Deliverable W-3

Benefit Cost Analysis of Potential Projects in the Wahiawa/Whitmore Village Area of the

Central Oahu Transportation Study

Prepared for

Oahu Metropolitan Planning Organization

Prepared by

SSFM International, Inc. with

Fehr & Peers and

Weslin Consulting Services, Inc.

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OVERVIEW OF THE CENTRAL OAHU TRANSPORTATION STUDY

The Central Oahu Transportation Study (COTS) will assess the multi-modal transportation needs of the region and identify key transportation system improvements, strategies and policies that can improve regional transportation mobility and access in a sustainable way. The strategies and system improvements will be technically feasible, financially realistic, sustainable, and meet regional transportation needs.

Previous work for the COTS included the development and analysis of projects in the Central Oahu area south of California Avenue in Wahiawa. These projects are regional in nature and will also benefit users in Wahiawa, Whitmore Village, and beyond.

After community concerns were expressed about the study area, OahuMPO decided to expand the study area to include all of Wahiawa and Whitmore Village. There will be four reports documenting the results of the study for the expanded study area. The reports include:

W-1 Identification of the Trends and Issues impacting the COTS area. This report describes the demographics, economic, and land trends occurring in the study area, and it identifies the impacts of those trends.

W-2 Presents the list of projects, their descriptions, and locations. This report provides an assessment of the Performance Measures and a Feasibility Assessment.

W-3 The Financial Assessment will be documented in this report. Financial assumptions and requirements including costs will be reviewed. The benefits and costs of the alternatives will be assessed and compared including any identified trade-offs.

W-4 The Final Report on Prioritization and Recommendations for Implementation will summarize and prioritize strategies; identify recommendations; identify impacts of no implementation; recommend an implementation timeframe; and, identify any impacts if implementation is not accomplished within the recommended timeframe.

Upon completion of the review of the projects in the expanded study area and further review in the affected communities, the lists of projects for the original and expanded study area will be combined into a final report.

Deliverable W-3 is organized as follows:

- Overview of the COTS Project and this Deliverable
- Executive Summary
- Section 1: Introduction
- Section 2: Benefit Analysis
- Section 3: Cost Analysis
- Section 4: Costs and Benefits Over Time
- Section 5: Compare and Contrast
- Section 6: Next Steps

EXECUTIVE SUMMARY

Benefit Cost Analysis (BCA) is a method of analyzing potential investments. It compares monetized benefits against financial capital and operating costs to see if an investment is reasonable. BCA is expressed as either a ratio (benefits divided by costs) or as net present value which subtracts costs from benefits. The BCA ratio over 1.0 has a positive benefit. A Net Present Value with a positive sign (greater than zero) has a positive benefit. The purpose of conducting BCA is to help consider the individual merit of a project to determine if it justifies further commitment of resources and continued planning. It is important to understand that BCA is only one method of analysis. Many times, project purposes go beyond what can be given a dollar value. An example is social equity, making the transportation investment available to those who are underserved, poor or from a minority population. For many decision-makers these non-quantified characteristics are more important than the BCA results.

There are many calculations that go into the BCA formula. Because this is a very early stage of planning, there are many assumptions that go into the development of monetary values. Among these are the base year (2018 in this study), time horizon (2040 in this study), inflation rate (1% in this study), and the time value of money/discount rates. These terms, procedures, and assumptions follow the *US DOT Benefit-Cost Analysis Guidance for Discretionary Programs* (2017) and certain other specialized guidance by mode.

Benefits

Benefit calculations for roadways typically include travel time savings, auto operating cost savings, safety, and emissions reductions. The benefits for transit projects include the same variables plus congestion reduction, mobility and equity, noise reduction, health, and reduced auto use/parking cost. Bicycle and pedestrian benefits include mobility and equity, recreational, health, and reduced auto use/parking cost.

Because benefits accrue over multiple years, for each project an opening date must be determined. The benefits start accruing in that year and continue through 2040. Future year benefits are discounted by 7% per guidance.

The total benefits for all COTS projects in the Wahiawa-Whitmore Village sub-area, taking into account future years, is shown in **Table ES-1**.

Costs

Costs for projects are made up of three parts. First, is the construction cost (and/or purchase of equipment for transit). This was initially calculated in 2018 dollars. It is inflated by 1% (per HDOT guidance) to an assumed year of construction, sometimes up to ten years ahead if the project is not already on the Statewide Transportation Improvement Program (STIP). Second, is the cost of land. Not all projects require additional land. For those that do, an assumption was made about the unit cost of an acre by reviewing adjacent parcels from the City & County Real Property records. Third, is the cost of operations and maintenance (O&M). This cost was calculated using national costs (for roadways and bicycle/pedestrian projects) and using Honolulu costs (for transit projects). O&M is a cost which is needed every year versus a one-time cost such as construction or land. Therefore, O&M costs were inflated up 1% from opening year to 2040.

The costs for all COTS projects, taking into account future years are shown in **Table ES-2**.

Benefit Cost Comparison

The benefit cost comparison is expressed at a ratio. Because benefits and costs are streamed over many years, a discount rate is applied. The rate of 3% is considered the most appropriate rate by the study preparers because these are public projects not requiring a return on investment other than the transportation benefits reflected in the project goals. Federal BCA guidance allows use of 3%, but only if BCA is also calculated at 7% (which is a rate commonly used for private investments). **Table ES-3** in this executive summary shows the BCA using the 3% discount rate. Negative numbers in the benefits columns mean that there is a negative benefit (i.e., no benefit for that project in that benefit category). Tables for both 3% and 7% discount rate can be found in **Section 5.1** of this report.

The highest transit project BCA at 3% discount rate is Project 702: Increase bus service to/from Schofield and Wahiawa (BCA = 4.26).

The highest bicycle and pedestrian facility is Project 804: New and upgraded bike lanes in Wahiawa Commercial District: Kamehameha Highway, California Avenue, and Lehua Street (BCA = 4.35).

The highest roadway access BCA ratio is Project 911: Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing (BCA = 180.95). Project 912: California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing also has a high BCA at 94.39.

