.

Exhibit 32: Average Revenue Miles Between Service Disruptions

	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
A	**2,594**	**2,674**	**1,755**	**2,112**	**-18.6%**
1	2,298	2,217	2,500	2,996	30.4%
3	2,456	3,246	2,314	3,179	29.4%
B	**2.402**	**2.420**	**1.581**	**2.383**	**-0.8%**
2/13	1.828	2.046	1.628	1.832	0.2%
C	**4,666**	**3,144**	**2,784**	**6,096**	**30.7%**
40	4,133	5,007	5,614	5,789	40.1%
E	**n/a**	**n/a**	**n/a**	**128**	**n/a**
19/20	3.582	5.605	3.559	2.488	-30.5%
42	4.174	4.678	3.307	3.187	-23.6%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.
Service interruption data for all TheBus routes was not provided.

In FY2005, Route C showed a decline in total number of service disruptions and an increase of average revenue miles between disruptions. Route B has remained about the same, as the total number of service disruptions declined but the average revenue miles increased, compared to FY 2002. Route A showed an increase in service disruptions and increase of average revenue miles between service disruptions from FY 2002.

Compared to their respective local route segments, Route B and C exhibit higher reliability in terms of average revenue miles between service disruptions compared to Routes 2/13 and 40, respectively. On the other hand, Route A has a lower average of revenue vehicle miles between disruptions compared to the comparable Route 1 and 3. In FY2005, Route E showed the worst performance for this measure among the BRT routes while Route C showed the best performance.

4.3 IDENTITY AND IMAGE

Identity and image, in the context of this report, refer to how the public perceives a transit service relative to the other transit and transportation options available. The public includes both riders and non-riders of the service. An important objective of BRT is to establish an identity and image that is separate from that of local bus services, to maximize the potential for attracting additional riders.

Honolulu BRT routes do not have a specific paint-scheme or design that characterizes the BRT vehicles or stations except for the hybrid-electric articulated buses. Particular buses are not assigned to Routes A, B and C, and stations are shared with local routes.

Before being discontinued in June 2005, Route E was characterized by operating 10 new, articulated hybrid-electric vehicles, which went into service in November 2004 and are painted in silver, and having dedicated stations served only by Route E. After June 2005, the vehicles are now operated on Route A and some Route E stops are not in use.

With regards to customer perception of BRT service, the Fall 2004 passenger survey of Route A, B, and C riders asked how riders rated TheBus service overall. A total of 21,796 responses to this question were received (10,875 Route A riders; 6,576 Route B riders; 4,345 Route C riders). **Exhibit 33** shows the results from this survey question.

Exhibit 33: Customer Survey Results - Overall TheBus Rating

	Route A	Route B	Route C	Total
Outstanding	51.5%	38.4%	42.6%	45.8%
Good	38.6%	44.8%	45.8%	41.9%
Fair	9.7%	13.5%	11.3%	11.2%
Poor	0.1%	2.5%	0.1%	0.8%
Very Poor	0.0%	0.7%	0.2%	0.3%

The results showed that the vast majority of riders surveyed gave TheBus service a Good or Outstanding rating and only 1.1% of riders rated the service poor or very poor. Route A had the highest percent of respondents rating the service as Outstanding or Good, while Route B had the highest percent of respondents rating the service as Poor or Very Poor. This low rating may be linked to previous analysis results that show Route B having the worst schedule adherence, the highest number of riders transferring and the highest variability in transfer times.

If data were available, it would be beneficial to compare the BRT routes to the overall TheBus system.

4.4 SAFETY AND SECURITY

For this analysis, **accidents** are used as the measure of safety and security. DTS defines a motor vehicle accident as "an unplanned event, involving a company vehicle operated by a company employee, which results in personal injury and/or property damage. The extent of injury and/or property damage is not important to this definition." **Exhibit 34** provides the total number of accidents for the BRT and comparable local routes from FY2001 to FY2005, while **Exhibit 35** provides the number of accidents per 10,000 vehicle service miles.

Exhibit 34: Number of Accidents

	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
A	**41**	**34**	**42**	**59**	**43.9%**
1	55	58	62	78	41.8%
3	21	35	31	41	95.2%
B	**28**	**37**	**44**	**26**	**-7.1%**
2/13	89	91	89	124	39.3%
C	**19**	**28**	**25**	**30**	**57.9%**
40	19	31	23	36	89.5%
E	**n/a**	**n/a**	**n/a**	**23**	**n/a**
19/20	31	32	24	41	32.3%
42	22	25	21	30	36.4%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.
Accident data for all TheBus routes was not provided.

Exhibit 35: Accidents per 10,000 Vehicle Service Miles

Accidents per 10,000 Vehicle Service Miles					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
A	**0.47**	**0.42**	**0.60**	**0.77**	**62.1%**
1	0.50	0.54	0.64	0.73	46.1%
3	0.32	0.55	0.57	0.70	120.1%
B	**0.67**	**0.92**	**1.23**	**0.67**	**-0.1%**
2/13	0.83	0.90	1.03	1.30	57.8%
C	**0.17**	**0.31**	**0.28**	**0.30**	**72.4%**
40	0.15	0.25	0.21	0.30	95.2%
E	**n/a**	**n/a**	**n/a**	**0.94**	**n/a**
19/20	0.49	0.50	0.41	0.65	30.7%
42	0.31	0.35	0.33	0.42	38.4%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004. Route 8 was discontinued in Jan. 2005
Accident data for all TheBus routes was not provided.

This accident analysis indicates an alarming increase in the number of accidents for nearly all routes in the last 4 years. Specifically, the analysis shows that:

- Route B had a lower accident rate than its comparable local routes, and while it increased in FY2003 and FY2004, the current rate (FY2005) is comparable to that of FY2002.
- Route E had a higher accident rate than its comparable local routes, and the highest among the BRT routes.
- Routes A and C had similar accident rates as their comparable local routes. While both showed an increase in the number of accidents between FY2002 and FY2005, the accident rate of their respective comparable local routes also showed an increasing trend of accidents.

4.5 CAPACITY

Based on the previous information on route headways, fleet composition and general vehicle assignment, **Exhibit 36** shows the person capacity calculations by BRT route on an hourly basis during weekday base periods (6:00am to 8:00pm):

Exhibit 36: Hourly Person Capacity - Weekday Base Period

		Field A	Field B	A x B
	Base Period Headways	Trips per Hour, per Direction	Est. Maximum Passenger Capacity per Vehicle	Base Period Person Capacity per Hour, per Direction
Route A: CityExpress!	15 minutes	4	100	400
Route B: CityExpress!	15 minutes	4	65	260
Route C: CountryExpress!	30 minutes	2	100	200

Route A base period headways shown in the table are based on the full route from Waipahu to Manoa.
Additional Route A partial length trips from about 6:00 am-8:30 am and 2:00 pm-5:30 pm are not included.
Route E, which was discontinued in June 2005, had an hourly base period person capacity of 408.

- Route A has a person capacity of 400 passengers per hour per direction.
- Route B has a person capacity of 260 passengers per hour per direction.
- Route C has a person capacity of 400 passengers per hour per direction.
- Before it was discontinued in June 2005, Route E had a person capacity of 408 passengers per hour per direction.

The full analysis of loads for all three routes in both directions is presented in **Appendix C**. The load distribution graphs show that average loads are well below the total person capacity per vehicle. The maximum load observed were also below the passenger capacity per vehicle for Routes A, C and E. However, the load distribution graphs for Route B suggests overcrowding during peak periods as the maximum load observed is greater than the estimated maximum passenger capacity per vehicle.

Person capacity per hour per direction could be increased by increasing service frequency, if warranted by future additional demand. While current analysis of passenger boardings and alightings show that loads are typically below the total person capacity, reducing service frequency or using of smaller vehicles is not recommended as it decreases the overall quality of BRT service.

5.0 SYSTEM BENEFITS AND COSTS

This section provides an evaluation of the Honolulu BRT system according to three attributes that comprise system benefits: 1) ridership, 2) capital cost effectiveness, 3) operating cost efficiency, 4) transit-supportive land development, and 5) environmental quality. This section also provides performance indicators pertaining to cost efficiency and effectiveness, and service productivity for the BRT system and for the individual BRT routes.

5.1 RIDERSHIP

Ridership is measured as the number of passenger trips carried by a service. High ridership is an indication that the service is attractive and appropriately designed. BRT systems attract three primary types of trips:

- Existing transit trips diverted from other transit services,
- Trips that were previously made by a non-transit mode (such as drive alone, carpool, walk or bicycle) now opting for BRT service, and
- New or ‘induced’ trips that were not made before by transit or any other mode.

The BRT ridership that consists of deflection from other transit services can be determined by observing the loss in ridership among local routes that serve the same areas. The BRT ridership above and beyond this local service deflection reflects new transit ridership.

Systemwide and Route-Level Ridership

Exhibit 37 provides total fixed route ridership on TheBus, and the ridership for each BRT and comparable local route, from FY2002 to FY2005.

Exhibit 37: Ridership - Systemwide and by Route

	FY2002	FY2003	FY2004	FY2005	% of Total System (FY2005)	% Change: FY02 to FY05
All Routes	**66,634,824**	**67,887,596**	**55,853,624**	**63,040,141**	**100.0%**	**-5.4%**
A	**3,428,362**	**3,403,810**	**2,880,231**	**3,273,751**	**5.2%**	**-4.5%**
1	6,983,991	7,122,417	5,702,692	6,385,113	10.1%	-8.6%
3	3,386,134	3,378,331	2,862,055	3,408,176	5.4%	0.7%
B	**2,492,550**	**2,652,275**	**2,155,620**	**2,305,318**	**3.7%**	**-7.5%**
2/13	9,726,199	9,578,516	7,898,880	8,779,166	13.9%	-9.7%
C	**1,476,781**	**1,484,942**	**1,170,390**	**1,440,749**	**2.3%**	**-2.4%**
40	2,655,042	2,890,456	2,448,543	2,759,656	4.4%	3.9%
E	**n/a**	**n/a**	**n/a**	**952,009**	**1.5%**	**n/a**
19/20	2,842,505	2,928,823	2,488,433	3,495,579	5.5%	23.0%
42	2,762,994	2,981,307	2,534,806	2,923,509	4.6%	5.8%

Ridership data from September 2003 reflects the transit strike.

Route E began operations in November 2004 and ended in June 2005.

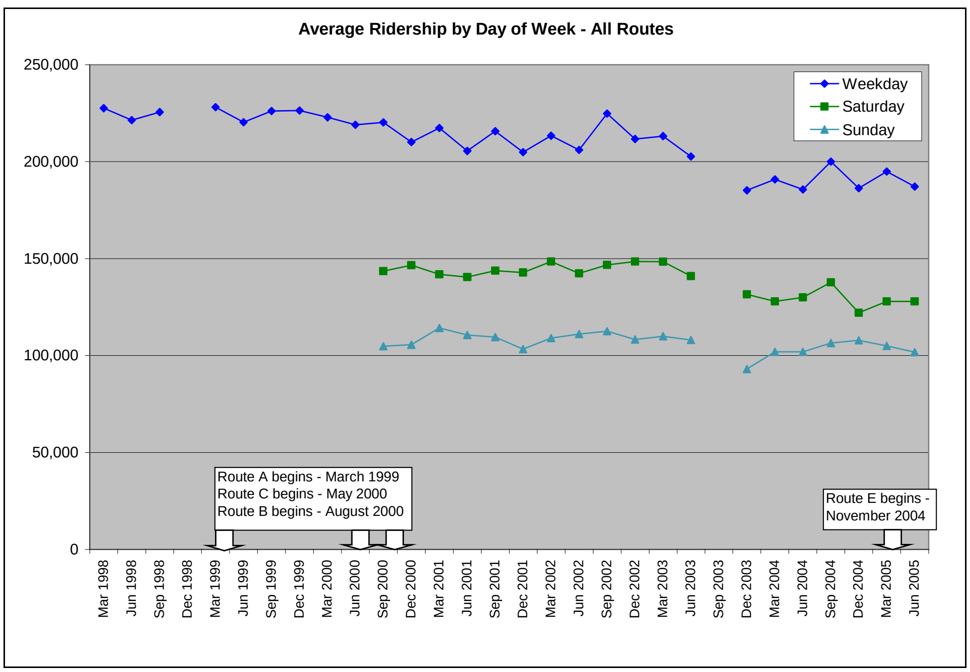
The ridership data used for this analysis are based on counts from the electronic fareboxes that register cash collections and keyboard entries made by the drivers for pass and transfer riders. DTS noted that the ridership reported to the National Transit Database (NTD) is higher than these figures to account for the rate of missed entries. As a point of reference, the total fixed route ridership reported to NTD was 73,524,474 in FY2002 (10.3% higher than the farebox count) and 69,100,627 in FY2003 (1.8% higher than the farebox count).