Table ES-1. Cumulative Benefits for Wahiawa-Whitmore Village Area Projects in the COTS

Project Number	Project Description	Start Year	End Year	Travel Time Saving	Vehicle Operating Cost Saving	Safety	Emissions Reduction	Congestion Reduction	Mobility & Equity	Noise Reduction	Recreational	Health	Reduced Auto Use/ Parking Cost	TOTAL BENEFITS (7%)	TOTAL BENEFITS (3%)
700 Transit Projects															
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$187,680	$489,768	$222,225	$30,125	$1,562,595	$130,050	$2,530	--	$223,670	$115,796	$22,054,892	$34,293,521
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$225,216	$587,722	$266,670	$36,150	$1,875,113	$156,060	$3,037	--	$268,404	$138,956	$26,465,871	$41,152,225
703	Expanded Late Night Service, Routes 51/52	2025	2040	$168,912	$440,791	$200,003	$27,112	$1,406,335	$117,045	$2,277	--	$201,303	$104,217	$19,849,403	$30,864,169
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$1,313,760	$1,313,760	$777,789	$105,436	$5,469,079	$446,250	$8,857	--	$782,845	$405,287	$107,494,471	$143,516,933
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$123,831	$323,149	$146,624	$21,159	$1,030,998	$85,807	$1,670	--	$147,577	$76,402	$10,458,648	$17,423,351
800 Bicycle and Pedestrian Projects															
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	--	--	--	--	--	$43,206	--	$1,386,781	$290,373	$12,338	$14,165,783	$22,775,944
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	--	--	--	--	--	$32,608	--	$743,067	$141,185	$691	$4,368,304	$7,868,811
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	--	--	--	--	--	$35,054	--	$430,700	$27,482	$2,975	$5,986,608	$9,604,225
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	--	--	--	--	--	$13,402	--	$258,420	$10,872	$468	$2,402,974	$3,880,095
900 Roadway and Traffic Operations Projects															
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$633,583		$4,869	$4,742							$6,599,887	$8,900,235
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$1,589,348	$(97,889)		$(4,089)							$13,594,531	$17,298,759

Project Number	Project Description	Start Year	End Year	Travel Time Saving	Vehicle Operating Cost Saving	Safety	Emissions Reduction	Congestion Reduction	Mobility & Equity	Noise Reduction	Recreational	Health	Reduced Auto Use/ Parking Cost	TOTAL BENEFITS (7%)	TOTAL BENEFITS (3%)
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$780,292		$2,032,172	$4,742							$29,999,778	$44,130,149
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$402,624	$421,546		$2,501							$7,555,753	$9,614,539
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$94,197			$4,742							$1,015,217	$1,369,064
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$637,155		$27,863	$4,742							$6,872,484	$9,267,843
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$753,643		$9,288	$4,742							$8,174,761	$12,025,203
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$295,123			$4,742							$3,193,189	$4,697,231
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$112,608										$1,199,137	$1,763,949

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Table ES-2. Cumulative Costs for Wahiawa-Whitmore Village Projects in the COTS

Project Number	Project Description	Start Year	End Year	Construction	Land	Operation & Maintenance	TOTAL COSTS
700 Transit Projects							
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$1,897,000	--	$8,387,322	$10,284,322
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$1,897,000	--	$7,766,039	$9,663,039
703	Expanded Late Night Service, Routes 51/52	2025	2040	$3,095,000	--	$10,354,719	$13,449,719
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$26,686,100	--	15,532,100	$42,218,200
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$3,310,200	--	$3,457,345	$6,767,545
800 Bicycle and Pedestrian Projects							
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$23,181,900	--	$64,000	$23,245,900
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$4,364,600	$182,000	$6,000	$4,552,600
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$6,356,900	--	$38,400	$6,395,300
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$893,000	--	--	$893,000
900 Roadway and Traffic Operations Projects							
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$3,519,700	--	$45,258	$3,564,958

Project Number	Project Description	Start Year	End Year	Construction	Land	Operation & Maintenance	TOTAL COSTS
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$17,999,000	--	$108,619	$18,107,619
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$7,303,048	--	$32,327	$7,335,375
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$30,289,000	$44,178,508	$238,963	$74,706,470
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,974,000	--	$9,698	$1,983,698
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$3,134,000	$867,792	$24,362	$4,026,154
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$60,000	--	$4,500	$64,500
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$45,000	--	$3,300	$48,300
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2024	2040	$3,519,700	--	$45,258	$3,564,958

Table ES-3. Benefit Cost Ratio for COTS Projects (3% Discount Rate for Benefits)

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
700	**Transit Projects**					
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$34,293,521	$10,284,322	3.33
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$41,152,225	$9,663,039	4.26
703	Expanded Late Night Service, Routes 51/52	2025	2040	$30,864,169	$13,449,719	2.29
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$143,516,933	$46,503,204	3.09
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$17,423,351	$6,767,545	2.57
800	**Bicycle and Pedestrian Projects**					
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$22,775,944	$23,245,900	0.98
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$7,868,811	$4,552,600	1.73
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$9,604,225	$6,395,300	1.50
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$3,880,095	$893,000	4.35
900	**Roadway and Traffic Operations Projects**					
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$8,900,235	$3,746,771	2.38
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$17,298,759	$19,802,492	0.87

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$44,130,149	$7,557,637	5.84
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$9,614,539	$81,698,996	0.12
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,369,064	$2,084,867	0.66
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$9,267,843	$4,231,488	2.19
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$12,025,203	$66,454	180.95
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$4,697,231	$49,763	94.39
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$1,763,949	$184,939	9.54

1.0 INTRODUCTION, ASSUMPTIONS, AND METHODOLOGY

The Central Oahu Transportation Study (COTS) is preparing several analyses to assist in decision making for which of many alternatives should be selected for possible funding and implementation. There are three types of projects being reviewed, and the report presents results according to the project type. This is in part because it is not appropriate or meaningful to compare projects of different types; for example, to compare a pedestrian sidewalk to a light rail system.

- Transit Projects
- Bicycle and Pedestrian Projects
- Roadway and Traffic Operations Projects

This report (Deliverable W-3) calculates project costs and benefits.

1.1 Purpose of Benefit Cost Analysis (BCA)

The purpose of a Benefit Cost Analysis (BCA) is to prepare objective, fact-based information to assist in decision making. BCA assesses values in dollar terms. This is a useful piece of information using units (i.e., dollars) readily understood by most.

Given the high degree to which assumptions have to be made, BCA should not be used as an absolute method for comparing projects, except possibly among those who have the same characteristics for mode. Other limitations to consider are:

- For some of the higher cost projects, the availability (or likely non-availability) of funding may be a more important consideration than its BCA ratio.
- Benefits can be harder to quantify than Costs. For projects with a high degree of social purpose, such as providing mobility to low income, senior, or persons with disabilities, BCA is not the most appropriate tool.

Even projects which have several benefits that can be measured, they will also have unmeasurable benefits which need to be "made visible," that is, explained in the narrative as important, but not measured in the equations.