A labor strike suspended TheBus operations for nearly the entire month of September 2003. This was followed immediately by a fare increase in October 2003 (the adult cash fare increased by 33% from $1.50 to $2.00, and the adult monthly pass fare increased by 48% from $27.00 to $40.00). Due to both of these factors, based on the farebox data, systemwide ridership fell from 67.9 million trips in FY2003 to 55.9 million in FY2004 (a drop of 17.7%).

While systemwide ridership has recovered to a large degree since the strike, ridership has not yet returned to pre-strike levels. For this reason in part, the FY2005 ridership of 63.0 million is lower than the FY2002 ridership of 66.6 million by 5.4%.

Exhibit 38 provides systemwide average daily ridership levels of TheBus over the seven-year period from March 1998 (FY1998) to June 2005 (FY2005).

Exhibit 38: Average Daily Ridership - Systemwide



Note that average weekday ridership data were not available in December 1998 and average weekend ridership data were not available prior to September 2000. Data from September 2003 were not used because this was the strike month.

As with Exhibit 37, **Exhibit 38** highlights the dip in systemwide ridership that took place after the September 2003 strike. Exhibit 38 also highlights that the introduction of the BRT services did not appreciably affect TheBus ridership from a systemwide perspective. This may be explained by the fact that the BRT routes carry less than 13% of the overall system ridership, and therefore do not have a large impact systemwide. It may also indicate that most BRT riders were existing transit riders who changed to the new BRT system from other transit services. A corridor-level analysis is presented next to examine this question.

Corridor Ridership Analysis

Route-level ridership data prior to August 2000 are available only in the form of quarterly weekday average daily ridership numbers, which were obtained through ridecheck sampling and extrapolation. This historical information is important as it establishes the more specific ridership impacts resulting from introduction of the Honolulu BRT services.

A corridor ridership analysis was conducted, using the historical ridecheck-based route-level data and the more recent route-level data from the farebox counts. As noted in Section 4.0 System Performance, each of the four Honolulu BRT routes follows a unique route alignment that does not exactly match any local route. For purposes of this analysis, "corridor ridership" was determined to be the sum of ridership on the BRT route and the ridership of select local routes that serve the same corridor segments as the BRT route. This serves as a proxy of the BRT ridership impact within that corridor. All corridor analyses were conducted using average weekday ridership data. Generally, the ridership data used for this analysis starts one year prior to implementation of the first BRT route (Route A, implemented in March 1999).

Exhibit 39 shows the results of the Route A corridor-level analysis. With the introduction of Route A in March 1999, average weekday ridership within the corridor (the top red line) increased steadily – reaching peaks in the years 2001 and 2002 of roughly 10-15% more corridor ridership than the pre-BRT corridor ridership. However, since the September 2003 strike, corridor ridership has fallen to levels that are roughly similar to the pre-BRT corridor ridership in 1998. The strike hurt Route 1 ridership much more than either Routes A or 3. Routes A and 3 each currently carry about 10,000 passengers per weekday; Route 1 carries about 20,000 passengers per weekday.

Exhibit 40 shows the results of the Route B corridor-level analysis. With the introduction of Route B in August 2000, average weekday corridor ridership (the top red line) reached a peak in late 2000 and early 2001, then gradually slid back to the pre-BRT levels. Route B ridership appears to largely be a result of shifting from Routes 2 and 13. After the September 2003 strike, corridor ridership has fallen to levels that are about 15% lower than pre-BRT levels.

Route B currently carries about 6,500 passengers per weekday; Routes 2 & 13 currently carry about 26,000 passengers per weekday.

Exhibit 39: Average Weekday Ridership - Route A "Corridor"

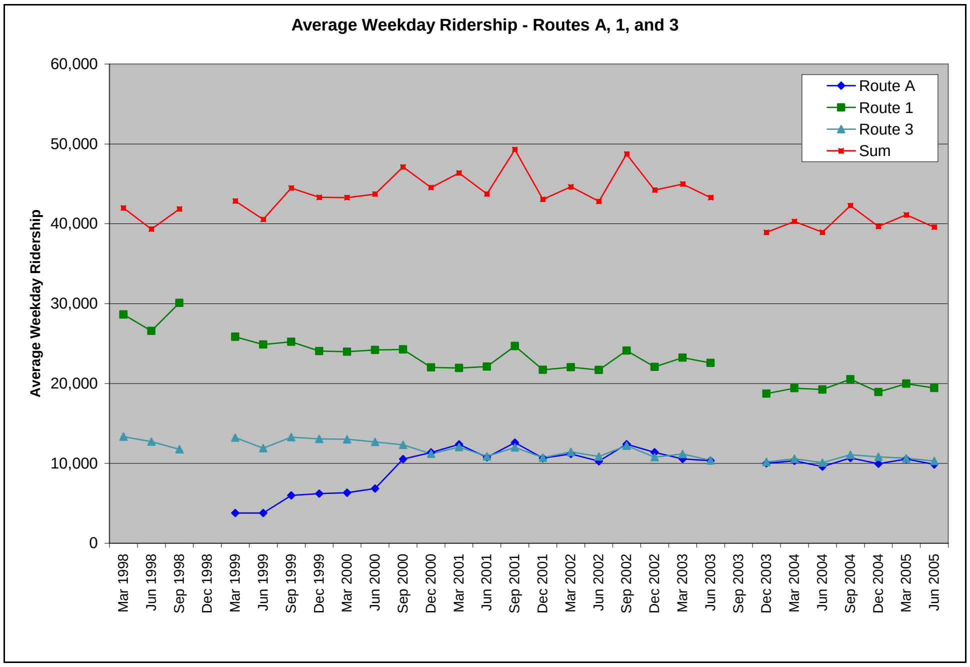


Exhibit 40: Average Weekday Ridership - Route B "Corridor"

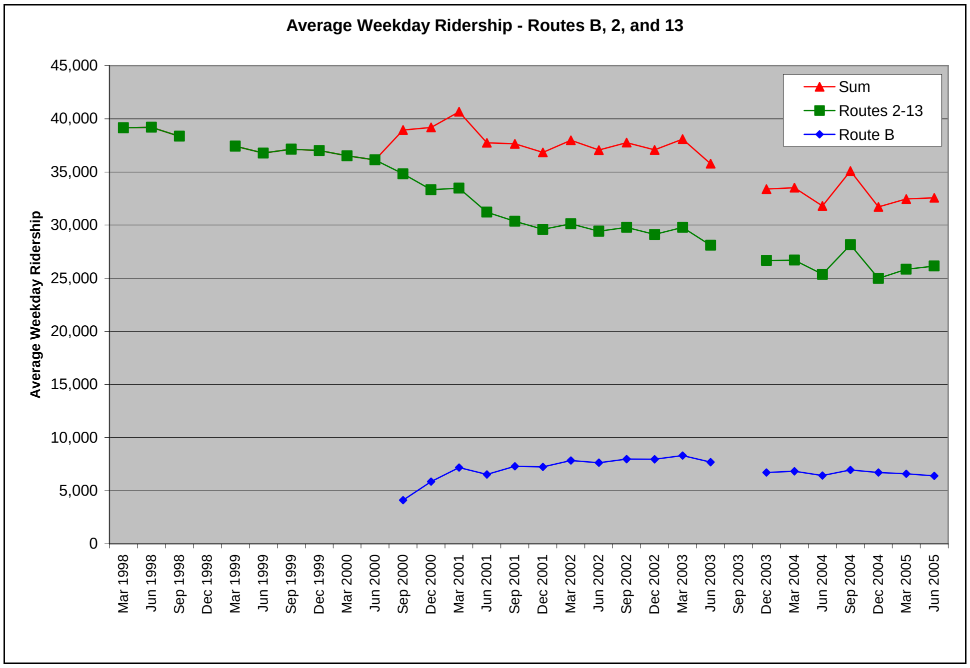


Exhibit 41 shows the results of the Route C corridor-level analysis. Around the same time that Route C was introduced in May 2000, local Route 51 was replaced by local Route 40. Route 40 ridership has been running lower than the former Route 51 by about 25%, or about 2,700 passengers per weekday. It is believed that this difference in ridership between Routes 51 and 40 was the ridership that shifted to the new Route C.

Route C ridership reached about 4,500 by December 2000 – indicating that about 1,800 of the Route C ridership base (4,500 minus 2,700) were new riders who were brought to the system. Therefore, it is estimated that the Route C ridership is composed of about 40% new riders and 60% existing bus riders. It is not known what portion of the new ridership came from other modes or where induced by the BRT service.

Following the September 2003 strike, ridership on both Routes C and 40 dipped slightly but not as much as most of the other routes. Route C currently carries about 4,000 passengers per weekday; Route 40 carries about 8,000 passengers per weekday.

Exhibit 41: Average Weekday Ridership - Route C "Corridor"

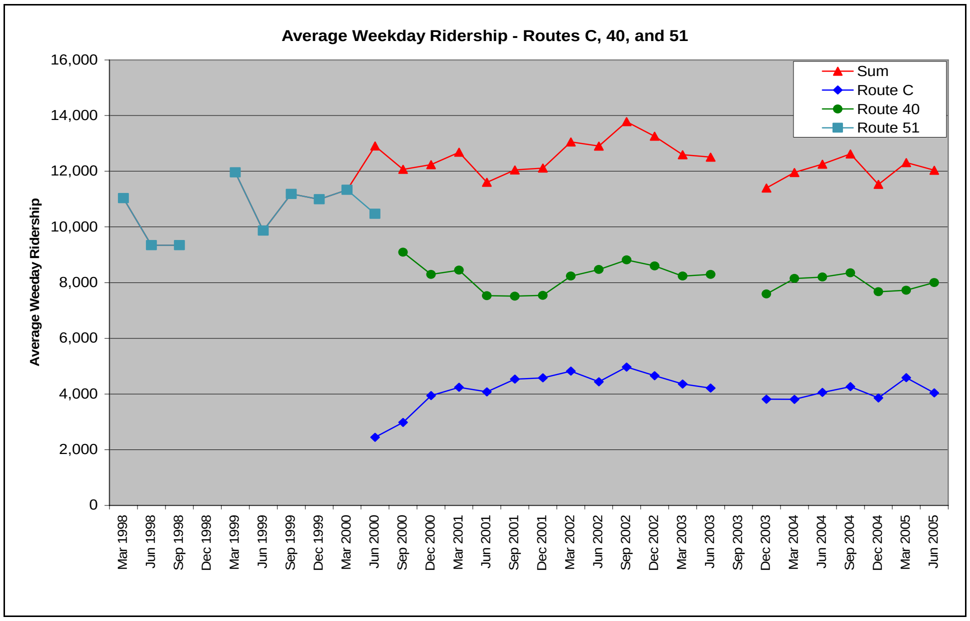
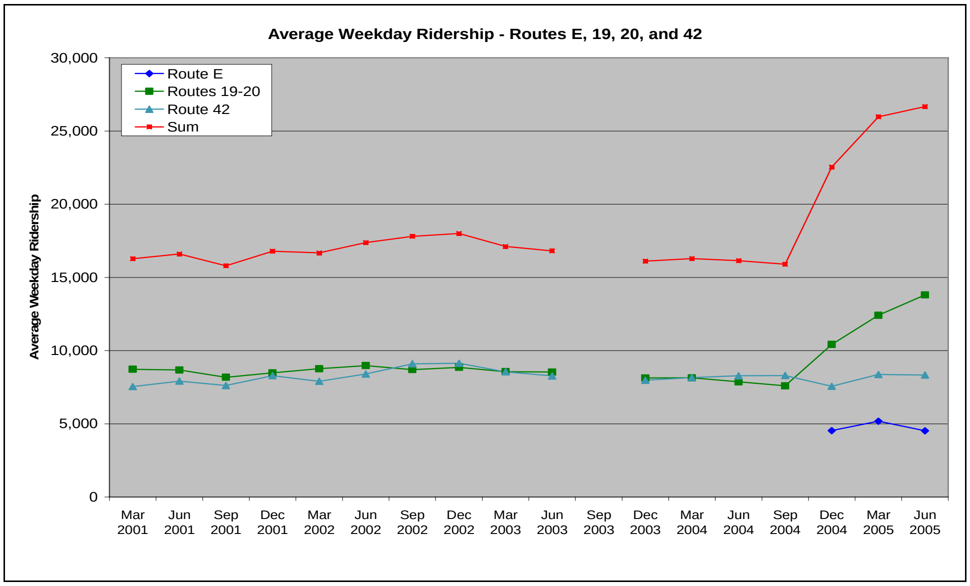


Exhibit 42 shows the results of the Route E corridor-level analysis. Route E was introduced in November 2004, well after the September 2003 strike. It carried up to 5,000 passengers per weekday until it was discontinued. During the same period of time, data for Route 19/20 shows ridership jumped up significantly from about 8,000 passengers per weekday in Sep 2004 to nearly 14,000 in June 2005; Route 42 ridership held steady at about 8,300 passengers per weekday.

Route 8 underwent service cuts when Route E was introduced, and was later interlined with Route 19/20 in December 2004. It was expected that ridership from Route 8 would migrate to the new BRT route; however, the data provided by DTS suggests that the former riders of Route 8 more often switched to Route 19/20 as evidenced by the large ridership jump of Route 19/20 after September 2004.

Exhibit 42: Average Weekday Ridership - Route E "Corridor"



Revenue Generation

Revenue generation relates to the additional passenger revenue that is obtained from operating a particular transit service. This is an important consideration from the transit agency's perspective.

Exhibit 43 provides total fare revenue generated on TheBus, and the fare revenue for each BRT and comparable local route, from FY2002 to FY2005. TheBus had a fixed route cash fare increase from \$1.00 to \$1.50 in July 2001 (monthly pass from \$25.00 to \$27.00), and another increase from \$1.50 to \$2.00 in October 2003 (monthly pass from \$27.00 to \$40.00). The second of these fare increases boosted the average fare paid per trip from \$0.43 in FY02 to \$0.64 in FY05 (an increase of 48%). As a result, fare revenue increased by 40% from FY2002 to FY2005 – despite a ridership drop of 5.4% during the same period. Fare revenue generated on Routes A, B, and C increased by about 35% from FY2002 to FY2005.

Exhibit 43: Fare Revenue - Systemwide and by Route[2]

	FY2002	FY2003	FY2004	FY2005	% of Total System (FY2005)	% Change: FY02 to FY05
All Routes	**$28,824,022**	**$30,341,193**	**$30,313,832**	**$40,389,921**	**100.0%**	**40.1%**
A	**$1,547,415**	**$1,518,990**	**$1,712,898**	**$2,115,153**	**5.2%**	**36.7%**
1	$2,629,230	$2,645,633	$2,856,926	$3,509,653	8.7%	33.5%
3	$1,416,694	$1,402,877	$1,586,075	$2,046,577	5.1%	44.5%
B	**$1,013,863**	**$1,071,009**	**$1,185,065**	**$1,359,583**	**3.4%**	**34.1%**
2/13	$3,812,995	$3,735,909	$4,114,963	$4,955,275	12.3%	30.0%
C	**$680,805**	**$671,054**	**$718,961**	**$919,520**	**2.3%**	**35.1%**
40	$1,280,837	$1,349,016	$1,523,118	$1,846,323	4.6%	44.1%
E	**n/a**	**n/a**	**n/a**	**$670,752**	**1.7%**	**n/a**
19/20	$1,668,190	$1,655,714	$1,832,201	$2,895,812	7.2%	73.6%
42	$1,518,264	$1,598,909	$1,802,873	$2,246,301	5.6%	48.0%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.

[2] *According to TheBus procedures, annual passenger revenues are allocated to each month on a proportional basis while other revenues are assigned for the month when earned. Passenger revenues are allocated to routes on the basis of the number of passengers for each fare type.*

5.2 CAPITAL COSTS

Capital costs are the one-time upfront costs associated with the planning, design, and construction of a new service. For a new BRT service, capital cost items may include but are not limited to right-of-way acquisition, dedicated running way, station and terminal improvements, maintenance facilities/equipment, additional vehicles, new technologies, and design/engineering.

Although cost data was only provided for Route E, it is estimated that the capital costs of the BRT routes were relatively small as there was little or no investment in running way segregation or grade separation. The total Route E capital costs provided include a design contract of $4 million for the Iwilei to Waikiki alignment and construction costs of approximately $23 million, however more detailed breakdown of these costs was not available.

There were no specific capital improvements for Route B and C, although new diesel articulated buses were bought and used for Route C and other express services. Ten hybrid-diesel buses were bought for Route E at a cost of $750,000 each, but are now being used on Route A since Route E is defunct. DTS and TheBus currently have a policy to not "brand" their vehicles to allow their use based on need. For example, Route 2 is a regular bus service that handles about 22,000 daily boardings now using articulated buses to help mitigate crowdedness.

Capital Cost Effectiveness

Given the low level of detail provided for the capital costs, very limited analysis was possible to gauge the capital cost effectiveness of the project.

The total Route E capital cost of approximately $27 million equates to $4.5 million per mile based on a length of 6 miles. This is slightly higher than typical BRT projects with little or no investments in running way segregation or grade separation.[3] The short duration of Route E and the lack of more detailed capital costs makes it difficult to perform any comparison or analysis of capital cost effectiveness.

The capital investment for Routes B and C, though not provided in detail, were also small but consistent with BRT projects of minimal running way segregation and/or grade separation. Again, the lack of detailed capital costs makes a comprehensive analysis of capital cost effectiveness difficult. However, considering the minimal capital investment in Route C, there were measurable improvements in travel time, ridership and reliability for Route C.

3 *The reader is referred to the FTA report "Characteristics of Bus Rapid Transit for Decision-Making", pages 2-5 and 2-6 for more information on typical BRT running way costs.*

5.3 OPERATING COSTS

Operating costs are the ongoing vehicle operations, maintenance, security, and administration expenses associated with a transit service. **Exhibit 43** provides the annual operating cost estimates for TheBus systemwide and for the individual BRT routes. These estimates are determined by a route-level operating cost allocation methodology used by OTS that involves fully allocated costs.

Exhibit 43: Annual Operating Cost Estimates[4]

	FY2002	FY2003	FT2004	FY2005	% of Total System (FY2005)	% Change: FY2002 to FY2005
All Routes	**$ 111,851,137**	**$117,335,043**	**$110,929,563**	**$126,918,901**	**100.0%**	**13.5%**
A	**$ 5,119,747**	**$ 5,121,988**	**$ 4,534,166**	**$ 5,188,707**	**4.1%**	**1.3%**
1	$ 7,080,849	$ 7,425,633	$ 6,911,617	$ 7,925,483	6.2%	11.9%
3	$ 4,107,295	$ 4,308,247	$ 4,230,107	$ 4,695,065	3.7%	14.3%
B	**$ 2,913,869**	**$ 2,835,033**	**$ 2,524,119**	**$ 2,889,772**	**2.3%**	**-0.8%**
2/13	$ 8,000,076	$ 8,239,747	$ 7,418,707	$ 8,450,290	6.7%	5.6%
C	**$ 4,467,924**	**$ 4,268,498**	**$ 4,283,754**	**$ 5,101,752**	**4.0%**	**14.2%**
40	$ 6,369,420	$ 6,602,035	$ 5,763,934	$ 7,152,791	5.6%	12.3%
E	**n/a**	**n/a**	**n/a**	**$ 2,060,948**	**1.6%**	**n/a**
19/20	$ 3,912,632	$ 4,256,528	$ 4,087,545	$ 4,623,224	3.6%	18.2%
42	$ 4,051,954	$ 4,218,004	$ 3,809,788	$ 4,864,379	3.8%	20.1%
Data from September 2003 is excluded from this analysis, as this was a strike month Route E began operations in November 2004 and ended in June 2005						

Systemwide operating costs for TheBus increased by 13.5% from FY2002 to FY2005. Operating costs for Routes A, B, and C changed by 1.3%, -0.8%, and 14.2% respectively, during the same time period. These costs, however, must be considered along with the amount of service provided in terms of vehicles service hours and miles.

Care is required in comparing annual operating cost estimates between the four BRT routes due to the cost allocation methodology used, which includes factors related to average speed, mileage and number of trips in an hour.

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4 *The basis for the operating cost estimates is a three factor allocation process. Separate expense factors are developed for total miles, total hours and the number of pull-outs for a route. The factors are developed for the past rolling twelve months of operations. Various NTD category expenses are assigned to hours, miles and pullouts as below. These costs do not include any allocation of capital costs such as depreciation for buildings or vehicles.*

- *Expenses related to hours are driver pay plus half of the fringe benefits as follows:*
Hours Expense: [Operator Wages -Platform]+[Operator Wages - Other]+0.5([Paid Absences]+[FICA]+[Pension]+[Medical and Dental]+[Other Fringe Benefit])*
- *Expenses related to pull-outs are the fixed management fee plus utilities as follows:*
Pullout Expense: [Management Fee]+[Utilities]
- *Expenses related to miles are all other expenses as follows:*
Miles Expense: [Total Monthly Expense]-[Hours Expense]-[Pullout Expense]

These totals are then divided by rolling twelve month total hours, pullouts or miles as applicable to obtain monthly unit factors that, again, are based on the past twelve months of operation. The rolling twelve month process was selected since some expenses tend to be "one" time such as insurance premiums. The factors are then applied against the actual scheduled hours, miles, or pull-outs for each route.

Service Provision

The general decreasing trend in vehicle service hours shown **Exhibit 44** for Routes A, B and C and other routes is likely due to schedule changes. It appears that TheBus has adjusted the schedules to better serve the demand over the past few years. Minor route changes could also have affected vehicle service hour provision. More information is needed from DTS and OTS to confirm this conclusion.

Vehicle service miles are closely linked to vehicle service hours. Consequently, schedule changes may also explain the decreases in vehicle service miles for Routes A, B, and C shown in **Exhibit 45**. Minor route changes could also affect vehicle service miles. More information is needed from DTS and OTS to confirm this conclusion.

As shown in **Exhibit 46**, Routes A, B, and C have greater values of vehicle service miles per vehicle service hour than their comparable local routes reflecting their higher operating speed. By decreasing the number of stops compared to the local routes, the BRT routes except for Route E had operating speeds as much as 20% higher than comparable routes.

Exhibit 44: Vehicle Service Hour (VSH) Provision

	FY2002	FY2003	FY2004	FY2005	% of Total System (FY2005)	% Change: FY02 to FY05
All Routes	**1,394,798**	**1,361,569**	**1,223,128**	**1,354,915**	**100.0%**	**-2.9%**
A	**68,564**	**63,969**	**54,146**	**59,623**	**4.4%**	**-13.0%**
1	105,401	103,026	91,172	100,658	7.4%	-4.5%
3	60,899	59,087	54,722	59,596	4.4%	-2.1%
B	**51,870**	**46,334**	**38,410**	**42,225**	**3.1%**	**-18.6%**
2/13	135,426	130,809	114,860	127,017	9.4%	-6.2%
C	**47,633**	**46,209**	**41,097**	**45,187**	**3.3%**	**-5.1%**
40	73,152	72,377	65,063	71,249	5.3%	-2.6%
E	**n/a**	**n/a**	**n/a**	**31,515**	**2.3%**	**n/a**
19/20	58,508	58,715	52,838	59,341	4.4%	1.4%
42	55,349	55,831	51,122	58,333	4.3%	5.4%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.