1.2 How the Benefit Cost Analysis was Completed

The procedures and values used in this analysis were developed using USDOT guidance, professional best practices, and computing techniques, which are explained in the various sections. A full list is found in the References at the end. Where Hawaii data and information was available, it was used; otherwise, national default values were used. Several of the study team also participated in a three-day BCA Workshop in Honolulu, Hawaii, which was delivered by Graduate School USA.

Among the key resource documents are the following:

- US Department of Transportation (USDOT). 2017. *Benefit Cost Analysis Guidance for Discretionary Programs.*
- Office of Management and Budget (OMB) *Circular A-94*. 1992. And the most recent update (November 2017) of Appendix C: Additional Guidance for Discounting.
- OMB *Circular A-4*: This circular concerns regulatory impact analysis when economic impact exceeds $100 million annually. While Circular A-4 is less pertinent to this project, its discussions on time horizon, baseline, and sensitivity analysis are helpful.

The BCA was done by first, separately calculating the benefits and costs of each project and checking them for reasonableness. The sources for benefit estimation vary by project type and are explained in the

paragraphs below. Benefits for roadway projects use variables that are very commonly calculated, including travel time savings, operating cost savings and safety. The bicycle and transit projects have project purposes that include a less commonly used category of benefits known as Livability, which is meant to connote economic development and access to mobility (equity); and Environmental Sustainability such as reduced auto use and emission reductions. A literature search yielded a few cases that could be followed, none from Hawai'i. Benefits considered by type of project are provided in **Table 1**. Benefit calculations are provided in **Chapter 2.0**.

Cost estimations include construction, land, and operations and maintenance (O&M). These calculations are provided in **Chapter 3.0**.

Second, both benefits and costs are considered over multiple years and need to be either inflated or discounted. This is explained in **Chapter 4.0**.

Table 1. Benefits by Project Type

Type Project	Benefit 1	Benefit 2	Benefit 3	Benefit 4	Qualitative
Transit	Travel Time Saving	Vehicle Operating Cost Saving	Safety	Emission Reduction	Congestion Equity Noise Parking
Bicycle and Pedestrian	Mobility	Recreation	Health	Auto Use	--
Roadway	Travel Time Saving	Operating Cost Saving	Safety	Emission Reduction	--
TDM, ITS, and Pricing	Travel Time Saving	--	--	--	--

Finally, for conducting the comparison of Benefits and Costs, two methods were used. The first was the Benefit Cost Ratio which is a sum of the present value of all benefits divided by the present value of all costs. Values greater than 1 indicate that the project has a favorable ratio. Those with values less than 1 indicate an unfavorable ratio. The second method of comparison was to subtract the sum total of Costs from the Sum total of Benefits to get the Net Present Value. When the result is greater than Zero, it is favorable, when it is less than Zero, it is unfavorable. The return on investment (ROI) method which measures the Net Present Value divided by Initial Investment Cost was not used. This is explained in **Chapter 5.0**.

1.3 Assumptions Made

In preparing the BCA calculations, several assumptions had to be made which are explained here.

Time Horizon. The time horizon covers the time period when the economic costs and benefits take place. It begins when the action is implemented or constructed and available to the public for use. The time horizon continues as long as the action is in effect, or until it has reached its useful life. This study looks at benefits and costs in one-year increments.

One of the basic principles of BCA is that actions need to be comparable, that is using the same units of measure. Since the "start" point of many of the projects being analyzed here is uncertain, a uniform ten-year projection for "start" was used for any project not already contained in the State Transportation Improvement Program (STIP). The start year used is 2028. The standard period of analysis selected was the study forecast year of 2040. Thus, for those costs that have a stream of values, at least twelve years

of benefits was applied, or longer if it was to start sooner than 2028. For many projects, there is a residual value beyond that period, but that is not part of the calculation for BCA.

- **Baseline**. The baseline year for analysis selected for this study was 2018. The baseline is necessary to allow assessment of relative benefits and costs attributable to the proposed project or action compared to not taking the action.
- **Time Value of Money and Discount Rate**. Because a dollar today is worth more than a dollar at a future date, this difference is factored into the benefit cost analysis through discounting or compounding to compute going from present value to future value. Factors for calculating these values can be looked up in tables to simplify the task. This study used both the factor tables for Annuity (annual payments) and Single Payments to look at something over a period of years. The tables were provided in the Workshop Participant Guide (Graduate School USA, 2018), although they can be found in many other places, including electronically.
- **Inflation Rate**. Federal regulations (23 CFR 450.2.8(1)) require using year of expenditures when preparing financial plans. Guidance from the State of Hawaii Department of Transportation (HDOT) dated October 9, 2017 instructs the OahuMPO and others to use an inflation rate of 1% when preparing the STIP. This was based on recent Consumer Price Index (CPI-U) data.
- **Sensitivity Analysis**. BCA analysis requires predictions about the future, but the future is rarely certain. A sensitivity analysis shows how results of the analysis change if assumptions change. A good example of this is using the recommended 7% discount rate versus the lower 3% discount rate. The 7% rate is an estimate of average before-tax rate for private investments. The 3% rate has shown to be more accurate for government debt which is pre-tax. Federal guidance allows using the lower rate if the higher rate is also shown. Sensitivity analysis for discount rates was done in this study, for example, in the transit analysis.
- **Value of Time**. This measure recognizes that people have alternate choices (than travel) for how they use their time. Hourly wages is one such measure. The USDOT Guidance provides default values for time, and these were used in this project analysis.
- **Risk**. Risk is a measure of uncertainty. There are three attributes to risk: Cause, Risk Probability, and Risk Severity. This study mentions risk but does not calculate the probability (likelihood) or severity (impact) of risks identified. Another way of looking at risk is to ask the question, what impacts the ability to succeed and achieve the desired results?

1.4 Limitations in the Use of Benefit Cost Analysis

There are many challenges when preparing a BCA. There are many unique variables associated with each set of costs, benefits, and risks. The time period for analysis must be determined and dollar values associated with each time period. This study uses best practices/tools and techniques. There are very few examples of BCA to learn from in the transportation planning field. The study team did its best to make educated guesses on input decisions, to test them when possible, and to justify them in this report. They are subject to criticisms and debate, and different assumptions would lead to different results. Therefore, more so than in many other areas of analysis, it is critical that the methodology be laid out so that it can be understood and the logic followed by the reader.