Exhibit 45: Vehicle Service Mile (VSM) Provision

	FY2002	FY2003	FY2004	FY2005	% of Total System (FY2005)	% Change: FY02 to FY05
All Routes	**19,042,633**	**18,603,402**	**16,531,305**	**18,243,518**	**100.0%**	**-4.2%**
A	**863,686**	**815,437**	**698,268**	**766,685**	**4.2%**	**-11.2%**
1	1,098,467	1,083,974	968,800	1,066,614	5.8%	-2.9%
3	663,022	639,409	540,590	588,069	3.2%	-11.3%
B	**420,274**	**404,062**	**356,340**	**390,746**	**2.1%**	**-7.0%**
2/13	1,076,899	1,006,848	861,616	950,947	5.2%	-11.7%
C	**1,091,788**	**914,813**	**890,706**	**999,736**	**5.5%**	**-8.4%**
40	1,252,347	1,236,716	1,112,790	1,215,613	6.7%	-2.9%
E	**n/a**	**n/a**	**n/a**	**243,569**	**1.3%**	**n/a**
19/20	626,828	644,588	583,888	634,403	3.5%	1.2%
42	717,946	711,040	642,255	707,610	3.9%	-1.4%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004 and ended in June 2005.

Exhibit 46: Vehicle Service Miles per Vehicle Service Hour

Operating Speed - Vehicle Service Miles per Vehicle Service Hour					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**13.7**	**13.7**	**13.5**	**13.5**	**-1.4%**
A	**12.6**	**12.7**	**12.9**	**12.9**	**2.1%**
1	10.4	10.5	10.6	10.6	1.7%
3	10.9	10.8	9.9	9.9	-9.4%
B	**8.1**	**8.7**	**9.3**	**9.3**	**14.2%**
2/13	8.0	7.7	7.5	7.5	-5.9%
C	**22.9**	**19.8**	**21.7**	**22.1**	**-3.5%**
40	17.1	17.1	17.1	17.1	-0.3%
E	**n/a**	**n/a**	**n/a**	**7.7**	**n/a**
19/20	10.7	11.0	11.1	10.7	-0.2%
42	13.0	12.7	12.6	12.1	-6.5%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004.

Operating Cost Efficiency

A number of performance indicators are used in the industry to track operating efficiency and productivity. Most have to do with normalizing operating costs, passenger trips, or subsidy by some measure of production such as VSH, VSM or passengers.[5]

5 *The reader is referred to the FTA report "Characteristics of Bus Rapid Transit for Decision-Making", page 4-13 for more information on operating cost efficiency.*

As shown in **Exhibit 47**, Routes A and C have higher operating costs per VSH. This is likely because the larger 60-foot articulated buses are used in these routes. The decreased number of stops offset some of the higher cost through increased fuel efficiency and decreased wear; however, on a per VSH basis, the BRT routes generally tend to be slightly more expensive than comparable local routes but less expensive than the average of all routes with some notable exceptions. It has been difficult to confirm these conclusions because of the lack of route-level operating data from TheBus and that the diverse fleet is not dedicated to particular routes.

Route B uses standard 40-foot buses similar to the local routes. In FY2004 and FY2005, Route B had lower operating costs than its comparable local routes. This is likely due to decreased number of stops and increased operating speeds, which increase fuel efficiency and reduce wear on the buses.

The short duration of Route E makes any comparison difficult, but it appears that in FY005 that the larger hybrid buses used were less costly to operate on a per VSH basis than the 40-foot buses used on the local routes. This is probably because the hybrid buses were new and/or because of the higher fuel efficiency of the hybrid engines; however, confirmation of this fact was not received from DTS or OTS.

Exhibit 47: Operating Cost per Vehicle Service Hour

Cost Efficiency - Operating Cost per Vehicle Service Hour					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**$80.19**	**$86.18**	**$91.30**	**$93.67**	**16.8%**
A	**$74.67**	**$80.07**	**$84.35**	**$87.03**	**16.5%**
1	$67.18	$72.08	$76.33	$78.74	17.2%
3	$67.44	$72.91	$77.85	$78.78	16.8%
B	**$56.18**	**$61.19**	**$66.11**	**$68.44**	**21.8%**
2/13	$59.07	$62.99	$65.01	$66.53	12.6%
C	**$93.80**	**$92.37**	**$104.87**	**$112.90**	**20.4%**
40	$87.07	$91.22	$89.15	$100.39	15.3%
E	**n/a**	**n/a**	**n/a**	**$65.40**	**n/a**
19/20	$66.87	$72.50	$77.87	$77.91	16.5%
42	$73.21	$75.55	$74.99	$83.39	13.9%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004.

Exhibit 48 shows that BRT Routes A, B and C consistently have lower operating costs per VSM than their comparable local routes. The greater operating speed possible on the BRT routes increases the number of VSM. The operating costs are somewhat higher on BRT routes using larger vehicles due to increased fuel consumption. However, since labor costs are similar and VSM are higher, the result is higher operating cost efficiency for the BRT routes except for Route E. The short duration of Route E makes comparisons difficult, but it appears that the larger hybrid buses used were more costly on a per mile basis than the 40-foot buses used on the local routes because of significantly lower operating speed shown in Exhibit 49.

Exhibit 48: Operating Cost per Vehicle Service Mile

Cost Efficiency - Operating Cost per Vehicle Service Mile					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**$5.87**	**$6.31**	**$6.76**	**$6.96**	**18.4%**
A	**$5.93**	**$6.28**	**$6.54**	**$6.77**	**14.2%**
1	$6.45	$6.85	$7.18	$7.43	15.3%
3	$6.19	$6.74	$7.88	$7.98	28.9%
B	**$6.93**	**$7.02**	**$7.13**	**$7.40**	**6.7%**
2/13	$7.43	$8.18	$8.67	$8.89	19.6%
C	**$4.09**	**$4.67**	**$4.84**	**$5.10**	**24.7%**
40	$5.09	$5.34	$5.21	$5.88	15.7%
E	**n/a**	**n/a**	**n/a**	**$8.46**	**n/a**
19/20	$6.24	$6.60	$7.05	$7.29	16.8%
42	$5.64	$5.93	$5.97	$6.87	21.8%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004.

As has been the case in most of the transit industry, there has been a general upward trend in operating costs likely driven by rising fuel and labor costs. As shown in **Exhibit 49**, Routes A, B, C and E have greater operating costs per passenger trip than their comparable local routes. To a certain extent, this is consistent with the higher level of service (higher frequency, higher capacity) provided by the BRT routes, and it can also indicate lower operating efficiency due to few passenger trips. In terms of operating costs per passenger trip, Route A was 14-27% higher, Route B was 30% higher, and Route C was 37% higher than comparable local routes in FY2005. However, the rates of increase in operating cost per passenger trip are considerably lower for Routes A and B than their comparable local routes over the last fours years. In contrast, Route C's costs are increasing faster than its comparable local route.

Exhibit 49: Operating Cost per Passenger Trip

Cost Effectiveness - Operating Cost per Passenger Trip					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**$1.68**	**$1.73**	**$2.00**	**$2.01**	**19.9%**
A	**$1.49**	**$1.50**	**$1.58**	**$1.58**	**6.1%**
1	$1.01	$1.04	$1.22	$1.24	22.4%
3	$1.21	$1.28	$1.49	$1.38	13.6%
B	**$1.17**	**$1.07**	**$1.18**	**$1.25**	**7.2%**
2/13	$0.82	$0.86	$0.94	$0.96	17.0%
C	**$3.03**	**$2.87**	**$3.67**	**$3.54**	**17.0%**
40	$2.40	$2.28	$2.36	$2.59	8.0%
E	**n/a**	**n/a**	**n/a**	**$2.16**	**n/a**
19/20	$1.38	$1.45	$1.65	$1.32	-3.9%
42	$1.47	$1.41	$1.51	$1.66	13.5%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004.

As shown in **Exhibit 50**, the BRT routes have generally fewer passenger trips per service hour than their local comparable local routes. However, Routes A, B and C did not experience the decline following the strike and fare rate increase in 2003 as some comparable local routes. Routes A and B in particular have improved in this measure more than comparable local routes. This also suggests a possible future convergence of service effectiveness as the BRT service levels are optimized to the demand.

Exhibit 50: Passenger Trips per Vehicle Service Hour

Service Effectiveness - Passenger Trips per Vehicle Service Hour					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**47.8**	**49.9**	**45.7**	**46.5**	**-2.6%**
A	**50.0**	**53.2**	**53.3**	**54.9**	**9.8%**
1	66.3	69.1	62.6	63.4	-4.3%
3	55.6	57.2	52.3	57.2	2.9%
B	**48.1**	**57.2**	**56.2**	**54.6**	**13.6%**
2/13	71.8	73.2	68.9	69.1	-3.8%
C	**31.0**	**32.1**	**28.5**	**31.9**	**2.8%**
40	36.3	39.9	37.7	38.7	6.7%
E	**n/a**	**n/a**	**n/a**	**30.2**	**n/a**
19/20	48.6	49.9	47.2	58.9	21.2%
42	49.9	53.4	49.7	50.1	0.4%

Data from September 2003 is excluded from this analysis, as this was a strike month.
Route E began operations in November 2004.

The BRT routes generally have fewer passenger trips per VSM, as presented in **Exhibit 51**. This may be due to BRT alignments producing less ridership per mile than more established routes, and it may also reflect longer trip distances than local services. It may suggest that the BRT routes can be optimized to increase their service effectiveness. Furthermore, the rate of growth is generally lower than comparable local routes, with only Route A outperforming one local route.

Exhibit 52 presents the revenue generated per VSH. With the exception of Route A, the BRT routes have lower revenue generation efficiency than comparable local routes. However, Routes A and B have improved more rapidly than the comparable local route in this measure. Following the fare increase in October 2003, the BRT routes experienced similar or greater revenue increases than their comparable local routes.

Exhibit 53 shows that the BRT routes consistently have a lower farebox recovery ratio than their comparable local routes. Routes A and B have experienced higher growth in farebox recovery, but have not reached the levels of their comparable local routes.

For Exhibits 51 through 53, the Data from September 2003 is excluded from these analyses, as this was a strike month.

Exhibit 51: Passenger Trips per Vehicle Service Mile

Service Effectiveness - Passenger Trips per Vehicle Service Mile					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**3.5**	**3.6**	**3.4**	**3.5**	**-1.3%**
A	**4.0**	**4.2**	**4.1**	**4.3**	**7.6%**
1	6.4	6.6	5.9	6.0	-5.8%
3	5.1	5.3	5.3	5.8	13.5%
B	**5.9**	**6.6**	**6.1**	**5.9**	**-0.5%**
2/13	9.0	9.5	9.2	9.2	2.2%
C	**1.4**	**1.6**	**1.3**	**1.4**	**6.5%**
40	2.1	2.3	2.2	2.3	7.1%
E	**n/a**	**n/a**	**n/a**	**3.9**	**n/a**
19/20	4.5	4.5	4.3	5.5	21.5%
42	3.8	4.2	4.0	4.1	7.4%

Exhibit 52: Fare Revenue Generated per Vehicle Service Hour

Fare Revenue Generated per Vehicle Service Hour					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**$20.67**	**$22.28**	**$24.95**	**$29.81**	**44.3%**
A	**$22.57**	**$23.75**	**$31.86**	**$35.48**	**57.2%**
1	$24.95	$25.68	$31.55	$34.87	39.8%
3	$23.26	$23.74	$29.19	$34.34	47.6%
B	**$19.55**	**$23.12**	**$31.04**	**$32.20**	**64.7%**
2/13	$28.16	$28.56	$36.06	$39.01	38.6%
C	**$14.29**	**$14.52**	**$17.60**	**$20.35**	**42.4%**
40	$17.51	$18.64	$23.56	$25.91	48.0%
E	**n/a**	**n/a**	**n/a**	**$21.28**	**n/a**
19/20	$28.51	$28.20	$34.90	$48.80	71.2%
42	$27.43	$28.64	$35.49	$38.51	40.4%

Exhibit 53: Route-Level Farebox Recovery Ratio

Revenue Generation - Route-Level Farebox Recovery Ratio					
	FY2002	FY2003	FY2004	FY2005	% Change: FY02 to FY05
All Routes	**25.8%**	**25.9%**	**27.3%**	**31.8%**	**23.5%**
A	**30.2%**	**29.7%**	**37.8%**	**40.8%**	**34.9%**
1	37.1%	35.6%	41.3%	44.3%	19.3%
3	34.5%	32.6%	37.5%	43.6%	26.4%
B	**34.8%**	**37.8%**	**46.9%**	**47.0%**	**35.2%**
2/13	47.7%	45.3%	55.5%	58.6%	23.0%
C	**15.2%**	**15.7%**	**16.8%**	**18.0%**	**18.3%**
40	20.1%	20.4%	26.4%	25.8%	28.4%
E	**n/a**	**n/a**	**n/a**	**32.5%**	**n/a**
19/20	42.6%	38.9%	44.8%	62.6%	46.9%
42	37.5%	37.9%	47.3%	46.2%	23.2%

5.4 TRANSIT-SUPPORTIVE LAND DEVELOPMENT

Transit-supportive land development refers to promoting greater accessibility, employment, and economic opportunities by concentrating development, increasing property values, and creating more livable places near transit services. As with rail services, the effectiveness of BRT depends in part on the successful integration of the BRT elements and their application with both the existing and future land developments in the corridor. BRT investments can have long-term impacts on future land developments in the corridor and enhance economic activity.

Based on discussions with DTS staff, it is not believed that the introduction of the Honolulu BRT services alone had a substantial impact on transit-supportive land development. DTS works closely with other departments of the City to integrate its service planning with ongoing land use planning efforts (such as the Islandwide Mobility Concept Plan, the Primary Urban Center Development Plan, and other neighborhood-based plans). As a result, DTS deemed that it was not practical to isolate out the specific land development impacts that the BRT services have had.

5.5 ENVIRONMENTAL QUALITY

Environmental quality is an indicator of regional quality of life, supporting the health and well-being of the public and the attractiveness and sustainability of the urban and natural environment. There are three potential environmental improvement mechanisms as a result of the implementation of BRT in a corridor:

- Technology Effect – Reduced corridor bus emissions due to the propulsion technology
- Ridership Effect – Trips diverted from private vehicles which increase transit ridership
- System Effect – Reduced vehicle emissions from reduced corridor congestion

The 10 hybrid buses operated in Route E and now in Route A have a direct technology effect on emissions. Their higher fuel efficiency translates to lower emissions per mile or hour of service, particularly when using ultra-low sulfur diesel or in comparison with older diesel buses. A wider ridership shift from older buses to newer, cleaner buses on BRT routes may also have reduced emissions but was not quantifiable.

The introduction of the BRT services did not appreciably increase systemwide ridership, however it did have an impact on corridor ridership along Route C. As much as 40% of the new ridership may have come from other, more polluting modes. Again, the emission impact is not quantifiable but assumed to be positive.

There were not data available to determine whether the BRT routes had any impact on corridor-level congestion. Overall, the impact of the BRT routes on environmental quality has been positive but minimal and not quantified.

6.0 CONCLUSIONS

The Honolulu Express! bus system is a case study of the benefits and costs of a very limited and incremental BRT deployment. With minimal capital investment, the Honolulu BRT system has primarily served to reduce travel times and improve services for riders who switched from local routes to BRT routes. Greater benefits in terms of improving ridership, customer satisfaction, capital and operating cost effectiveness, transit supportive land use, and environmental quality may be possible with more significant investments in dedicated running ways, advanced vehicles, stations, ITS elements, and fare collection. The project has also highlighted some key lessons in the following areas.

6.1 SUMMARY OF LESSONS LEARNED

Planning and Outreach - The BRT system planned for Oahu was one feature of a strategic transit service plan developed with extensive public participation in the late 1990s by DTS to reconfigure the transit network to a “hub-and-spoke” system. This process, formally known as “Oahu Trans 2K”, involved more than one hundred public meetings and included over a thousand Oahu residents and commuter members. Several decisions since then, which were influenced by public opinion or resistance from other state agencies, have not allowed the BRT system to maximize its potential benefits through improved operations. For example, DTS decided during planning to defer or cancel plans to implement exclusive BRT lanes and direct access ramps. Continued planning and outreach is needed to determine the future direction of BRT plans in Honolulu.

ITS and Fare Systems - Several advanced technologies were planned, tested, but few have been implemented thus far as part of Honolulu’s BRT initiatives. For example, real-time traveler information on-board the AVL-equiped buses and at major stations was originally planned and tested on Route E, but implementation has been delayed because of unresolved technical, integration and data problems. At the time of this report, “On-Street” signs displaying travel information are currently planned for installation. It was also decided that implementing signal prioritization would have negatively impacted traffic along the corridor. Finally, DTS has not implemented off-vehicle fare collection or multiple door entry to vehicles in order to maintain a single fare collection interface across all fixed routes.

Had the planning of these systems been allowed to follow the traditional system engineering analysis process, which is required for federally-funded ITS projects, the implementation of the technologies may have gone smoother.[6] This process, which includes the analysis of stakeholders and needs, concept of operations, requirements definition, alternatives, procurement options, standards and procedures, and operations and maintenance, may have mitigated the problems encountered and/or improved the outcome of deployment.

Route E Planning and Discontinuation - Route E was quickly implemented in 2004, despite city council concerns and the rescinding of federal funding. There was criticism that the route was not adequately planned and did not provide high-quality, rapid service as

[6] *The reader is referred to the following link for documentation on the FHWA Rule on ITS Architecture and Standards and FTA National ITS Architecture Policy for Transit Projects:*
http://www.fta.dot.gov/legal/federal_register/2001/361_1547_ENG_HTML.htm

intended. Morever, the branding and unique livery of Route E buses may have created initial confusion for passengers. The service was ultimately discontinued in June 2005 due to poor ridership performance and high costs. The termination of Route E may also lead investors and developers to question the permanence of the BRT routes, making them wary of making or promoting long-term investments that are served by a BRT route.

Costs and Benefits – There was not enough information to determine if the balance of costs and benefits presented by the Honolulu BRT system is optimal in the present or future. However, the Honolulu BRT project and system is an interesting case study of the benefits and costs of a very limited BRT deployment. Considering the minimal capital investment in infrastructure, the BRT routes deliver measurable travel time savings to riders (as high as 33% over comparable local routes) by eliminating stops. These savings were achieved with a modest increase in operating costs per vehicle service hour for Routes A and C, primarily due to the use of larger buses, and no increase for Route B compared to local routes. Greater benefits may be possible with more significant investments in dedicated running ways, advanced vehicles, stations, ITS elements, and fare collection.

Furthermore, the fully allocated costs of the Honolulu BRT system increased at a lower rate than the transit system as a whole, but the BRT routes are generally less cost effective in terms of operations. At the same time, the revenue increase on BRT routes due to the fare increase was superior to overall revenue increases. This suggests that the BRT routes are a more expensive but effective method of retaining ridership during fare increases.

Evaluation Limitations – There were also a number of lessons for the evaluation of BRT systems in the course of conducting this evaluation of the Honolulu BRT system. The lack of certain data prohibited a more comprehensive analysis of the following characteristics in support of the objectives of the BRT Initiative outlined in the first section of this report:

- **Ridership.** Impacts on ridership pre- and post-BRT implementation were difficult to assess because the BRT routes often did not replace or overlap with local routes. Consequently it became difficult to identify comparable segments and isolate the effect that the BRT components had on ridership. For example, while the corridors served by BRT were able to maintain or slightly increase ridership levels despite systemwide decreases, there were other significant factors such as the September 2003 strike and a fare increase that affected ridership levels.
- **ITS Implementation.** The limited implementation of ITS constrained the assessment of typical BRT technologies in providing riders with enhanced traveler information and improving the quality of bus service.
- **Cost Data.** The lack of detailed data on capital and operational costs has limited the level of analysis on cost effectiveness and operational efficiency of the BRT routes. Planned and actual costs by component would allow a more comprehensive evaluation of the implementation and operation of the BRT system.
- **Land Use and Environmental Quality**. Impacts on land use around a BRT system requires a controlled, before-and-after assessment in order to identify relationships between development and transit planning. For the Honolulu BRT system, the impacts on land use development could not be isolated due to integrated land use planning efforts. The impacts on environmental quality were limited by the fact that vehicles are not dedicated to any specific routes and by the absence of corridor-level congestion and emissions data.

6.2 SUMMARY OF SYSTEM PERFORMANCE

The Honolulu BRT routes possess several basic BRT characteristics, including limited stops and express services, and minimal capital investments in running ways or ITS. Stop spacing is greater than comparable local routes on overlapping segments, allowing for improved travel speeds and travel times. Station dwell times for local and BRT routes are comparable, largely because of the absence of multi-entry boardings and off-board fare collection methods. While dedicated bus lanes were planned, only Route C currently operates in a bus lane for part of the alignment while the other routes share road space with general traffic. The amount of travel time savings and improved reliability is not as significant as BRT systems with some dedicated or exclusive lane treatments.

For the most part, DTS does not dedicate a fleet of specialized vehicles to the BRT services. Vehicle and station design do not possess a differentiated design with the exception of 10 articulated hybrid buses with a silver livery. Stations except for Route E are also shared with local routes, making it difficult to easily recognize and emphasize BRT service.

Although the buses are equipped with AVL technology, the Honolulu BRT routes do not take full advantage of these systems, which are currently not fully operational, to improve service quality and operations. Implementation of these technologies could yield greater benefits in travel time savings, customer satisfaction and ultimately increased ridership.

Travel Time

Travel time savings on all operational Honolulu BRT routes (Routes A, B and C) were compared to local routes on parallel or overlapping segments. While overall impact on travel time savings on Route A was difficult due to the short segments of comparable local routes, Routes B and C offered travel time savings in both directions and in all time periods of the day as high as 33% compared to local routes. Travel time savings are likely due to the significant reduction in the number of stops (approximately half the stops on Route B, and one-quarter on Route C). Increased spacing between stops also yielded higher average speeds on BRT routes compared to comparable local routes. The average wait time on BRT routes was between 6 and 10 minutes according to a passenger survey.

Reliability

The results of the schedule adherence analysis on the BRT routes and comparable local routes were mixed. Adherence to schedules (on-time if within 0 to +5 minutes) was higher on Route A than on the comparable Route 3, but lower than the also comparable Route 1. Route B has lower schedule adherence than Route 2. Schedule adherence improved the most on Route C, which recorded more on-time trips, although it is the longest route examined. Routes B and E were the most likely to run late.

The results of service reliability in terms of average revenue miles between service disruptions was mixed with Routes B and C performing better than comparable local routes, but Route A and E had worse performance.

Safety and Security

Passenger surveys to measure the sense of safety and security customers feel on the BRT routes were not available. Using accident rates as a measure of safety and security, the results again were mixed, which reflects an alignment without any traffic separation or preferential treatment. Improvements and comparisons of accidents per 10,000 vehicle service miles on BRT routes and comparable local routes were not consistent for all the BRT routes. Compared to their respective local routes, accident rates were lower on Route B, while Routes A and C had similar rates and Route E had a high accident rate before being discontinued in June 2005.

Customer Satisfaction

The vast majority of riders surveyed gave TheBus service, including the BRT routes, a “Good” or “Outstanding” rating and about 1% of riders rated the service “Poor” or “Very Poor”. The BRT routes had similar satisfaction ratings as the overall TheBus system. Route A had the highest percentage of respondents rating the service as “Good” or “Outstanding”, while Route B had the highest percent of respondents rating the service as “Poor” or “Very Poor”.

6.3 SUMMARY OF SYSTEM BENEFITS

Ridership

Ridership analysis showed that most BRT customers were previous users of local routes. The implementation of the BRT routes generally did not yield significant increases in ridership on these corridors except for Route C. The labor strike on September 2003, followed immediately by a fare increase in October 2003, significantly affected ridership, which fell almost 20% during this period. Although systemwide ridership has largely recovered since 2003, the direct impact of BRT routes on ridership are only estimated on a corridor level because systemwide ridership impacts are difficult to isolate.

The introduction of the BRT services did not appreciably affect TheBus ridership from a systemwide perspective. This may be explained by the fact that the BRT routes carry less than 13% of the overall system ridership and therefore do not have a large impact systemwide. It also indicates that most BRT riders were existing transit riders who changed to the new BRT system from other transit services.