The concern for the analyst is that the reader put too much importance into these BCA numbers simply because they are out there. As stated earlier, it is important to consider many other factors, and many that are not quantifiable and cannot be neatly placed into an equation. For completeness, non-quantified benefits are revealed and described so they are not lost. For some reviewers, the non-financial information will be of greater value.

BCA Guidance for Discretionary Grant Programs has been available from the USDOT since July 2017. This study uses that guidance including national default values for travel time savings, operating cost, value of statistical life/injuries/property damage, and pollutant emissions. The US Department of Transportation, Office of Inspector General (February 2018) recently conducted a review of BCA analyses submitted under the Transportation Investment Generating Economic Recovery (TIGER) grant program. BCA is part of the application qualification process. OIG found that the way BCA were developed and reviewed was not standardized and lacked key information and they called for more consistency. Stated another way, the practice of BCA in transportation is evolving.

2.0 BENEFIT ANALYSIS

Benefits of a transportation project are the direct, positive effects of that project. In other words, the desirable outcomes of investing in a project. For example, the project may reduce the number or severity of crashes, eliminate long delays during peak hours, or provide a shorter route. These benefits are translated into monetary values.

The following sections identify categories of benefits for the different project types: Transit, Bicycle and Pedestrian, and Roadway. Each benefit has a specific unit of measure that is calculated for each project for a single year. These units are assigned a value based on accepted transportation planning methods and literature. Therefore, each project has a monetary benefit that can be compared to other projects.

2.1 Identification and Monetization of Benefits for Transit Projects

Table 2 shows the benefits that are usually monetized in the United States Department of Transportation (USDOT) guidance for discretionary grants. These benefits include travel time savings, cost savings, safety, and environmental (e.g., emission reduction).

Qualitative based benefits are acknowledged but may be considered more difficult to quantify and monetize. Discussion on these benefits while recommended to be qualitative, have been monetized. For example, guidance states: "Currently, USDOT has not developed reliable means to estimate the public value of noise reductions for U.S. projects…" However, in 2013 the USDOT Federal Highway Administration provided a benefit valuation for noise based on vehicle miles traveled. It is acknowledged that Federal guidance changes, and it is appropriate to include quantitative-based benefits. Check marks identify those benefits which are included in the following transit project discussion.

Table 2. Transit Project Benefits

Guidance Based	Included in Review	Qualitative Based
Travel Time Savings	✓	Parking Cost Savings
Vehicle Operating Cost Savings	✓	Chauffeur Driver Savings
Safety	✓	Route Shift
Emissions Reduction	✓	Real Estate
Congestion	✓	Economic Benefits
Equity/Mobility	✓	Health
Noise	✓	Parking Cost Savings

2.1.1 Travel Time Savings

Travel time savings are calculated by identifying the number of passengers and the estimated travel minutes saved by the passenger with the project (minutes saved were averaged from selected origin and destination points).

Table 3 presents the travel time savings for the transit projects. Ridership was based on mode, service characteristics, and estimates of ridership from comparable projects.

Table 3. Transit Project Travel Time Savings

Project Number	Project Description		Travel Time	
		Weekday Passengers	Time Saved/Yr (person-hrs)	Total Annual Travel Time Benefit
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	500	12,750	$187,680
702	Increase bus service to/from Schofield and Wahiawa	600	15,300	$225,216
703	Expanded Late Night Service, Routes 51/52	450	11,475	$168,912
704	Bus Rapid Transit to Pearl Highlands Rail Station	1,750	89,250	$1,313,760
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	330	8,412	$123,831

2.1.2 Vehicle Cost Savings

Vehicle cost savings measures the savings realized by taking transit versus using a personal vehicle. Vehicle cost savings were calculated based on the following factors:

- Half the daily passenger estimate is assumed to be new users. The 50% estimate was based on the HART 2012 Transit Passenger Survey which found that over 55% of the current bus riders would drive or drive with someone else if the bus were not available. 50% was used as a conservative estimate.
- 53.8% will be traveling to work or college. This breakdown is based on the HART 2012 Transit Passenger Survey.
- Average miles travel saved.

Operating costs per mile are calculated on gasoline, maintenance, tires, and depreciation (assuming an average of 15,000 miles driven per year) as provided by the USDOT *Benefit Cost Analysis Guidance for Discretionary Grant Programs*. Fixed costs are not included in this calculation. The US DOT BCA Guidance document identifies per mile vehicle operating cost for a car as $0.40 per mile (in 2016 dollars) as shown in Table 8 of Appendix A. Inflation adjusted for 2018, this value is $0.42 per mile. **Table 4** shows the vehicle cost savings for each transit project.

Table 4. Transit Project Vehicle Cost Savings

Project Number	Project Description	Vehicle Cost Savings	
		Vehicle Miles/Saved Year	Total Annual Vehicle Operating Cost Benefit
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	1,166,115	$489,768
702	Increase bus service to/from Schofield and Wahiawa	1,399,338	$587,722
703	Expanded Late Night Service, Routes 51/52	1,049,504	$440,791
704	Bus Rapid Transit to Pearl Highlands Rail Station	4,081,403	$1,313,760
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	769,401	$323,149

2.1.3 Safety Benefits

Safety benefits were calculated based on the vehicle miles traveled saved and national experience of the safety factors that are shown in **Table 5**. These include monetized values for the fatality reduction, serious injury avoidance, and property damage that were avoided by a switch to the transit project.

Table 5. Transit Project Safety Benefits

Project	Project Description	Safety
		Total Annual Safety Benefit
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	$222,225
702	Increase bus service to/from Schofield and Wahiawa	$266,670
703	Expanded Late Night Service, Routes 51/52	$200,003
704	Bus Rapid Transit to Pearl Highlands Rail Station	$777,789
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	$146,624

The US DOT BCA guidance document includes the cost of various collisions from Property Damage Only (PDO) through fatalities with several levels of injury severity. At the high end, the cost of a fatal collision is the most expensive at $9,600,000 (in 2016 dollars). At the low end, the cost of a PDO collision is identified as $4,252. Inflation-adjusted to 2018 dollars these costs are as follows:

- PDO = $4,439
- Injury = $225,485
- Fatal = $10,021,548

It may seem odd to have a partial reduction for a fatality or partial numbers for injuries and property damage. However, these safety factors will be calculated over multiple years.