Introduction of BRT service on the Route A corridor initially increased ridership. The effects of the strike and fare increases in FY04 diminished ridership significantly. Ridership has now returned to pre-BRT levels, which is significant given that fares have almost doubled in the meantime.

The Route B corridor experienced similar patterns as Route A, except that its recovery has not been as robust. It is currently approximately 15% below pre-BRT levels. However, given the fare increases this is still noteworthy.

Route C ridership reached about 4,500 by December 2000 – indicating that about 1,800 of the Route C ridership base (4,500 minus 2,700) were new riders who were brought to the system. Therefore, it is estimated that the Route C ridership is composed of about 40% new riders and 60% existing bus riders. It is not known what portion of the new ridership came from other modes or where induced by the BRT service.

Following the September 2003 strike, ridership on both Routes C and 40 dipped slightly, but not as much as most of the other routes.

TheBus had a fixed route cash fare increase from $1.00 to $1.50 in July 2001 (monthly pass from $25.00 to $27.00), and another increase from $1.50 to $2.00 in October 2003 (monthly pass from $27.00 to $40.00). The second of these fare increases boosted the average fare paid per trip from $0.43 in FY02 to $0.64 in FY05 (an increase of 48%). As a result, fare revenue increased by 40% from FY2002 to FY2005 – despite a ridership drop of 5.4% during the same period. Fare revenue generated on Routes A, B, and C increased by about 35% from FY2002 to FY2005.

Capital Costs

Given the low level of detail provided for the capital costs, very limited analysis was possible to gauge the capital cost effectiveness of the project. The short duration of Route E and the lack of more detail in the capital costs provided makes it difficult to perform a comprehensive analysis of capital cost effectiveness. The capital investment for Routes B and C were also small but consistent with BRT projects with minimal running way segregation and/or grade separation. They resulted in increased ridership and decreased travel times. The capital investment for Route C also caused measurable improvements in travel time, ridership and reliability.

Operating Costs

An analysis of the operating cost efficiency associated with the BRT routes and comparable local routes showed relative improvement, especially considering the larger vehicles used on routes A and C:

- Systemwide operating costs for TheBus increased by 13.5% from FY2002 to FY2005. Operating costs for Routes A, B, and C changed by 1.3%, -0.8%, and 14.2% respectively during the same time period.
- By decreasing the number of stops compared to the local routes, the BRT routes except for Route E had operating speeds as much as 20% higher than comparable routes.
- Routes A and C have higher operating costs per VSH likely because the larger 60-foot articulated buses are used in these routes. In FY2004 and FY2005, Route B had lower operating costs than its comparable local routes. This is likely due to decreased number of stops, which increases fuel efficiency and reduces wear on the buses.
- BRT Routes A, B and C consistently have lower operating costs per VSM than their comparable local routes.
- Routes A, B, C and E had greater operating costs per passenger trip than their comparable local routes. However, the rates of increase in operating cost per passenger trip are considerably lower for Routes A and B than their comparable local routes over the last fours years.
- BRT routes have generally fewer passenger trips per service hour than their local comparable local routes. However, Routes A, B and C did not experience the decline following the strike and rate fare in 2003 as some comparable local routes.
- The BRT routes generally have fewer passenger trips per VSM.
- With the exception of Route A, the BRT routes have lower revenue generation efficiency than comparable local routes. BRT routes consistently have a lower farebox recovery ratio than their comparable local routes.

Land Development

It is not believed that the introduction of the Honolulu BRT services alone had a substantial impact on transit-supportive land development, although the affects could not be determined at this time.

Environmental Quality

Overall, the impact of the BRT routes on environmental quality has been positive but minimal and not quantifiable. The Honolulu BRT service does not have dedicated vehicles for its routes, which makes it difficult to isolate the technology effects of the BRT service on environmental quality. However, the ten hybrid-electric articulated vehicles in the fleet did demonstrate higher fuel economy compared to standard diesel-powered articulated buses. Environmental improvements from BRT service effects in diverting trips from private vehicles and reducing congestion could not be quantified.

APPENDIX A: ZIPPER LANE SPEED IMPACTS

To determine the travel speed impacts of the Zipper Lane, traffic data were obtained from the State of Hawaii Department of Transportation Traffic Data Collection and Management Program (provided by the Planning Branch, Highway Division). Seven weeks of weekday-only traffic speed data (one week for each month from Jan-Jul 2005) were analyzed. The results are shown in **Exhibit A-1**.

Exhibit A-1: H-1 Freeway Average Speeds by Lane (in miles per hour)

Time of Day	Lane 1	Lane 2	Lane 3	Lane 4	Zipper Lane
5:30-5:45 am	56.3	55.1	50.9	49.3	52.4
5:45-6:00 am	54.9	52.6	49.9	47.3	51.0
6:00-6:15 am	53.9	52.3	48.9	47.3	49.1
6:15-6:30 am	51.0	49.1	46.4	45.3	47.1
6:30-6:45 am	48.1	46.9	44.3	42.9	45.6
6:45-7:00 am	50.0	49.1	45.0	45.7	47.0
7:00-7:15 am	53.3	49.4	45.7	44.9	46.9
7:15-7:30 am	55.4	52.7	48.7	47.6	49.1
7:30-7:45 am	56.0	53.6	50.7	49.6	50.1
7:45-8:00 am	58.7	56.6	53.6	52.1	53.6
8:00-8:15 am	59.4	57.9	53.6	52.1	55.0
8:15-8:30 am	59.6	57.0	53.9	54.1	56.0

Location of sensor counts is the H-1 Freeway at Halawa Stream Bridge.
Average speeds are based on seven weeks (35 weekdays) in 2005.

The data indicate that average travel speeds in the Zipper Lane tend to be roughly the same as speeds in the general purpose traffic lanes – meaning that the Honolulu BRT vehicles are not likely to generate much travel time savings from using the Zipper Lane relative to using other lanes. Nevertheless, the Zipper Lane improves travel speeds for all lanes since it widens the freeway from four lanes to five.

APPENDIX B: RIDECHECK SPEED DISTRIBUTIONS

Exhibit B-1: Eastbound Speed Distribution (AVL Data)

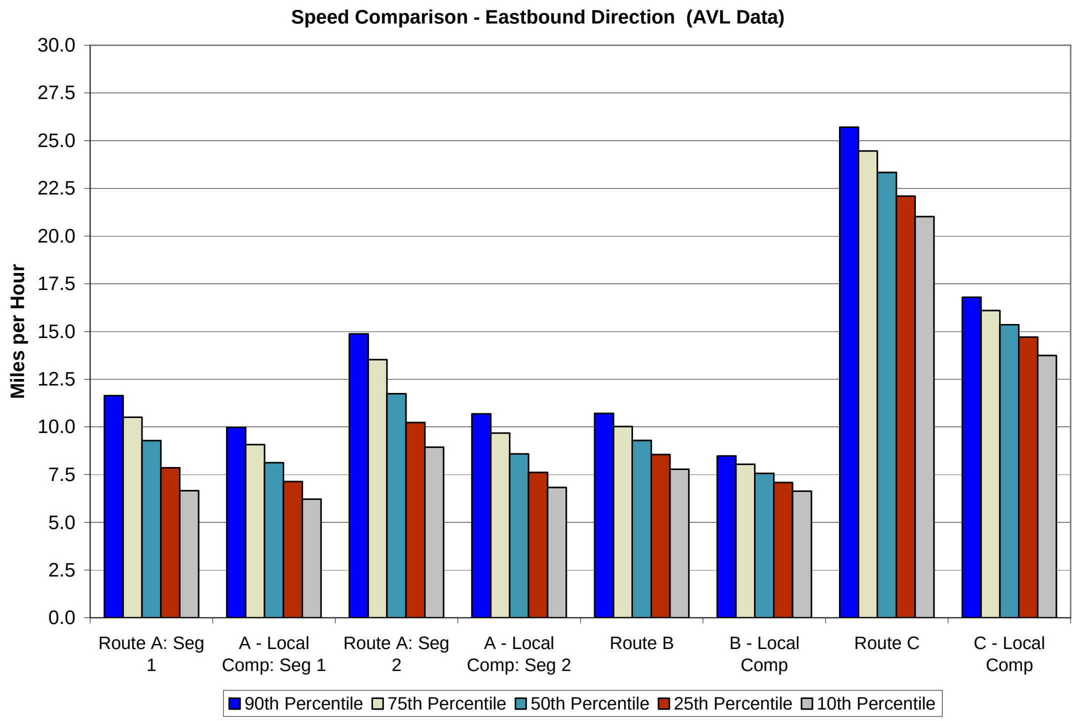


Exhibit B-2: Westbound Speed Distribution (AVL Data)