2.1.4 Emission Reduction

Emission reductions are based on the calculated vehicle miles traveled saved by switching to the transit project and how those miles saved impact emissions. Converting vehicle miles saved was converted to Greenhouse Gas (GHG) emission reductions by using the U.S. Environmental Protection Agency (EPA) Greenhouse Gas Calculator. The tool converts standard metrics for fuel use into metric tons of carbon dioxide equivalent, $MTCO_2e$ using standard national conversion factors (EPA, 2017). Monetization on those emissions are based on guidance received from the USDOT TIGER BCA Resource Guide (USDOT, 2015). Transit project emission reduction benefits are provided in **Table 6**.

Table 6. Transit Project Emission Reduction Benefits

Project Number	Project Description	Emission Reduction	
		Vehicle Miles/Saved Year	Emission Reduction Annual Cost Benefit
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	1,166,115	$30,125
702	Increase bus service to/from Schofield and Wahiawa	1,399,338	$36,150
703	Expanded Late Night Service, Routes 51/52	1,049,504	$27,112
704	Bus Rapid Transit to Pearl Highlands Rail Station	4,081,403	$105,436
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	769,401	$21,159

2.1.5 Additional Benefits for Transit Projects

Additional benefits that were monetized for transit projects include congestion reduction, mobility and equity, and noise reduction.

- **Congestion reduction** benefits includes factors such as delay, additional fuel consumption, reduced business activity, and employment opportunity losses. The Victoria Transport Policy Institute *Evaluating Public Transit Benefits and Costs* (2018) identified value ranges for congestion reduction on vehicle miles traveled (or kilometers). Their review showed a range from $1.20 per VMT saved in 2011 (which is $1.34 in 2018) to $2 per VMT ($2.24 in 2018). Congestion relief was valued at $1.34 per VMT saved to be on the conservative end of the range.
- **Mobility and equity** represent an important benefit for transit projects. A project can provide mobility to low-income, seniors, or disabled persons providing access to jobs and services that are otherwise not available or are too costly to access. Many low-income people rely upon taxis or rides from family and friends which can be inconvenient and in the case of taxis or ride share too expensive. Mobility and equity benefits were applied based upon $1.02 (in 2018 dollars) per passenger by 255 days was used for bus projects and $1.37 for high capacity transit projects. Economic studies would need to be performed to recommend a higher factor.

- **Noise reduction** was based on the FHWA guidance from 2013 noted previously in **Section 2.1**. Noise reduction is based on vehicle miles traveled (VMT) saved by a value of $217 (2018 value) per VMT. The value of the noise reduction benefit is low compared to the other benefits.
- **Health** cost savings of transit projects has been increasingly studied as the United States obesity levels rise. A 2017 study conducted by Zhaowei She, Douglas M. King, and Sheldon H. Jacobson showed that a one percent increase in public transit use resulted in a 0.221 percent decrease in obesity rates. This correlates with studies that have found that transit users walk more and walk longer distances that non-transit users.

  A 2008 study estimated the health care cost savings of implementing light rail transit in Charlotte, North Carolina. Estimates were based upon an obesity rate of 23%; Honolulu has a countywide obesity rate of 22.3%. Health care costs were identified as either direct or indirect and calculated using conservative estimates. Annual direct costs were estimated at $458 ($556.66 in 2018) and indirect costs at $429 (521.41 in 2018). A third category of "willingness to pay" was valued at $787 per year ($921.16 in 2018). This third category is based upon how much people are willing to pay each year for weight loss programs. The third category of cost savings is not included in this benefit calculation. Using the median public health costs saved resulted in an average savings per passenger boarding applied to public transit projects of:

  - $230.70 (2018) for Direct cost savings
  - $216.64 (2018) for Indirect cost savings
- **Parking** cost savings is another qualitative benefit that can be applied to transit projects. Typical parking cost savings recommended by the Victoria Transport Policy Institute for mode shifts from auto to transit for a round trip are identified as:
  - $9 for commute trips for large cities; $6 other trips
  - $6 for commute trips for medium sized cities; $4 other trips
  - $3 for commute trips for small sized cities; $2 other trips

  Many of Honolulu's employers provide parking at a discounted rate. However, other costs are involved in parking supply which include operations and maintenance. The recommended parking rates listed above include passenger and employer cost savings. Benefits were calculated on 50% of transit ridership estimated to be shifted from auto. Central Oahu commuters are estimated at 53.8% of the current transit trips (per DTS/HART surveys) with 46.2% composed of other trips. Commute trips were valued at $1.50 each trip (half of the round-trip amount) and non-commute trip parking cost savings were valued at $1. Parking cost savings were calculated for project 102.5 (Park & Ride Lot with Flyer Stop) as operations and maintenance costs are included within the cost structure of the project and benefits will be realized from other areas. **Table 7** presents the additional benefits that have been monetized for this project.

Table 7. Additional Transit Project Benefits

Project Number	Project Description	Qualitative Based Benefits				
		Congestion Reduction	Mobility & Equity	Noise Reduction	Health Cost Savings	Parking Cost Savings
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	$1,562,595	$130,050	$2,530	$223,670	$115,796
702	Increase bus service to/from Schofield and Wahiawa	$1,875,113	$156,060	$3,037	$268,404	$138,956
703	Expanded Late Night Service, Routes 51/52	$1,406,335	$117,045	$2,277	$201,303	$104,217
704	Bus Rapid Transit to Pearl Highlands Rail Station	$5,469,079	$446,250	$8,857	$782,845	$405,287
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	$1,030,998	$85,807	$1,670	$147,577	$76,402

2.1.6 Non-Quantified Benefits for Transit Projects

It is commonly recognized that investment in public transportation projects whether bus or higher capacity modes provide an economic benefit to the community. These costs have not been monetized however two elements within this category are briefly discussed:

The American Public Transportation Association (APTA) has a long history of researching the benefits of transit investment. APTA summarizes that for every $1 invested in public transportation $4 in economic returns are realized (APTA, 2018). Investment includes spending on operations and maintenance.

A second common economic benefit cited by APTA is that for every $1 billion invested in public transportation, over 50,000 jobs are created or supported, both directly and indirectly. These two economic “quick facts” actually double count the benefit, but they do point to the overall economic benefit of public transit investment.

2.1.7 Sum of Quantified Benefits for Transit Projects

Table 8 provides the sum of the monetized benefits for the transit projects. This includes travel time savings (**Table 3**); vehicle operating cost savings (**Table 4**); safety (**Table 5**); emissions reduction (**Table 6**); and congestion, equity/mobility, and noise (**Table 7**).

Table 8. Sum of Annual Benefits for Transit Projects

Project Number	Project Description	Total Annual Project Benefit Value
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	$2,964,439
702	Increase bus service to/from Schofield and Wahiawa	$3,557,327
703	Expanded Late Night Service, Routes 51/52	$2,667,995
704	Bus Rapid Transit to Pearl Highlands Rail Station	$11,023,492
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	$1,957,216

2.2 Identification and Monetization of Benefits for Bicycle and Pedestrian Projects

For this analysis, the baseline year was 2018 and the study forecast year was 2040. The majority of projects are expected to be able to be constructed by 2023. Those projects requiring more intensive construction, such as a bridge, are assumed to have a start year of 2028. The monetization of benefits is estimated starting with the project opening years of 2023 and 2028 respectively, to account for the benefits that don't accrue immediately. All project benefits are taken through the study forecast year 2040. Each proposed facility is analyzed in order to determine its impact on the growth of pedestrians and bicycle volumes. Methodology from NCHRP Report 552: *Guidelines for Analysis of Investments in Bicycle Facilities* (TRB, 2006) was used to identify and forecast the bicycle demand. It notes that value for pedestrian is not appropriate in urban areas because there are already well-developed and safe pedestrian facilities. Maps from the 2010 U.S. Census Bureau identify the locations proposed for bicycle and pedestrian improvements in this study as urbanized and thereby not appropriate to calculate benefits.

Benefits provided in NCHRP Report 552 were provided in 2006 dollars and thus needed to be extrapolated to 2018 dollars. In order to do this, inflation adjustment values were calculated between 2006 and 2012 using the gross domestic product taken from Table 1.1.9 Implicit Price Deflators for Gross Domestic Product (BEA, 2016) from the Bureau of Economic Analysis, National Income and Product Accounts webpage. An inflation rate of 1% per year from 2012 to 2018 was then applied, as per Consumer Price Index (CPI-U) data from the State of Hawaii Department of Transportation (HDOT). After accounting for the effects of inflation, to express costs and benefits in real dollars, an adjustment was made to account for the time value of money.

OMB Circular A-94 (*Guidelines and Discount Rates for Benefit Cost Analysis of Federal Programs*) provides a real discount rate of 7% per year to discount benefits and costs to their present value in their BCA. This was applied in calculation of total benefits, Benefit Cost ratio, and net present value. An undiscounted and less conservative 3% discounted rate were also used in calculation of total benefits for comparison.

All benefits reasonably expected to result from the implementation of a project needed to be monetized for inclusion in the BCA. Benefits then needed to be calculated on an annual basis from the year of opening throughout the analysis year.

Walking and cycling play unique and important roles in an efficient and equitable transportation system. They provide basic mobility, affordable travel, access to motorized modes, physical fitness and recreation. Benefits from bike and pedestrian infrastructure projects contribute to most of the benefits discussed above directly or indirectly. The direct benefits from these projects are discussed.

The various benefits monetized as a result of bicycle and pedestrian benefits are provided in **Table 9**.

Table 9. Monetized Benefits for Bicycle and Pedestrian Projects

Benefit	Description
Mobility	Increased use as a result of user feeling of increased safety and mobility.
Recreational	User recreational time as a result of facility.
Health	Public health impact benefits resulting from increase in active transportation.
Auto Use	Reduction in vehicle operating costs as a result of modal shift away from vehicle.

In order to quantify benefits, existing users as well as future users resulting from the construction of the proposed project need to be estimated. The approaches for tabulating existing and new bicyclists and pedestrians are based on separate methodology presented in NCHRP Report 552. Traffic analysis zone (TAZ) populations were taken from the 2010 U.S. Census and extrapolated using a growth rate of 0.5% per year taken from Resident Population by County, US Census Bureau, Population Division. Populations were tabulated for areas within ¼-mile, ½-mile, and 1-mile of the proposed project.

The total number of bicyclists is made up of commuting and recreational users. A factor from NCHRP Report 552 was applied to the populations in relation to their distance from the facility for calculation of bicycle trips. A 0.2% bicycle commuter percentage was used for the area, as reported in the Central Oahu Public Use Microdata Area provided by the US Census Bureau. General assumptions used from NCHRP Report 552 are that 80% of area residents are adults, 50% of adults are commuters, and 0.60% of adults use bicycles. Formulas used to calculate existing and new bicycle users is as follows:

- Daily Existing Bicycle Commuters = R * 80% * 50% * C
- Daily Existing Adult Bicyclists = R * 80% * 50% * C
- Daily New Bicycle Commuters = Σ (Existing Bike Commuters * (L -1))
- Daily New Adult Bicyclists = Σ (Existing Adult Bicyclist * (L -1))
    - R = population
    - C = Commuter%
    - L = average length of trip in miles

Pedestrian trips used TAZ populations for areas within 1-mile of the proposed facility. The National Household Travel Survey data states that 10.5% of all trips are made by walking. NCHRP Report 552 states that individuals make an average of 3.2 trips per day. The 2012 National Survey of Pedestrian and Bicyclist Attitudes and Behaviors, Highlights Report (reported on the Pedestrian and Bicycle Information Center webpage) states that of all pedestrian trip purposes, 15% are made for recreation while 39% are made for exercise or health. Other trips purposes are less likely to be affected by these projects. While off-street asphalt paths existed along the majority of roads, most lacked the continuity in grade and width as well as protection that comes from an ADA-compliant sidewalk. The proposed shared-use paths follow complete street principles through inclusion of 10’ wide 2-way shred-use paths with full curb and gutter protection, increasing accessibility by pedestrians and bicyclists. New pedestrian trips were estimated to increase 22% as a result of these complete street projects, as reported by FHWA to U.S. Congress on the Outcomes of the Non-motorized Transportation Pilot Program SAFETEA-LU Section 1807 and reported by the National Complete Streets Coalition.

2.2.1 Mobility

Pedestrian and bicycle improvement projects increase the mobility for all commuters by improving safety and mobility for pedestrians and bicyclists. This can have the effect of increasing active transportation

while reducing vehicle use. The increase in bike and pedestrian commuting trips can also have an indirect positive effect in reducing vehicle travel times and hence considered as an added benefit.