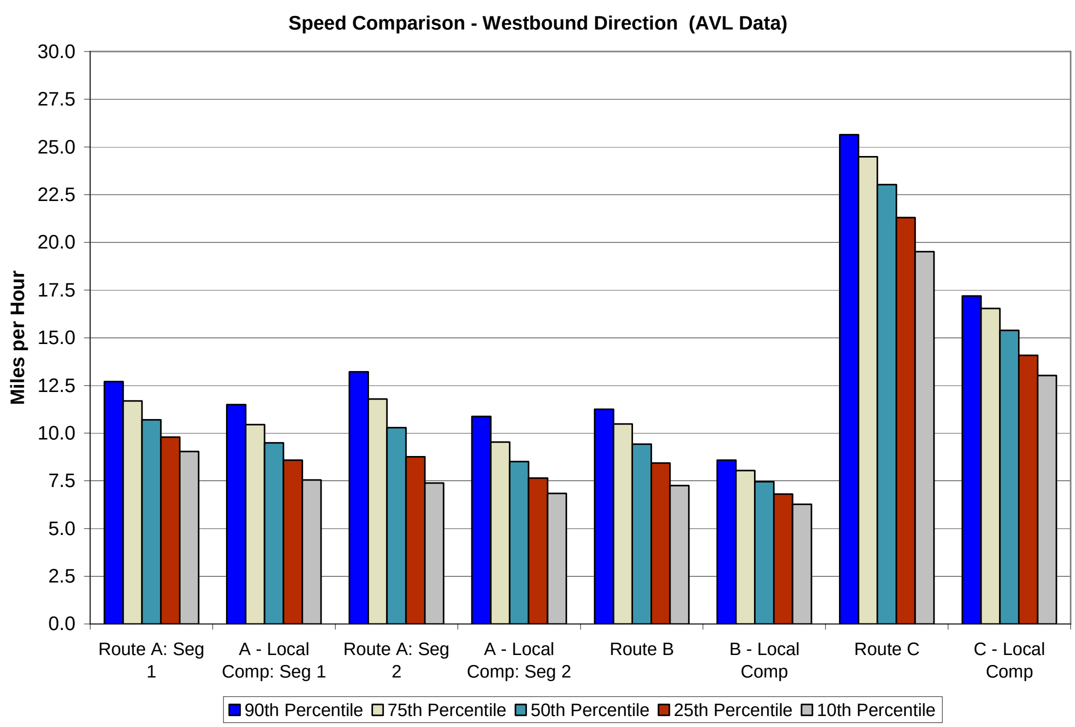
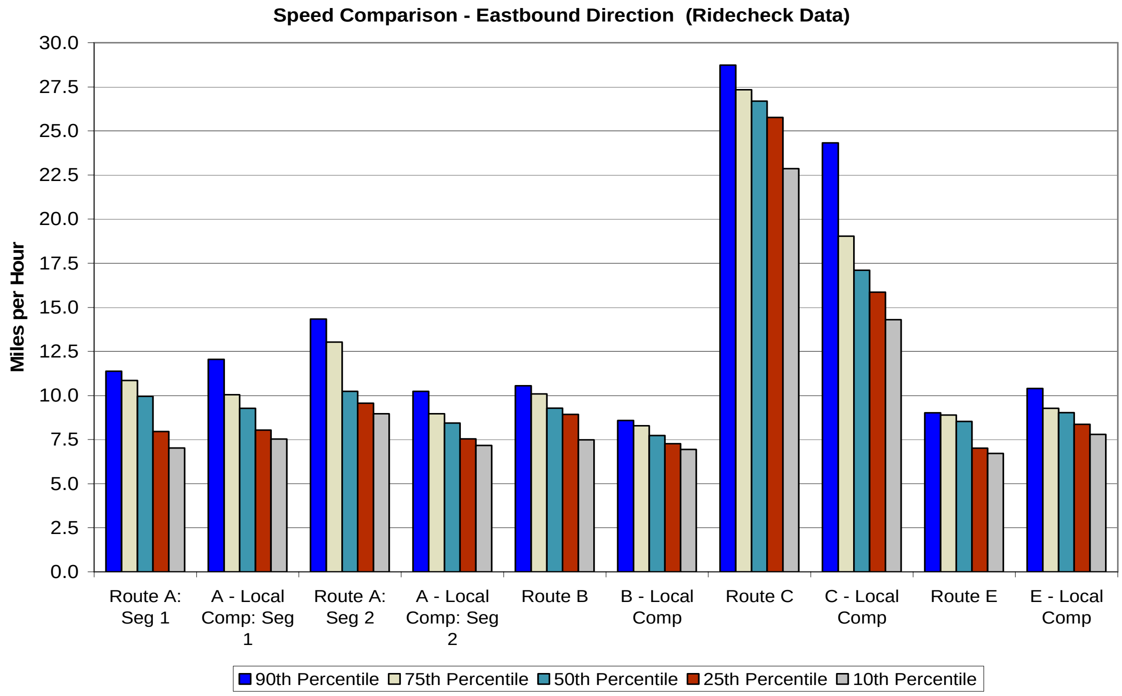
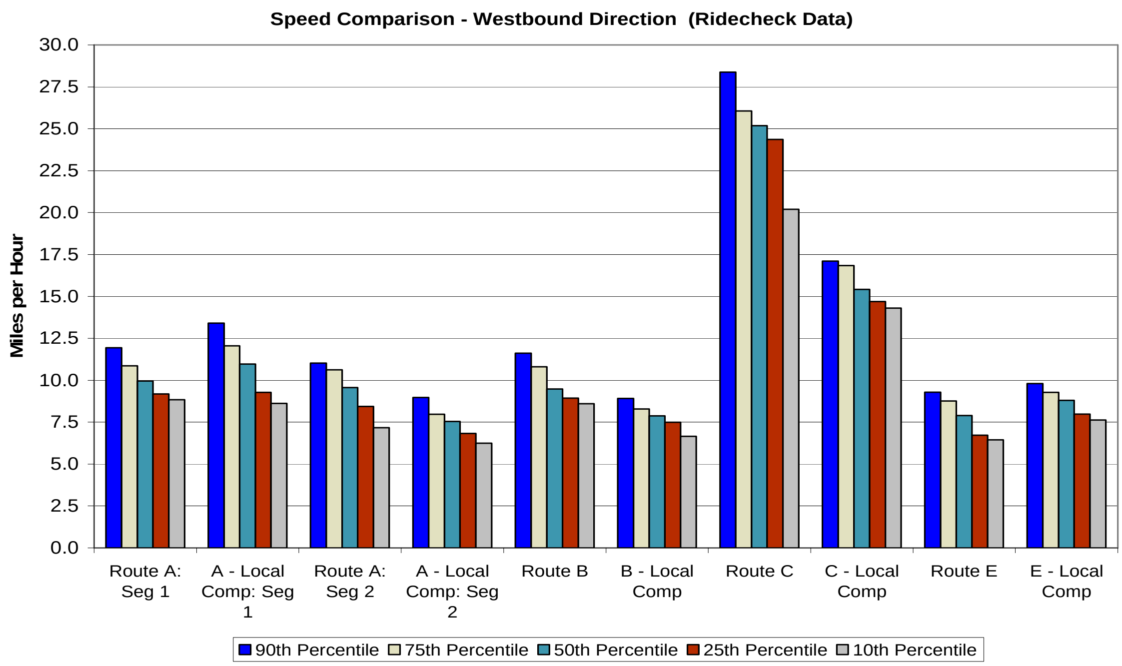


Exhibit B-3: Eastbound Speed Distribution (Ridecheck Data)



The eastbound speed distribution from the ridecheck data are similar to the eastbound speed distribution from the AVL data (from Exhibit A-1).

Exhibit B-4: Westbound Speed Distribution (Ridecheck Data)



The westbound speed distribution from the ridecheck data are similar to the west-bound speed distribution from the AVL data (from Exhibit A-2).