With the implementation of bicycle projects, the ability of bicyclists to move more freely increases. According to NCHRP Report 552, bicyclists are willing to spend more time on commuting depending on the type of facility and whether it is on or off street. The additional time and value tabulated as a result of these facilities is:

- Off-street bicycle facilities: additional 20.38 minutes which equates to $4.80
- On-street bicycle lanes without parking: additional 18.02 minutes which equates to $4.25
- On-street bicycle lane with parking: additional 15.83 minutes which equates to $3.74

These benefits are only applied to commuter travel as recreational riding is not constrained by time. The formula used to calculate existing and new bicycle users is as follows:

- Annual Bicycling Mobility Benefit = M*(V/60)*(Existing Bicycle Commuters + New Bicycle Commuters) * 50 * 5 * 2
    - M = extra time bicyclists are willing to spend per facility type
    - V = hourly value per type

NCHRP Report 552 states that walking is 10 times more common than bicycling as an estimated 70% of adults walk at least once per week while only 7% bike. As a result, NCHRP Report 552 provides methodology to estimate the mobility benefits resulting from increased bicycle ridership however, pedestrian facilities and benefits are considered to have an insignificant impact on total demand. NCHRP Report 552 also states that the mobility benefits are not applicable to pedestrians as it seems unlikely that new facilities will have a significant impact on pedestrians commuting to work. This is also true for bike routes, which are seen to have an insignificant impact on commuting.

Mobility benefits for bicycle and pedestrian projects are provided in **Table 10**.

Table 10. Mobility Benefits for Bicycle and Pedestrian Projects

Project #	Project Description	Year of Opening	Year of Analysis	Total Annual Mobility Benefits (2018 dollars)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$43,206
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$32,608
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$35,054
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$13,402

2.2.2 Recreational Bicycling and Walking

In general, people bicycle and walk for recreation because they enjoy the activity and the improved sense of well-being that comes from it. While there is a monetary cost to owning and maintaining a bike, the apparent cost of any given ride is generally very low. The larger cost of riding is the value of the time that it takes. NCHRP Report 552 provides the net benefits of outdoor recreational activities by subtracting the ownership and time costs from the overall benefits realized from the user as a result of the activity. On average, bicyclists ride an estimated 60 minutes per day with a time value savings of $11.80 per hour ($0.20 per minute). The formula used to calculate the recreational benefits resulting from new facilities is as follows:

- Annual Recreational Benefit (For Bicycle Projects) = D * 365 *(Daily New Adult bicyclists – Daily New Bicycle Commuters)
    - D = hourly value
    - Daily New Adult bicyclists – Daily New Bicycle Commuters = New Users who use the facility for Recreational purpose
- Annual Recreational Benefit (For Pedestrian Projects) = D * 365 * (New Pedestrians who use the facility for Recreational purpose)
    - D = hourly value

The recreational benefits of bicycle and pedestrian projects are shown in **Table 11**.

Table 11. Recreational Benefits of Bicycle and Pedestrian Projects

Project #	Project Description	Year of Opening	Year of Analysis	Total Annual Recreational Benefits (2018 dollars)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$1,386,781
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$743,067
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$430,700
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$258,420

2.2.3 Health

The benefits of physical activity in enhancing overall health are well established; however, they are challenging to monetize. NCHRP Report 552 provides a methodology for estimating the public health impact of bicycle facilities in terms of economic impacts using a value of $151 of health savings per person per year. The formula used to calculate the health benefits resulting from new facilities is as follows:

- Annual Health Benefit (For Bicycle Projects) = Daily New Adult bicyclists * H

- Annual Health Benefit (For Pedestrian Projects) = (New Pedestrians who use the facility for Health purposes) * H
    - H = health savings per person per year

The health benefits of bicycle and pedestrian projects are provided in **Table 12**.

Table 12. Health Benefits of Bicycle and Pedestrian Projects

Project #	Project Description	Year of Opening	Year of Analysis	Total Annual Health Benefits (2018 dollars)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$290,373
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$141,185
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$27,482
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$10,872

2.2.4 Reduced Auto Use

A common goal of transportation infrastructure improvement projects is to improve the flow of traffic by reducing congestion. This can be achieved through the reduction in single occupancy auto use or increase in capacity. USDOT's *Revised Departmental Guidance on Valuation of Travel Times in Economic Analysis*, publishes guidance on the appropriate value of travel time savings (VTTS) for use in evaluating the benefits of transportation infrastructure investments.

Vehicle operating costs refer to changes in the costs of owning and operating a vehicle. According to AAA, the average annual cost for owning and operating a car is $8,849 nationally, but they do not calculate the cost by state. This is based on the assumption that 15,000 miles are driven annually, which is on the higher end for Hawaii and includes vehicle depreciation rates.

A study by GOBankingRates determined the cost of owning and operating a vehicle for all 50 states. This study considered other factors rather than depreciation, such as gas prices, registration/license fees, insurance, and average car maintenance and repair costs. According to the GOBankingRates study, the cost of owning and operating a vehicle in Hawaii is $12,061 for a three year average, which is the 12th highest in the nation.

Projects that alter vehicle miles traveled, traffic speed and delay, roadway surfaces, or roadway geometry may affect vehicle operating costs. It was assumed that on average people work 50 weeks per year for 5 days per week. The distance of commuting trips was multiplied by 2 to account for trips to and from work.

For Bicycle projects, NCHRP Report 552 recommends using a value of $0.094 of savings per mile for suburban areas. It states that the auto use benefit is not applicable to pedestrians as it seems unlikely that

new facilities will have a significant impact on pedestrians commuting to work. The monetary benefits of travel time and vehicle operating cost savings are tabulated for use under auto use. The formula used to calculate the benefits of reduced auto use resulting from new facilities is as follows:

- Auto Use Benefit = Daily New Bicycle Commuters * L * S * 50 * 5 * 2
  - L = average length of trip in miles
  - S = savings per mile

The auto use benefit for bicycle and pedestrian projects is shown in **Table 13**.

Table 13. Reduced Auto Use Benefits of Bicycle and Pedestrian Projects

Project #	Project Description	Year of Opening	Year of Analysis	Total Annual Reduced Auto Use Benefits (2018 dollars)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$12,338
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$691
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$2,975
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$468

2.2.5 Safety

Transportation infrastructure improvements can reduce the likelihood of fatalities, injuries, and property damages that result from crashes on the facility, both by reducing the number of such crashes and/or their severity. Estimating the change in the number of fatalities, injuries, and amount of property damage can be done using crash modification factors (CMFs), which relate different safety improvements to crash outcomes. CMFs are estimated by analyzing crash data and types and relating outcomes to different safety infrastructure. However, NCHRP Report 552 does not recommend including user safety benefits in a quantitative analysis because the data is inconclusive.

2.2.6 Sum of Benefits for Bicycle and Pedestrian Projects

Table 14 provides a summary of the total annual benefits for bicycle and pedestrian projects. This includes benefits associated with the following: mobility (**Table 10**), recreation (**Table 11**), health (**Table 12**), and reduced auto use (**Table 13**).