APPENDIX C: LOAD DISTRIBUTIONS BY ROUTE BY DIRECTION

Exhibit C-1: Load Distribution Route A – Eastbound

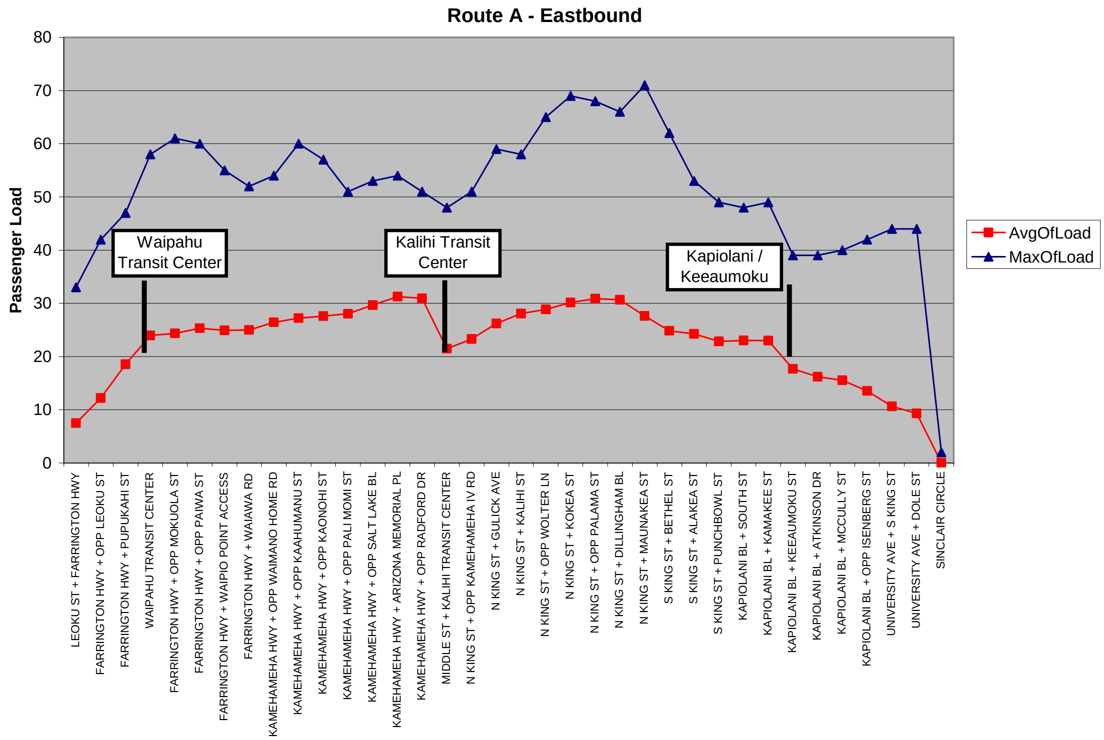


Exhibit C-2: Load Distribution Route A – Westbound

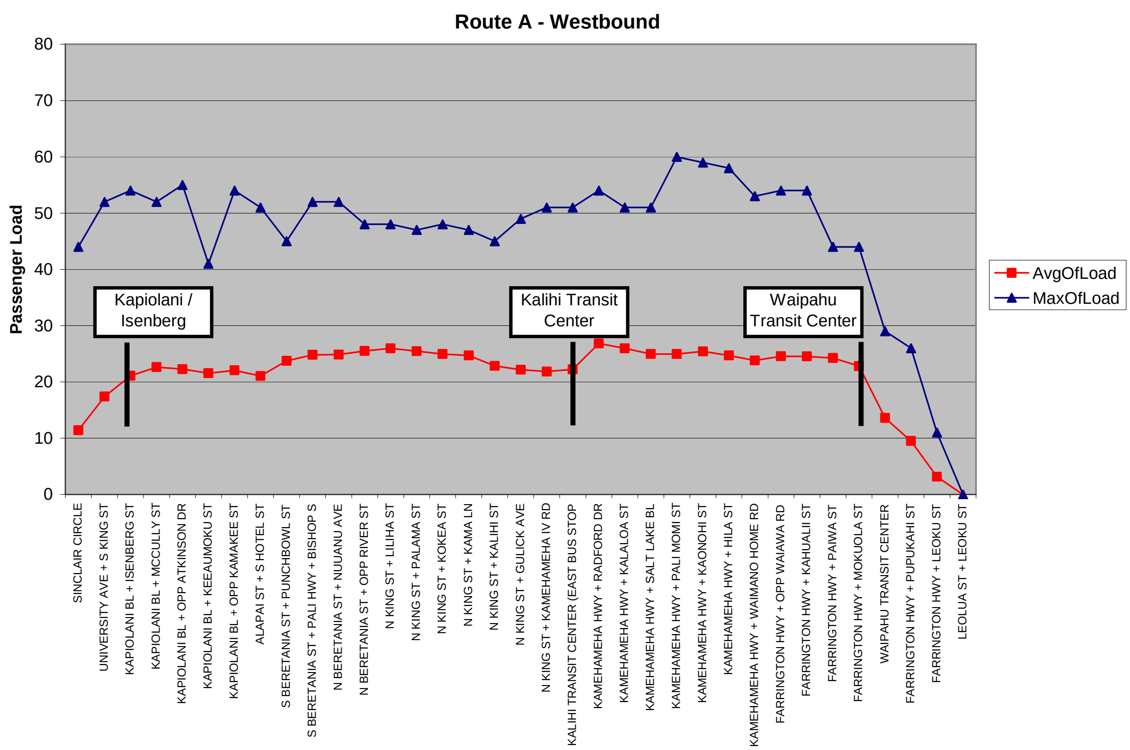


Exhibit C-3: Load Distribution Route B – Eastbound

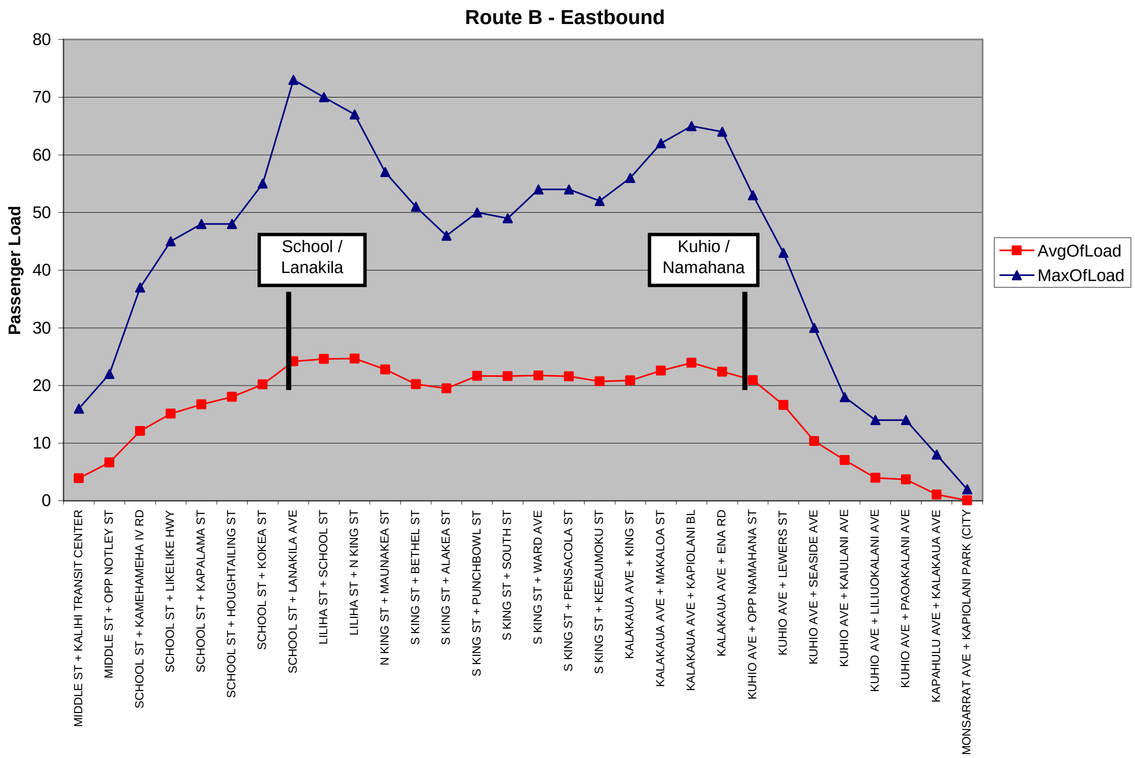


Exhibit C-4: Load Distribution Route B – Westbound

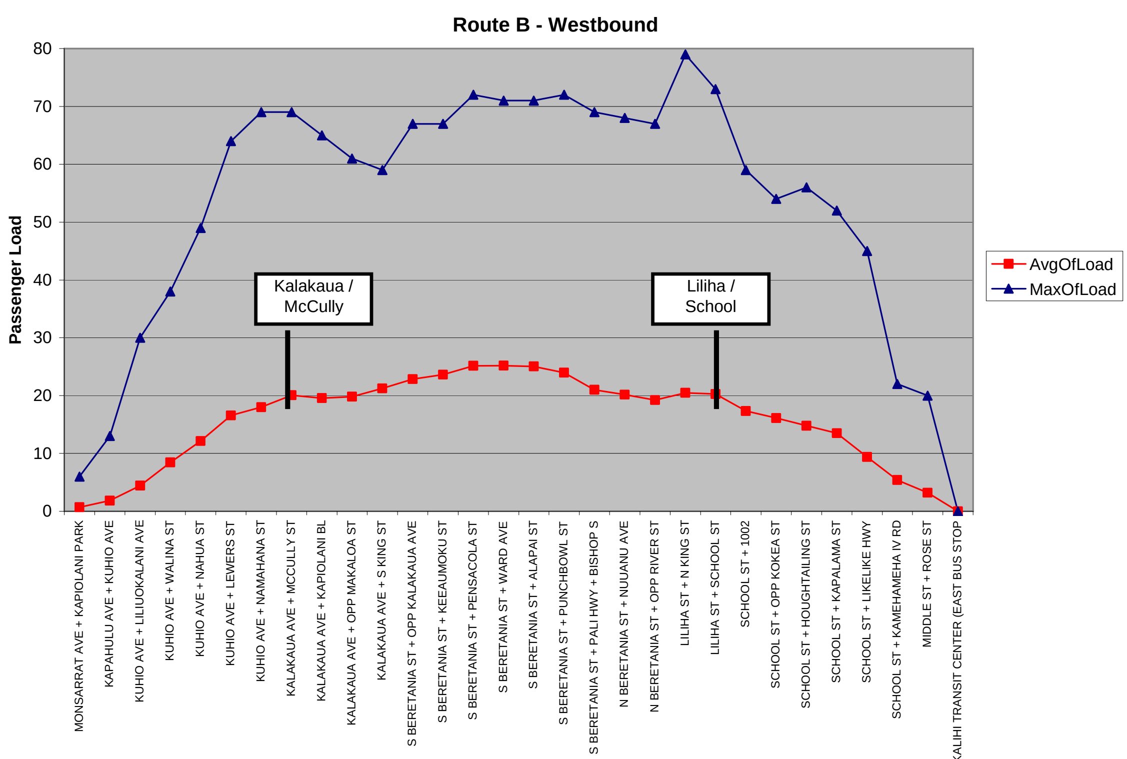


Exhibit C-5: Load Distribution Route C – Eastbound

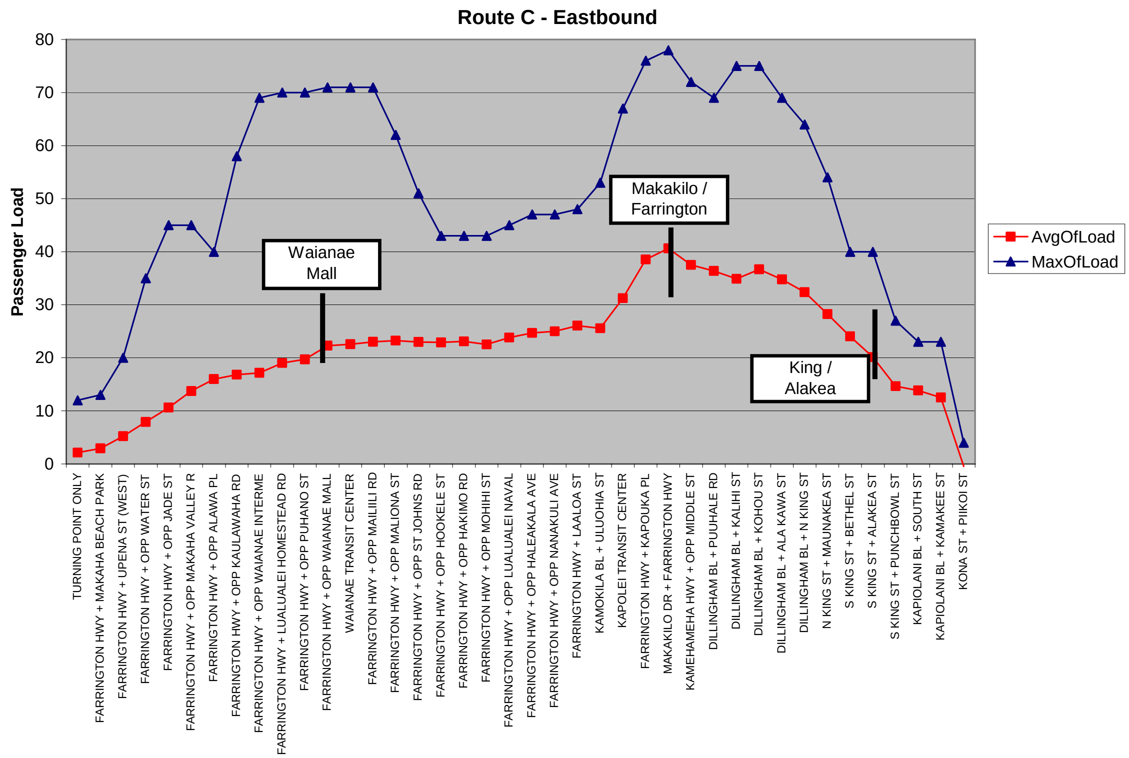


Exhibit C-6: Load Distribution Route C – Westbound

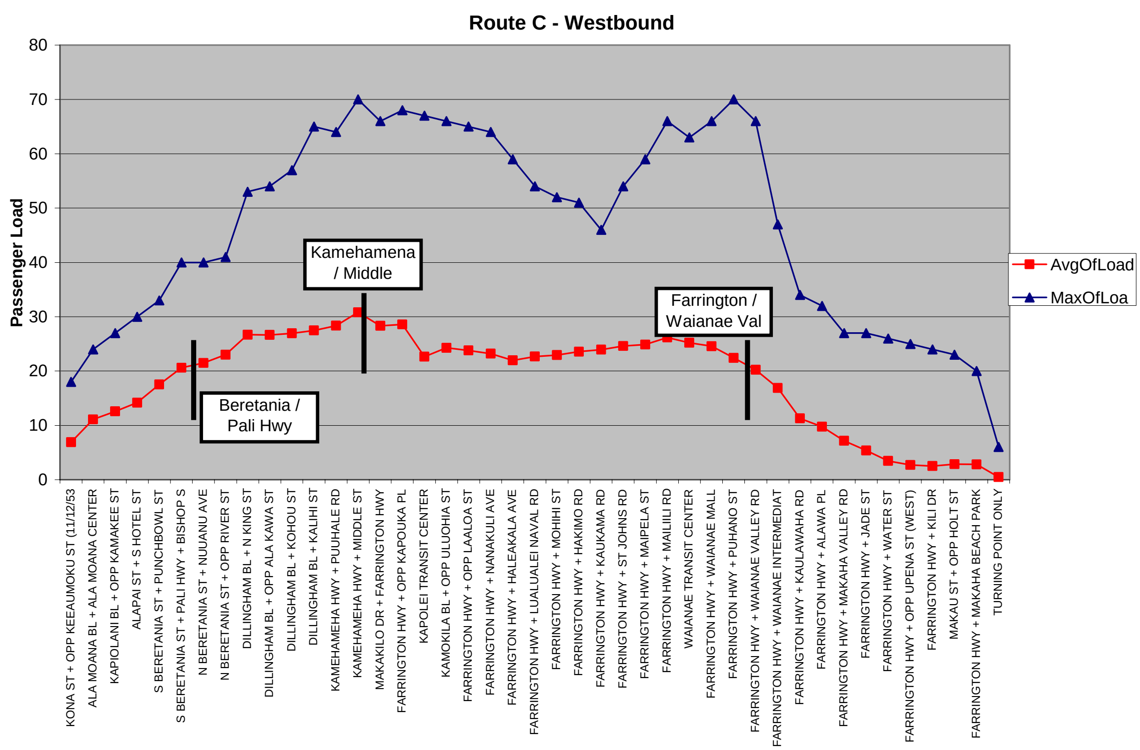


Exhibit C-7: Load Distribution Route E – Eastbound

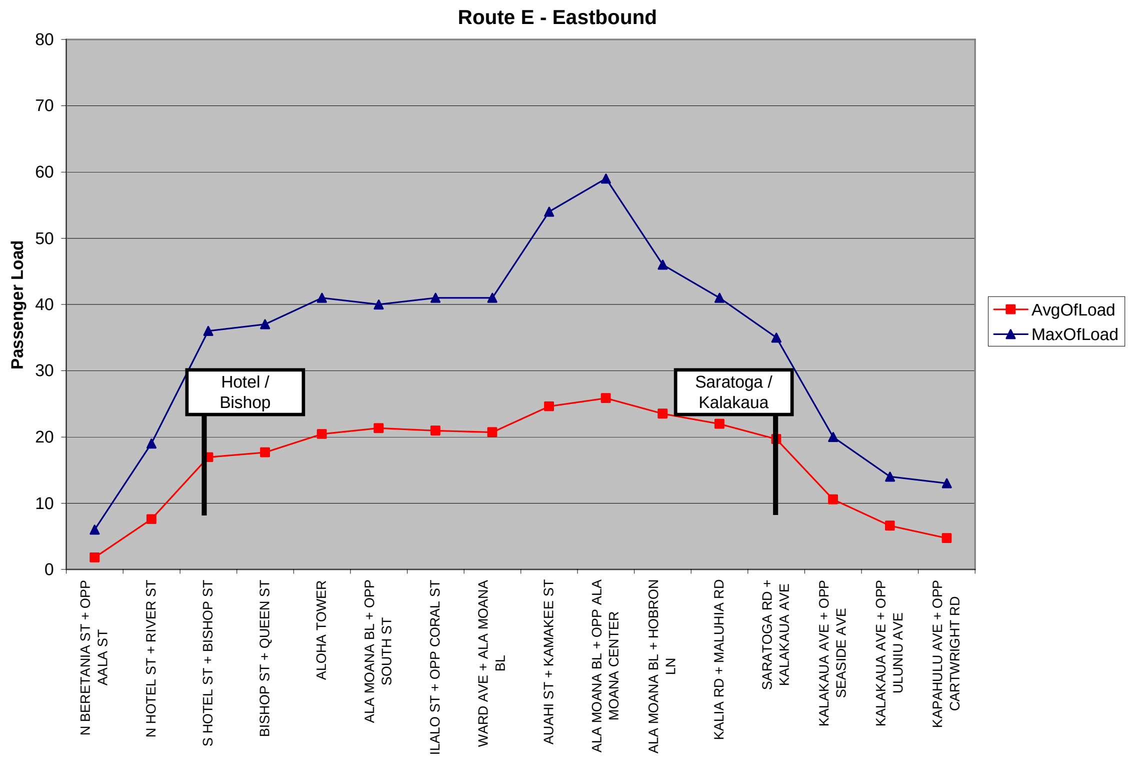


Exhibit C-8: Load Distribution Route E – Westbound