Table 14. Sum of Annual Benefits of Bicycle and Pedestrian Projects

Project #	Project Description	Year of Opening	Year of Analysis	Total Annual Benefits (2018 dollars)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$1,732,698
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$917,551
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$720,175
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$283,162

2.3 Identification and Monetization of Benefits for Roadway Projects

Monetized benefits of roadway projects include an array of elements including travel time savings, lower vehicle operating costs based on reduced travel distance, safety enhancements in the form of fewer collisions, and reduced vehicle emissions resulting in improved air quality. These benefits are described in detail in the *Benefit Cost Analysis Guidance for Discretionary Grant Programs* published by the U.S. Department of Transportation (July 2017). This document was used to develop the primary methodology for evaluating the pertinent benefits and costs associated with roadway projects in this study. Additional ancillary benefits of roadway project are described in the USDOT document (including resilience, work zone impacts, noise pollution, etc.). However, most of these require a finer-grained level of analysis than conducted for this study and are not addressed here. The roadway project benefits considered in this study are shown in **Table 15**. Benefits were not calculated for Project 403.7, Kamehameha Highway Roosevelt Bridge (rehabilitation) since the project is not one that adds capacity or has a transportation benefit. Rather, it is a bridge rehabilitation. Any benefits to the transportation network would be due to structural integrity of the facility and are not calculated here.

Table 15. Roadway Project Benefits

Guidance Based	Included in Review	Qualitative Based	Included in Review
Travel Time Savings	✓	Congestion	
Vehicle Operating Cost Savings	✓	Equity/Mobility	
Safety	✓	Noise	
Emissions Reduction	✓	Parking Cost Savings	
		Chauffeur Driver Savings	
		Route Shift	
		Real Estate	
		Economic Benefits	

2.3.1 Travel Time Savings

The construction of new or expanded roadway facilities is intended to increase vehicle capacity for purposes of reducing travel delays, especially during peak congestion periods. Reducing delays results in travel time savings and increased reliability, which has both quality of life and discernible economic benefits in terms of increased employee productivity and the value of personal and/or business travel time. This benefit can be estimated based on the reduced travel time between select destinations within the study area between a set of defined origin and destination (O-D) pairs as listed in Performance Measure 4 described in Deliverable B-2 and subsequently applied and quantified in Deliverable E-1 for this study. The savings in travel time (or slight increase in some cases) is the combination of reduced travel time between all O-D pairs.

The USDOT BCA Guidance document includes specific monetary values of time for personal travel and business travel, as well as a blended value for personal and business travel time when the split of each is not known. That is the case in this study where the OahuMPO travel demand model (like most regional travel demand models does not readily discern between these types of trips. The blended value in 2016 dollars is $14.10 per person-hour for private vehicle use as shown in Table 6 of Appendix A to the BCA Guidance document. This value was inflation-adjusted to 2018 dollars using data from www.usinflationcalculator.com and results in a blended value of $14.72. Since the output from the model for individual street segments is in vehicle trips, an average vehicle occupancy factor of 1.4 from the model was applied to the projected vehicle volume at each project site location to convert the number of vehicle-hours saved to person-hours saved.

The summary of the monetized travel time savings benefits for the applicable projects is included in **Table 16**.

Table 16. Roadway Project Travel Time Savings

Project Number	Project Description	Travel Time		
		Travel Time Saved/Year (person-hrs)	Value of Time	Total Annual Travel Time Benefit
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	43,042	$14.72	$633,583
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	107,972	$14.72	$1,589,348
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	53,009	$14.72	$780,292
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	27,352	$14.72	$402,624
909	Kamehameha Highway/Whitmore Avenue Intersection Modification	6,399	$14.72	$94,197
910	Kamehameha Highway at Whitmore Avenue Intersection Improvements	43,285	$14.72	$637,155
911	Roundabout at Kamehameha Highway and California Avenue	51,199	$14.72	$753,643
912	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	20,049	$14.72	$295,123

Project Number	Project Description	Travel Time		
		Travel Time Saved/Year (person-hrs)	Value of Time	Total Annual Travel Time Benefit
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	7,650	$14.72	$112,608

2.3.2 Automobile Operating Cost Savings

Enhanced roadway capacity can also reduce the overall distance that vehicles must travel to reach their destination. This is especially true of new roads or widened roadways that reduces diversion or shortens the overall travel path. Use of the travel demand model for the more substantive roadway projects allows for the calculation of the change in vehicle miles of travel (VMT) resulting from individual project implementation. In some cases, VMT may actually increase with a project if the longer path can be traveled a higher rate of speed, which will reduce the overall travel time for a trip.

For this study, VMT was calculated for both the COTS study area, as well as for the entire island of Oahu, which is the geographic extent of the model roadway network. This analysis uses the COTS area VMT to show the immediate area benefit of the applicable projects. Specifically, the change in VMT between conditions with each project and the 2040 baseline condition was used to identify the reduced travel distance and corresponding reduced vehicle operating cost.

The cost of operating a vehicle is directly related to the number of miles driven, and reducing overall VMT can directly translate to lower operating costs in terms of fuel, maintenance, tires, etc. The US DOT BCA Guidance document identifies per mile vehicle operating cost for a car as $0.40 per mile (in 2016 dollars) as shown in Table 8 of Appendix A. Inflation adjusted for 2018, this value is $0.42 per mile. While some of the vehicles using the study area roadways are trucks, which have a higher operating cost (and corresponding greater potential savings), the proportion of trucks is less than 5% of the total vehicle flow on all of the study roadways. As such, the resulting operating savings using only car operating cost savings are considered conservative for purposes of this analysis.

The summary of the monetized travel time savings benefits for the applicable projects is included in **Table 17**.

Table 17. Roadway Project Vehicle Operating Cost Savings

Project Number	Project Description	Vehicle Operating Costs Savings		
		Vehicle Miles Saved/Year[1]	Operating Cost	Total Annual Vehicle Operating Cost Savings
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	(233,070)	$0.42	$(97,889)
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	1,003,680	$0.42	$421,546

[1] Negative number indicates increase in vehicle miles traveled; thus, negative benefit amount indicates increased cost for drivers.

2.3.3 Safety

Depending on the collision history of a particular location, safety benefits can amount to a substantial savings with implementation of a project, if it can be shown that an improvement will reduce the

likelihood of a fatal, injury or property damage only (PDO) collision. The greatest benefits are achieved when fatal collisions are avoided given their order of magnitude higher cost.

The US DOT BCA guidance document includes the cost of various collisions from PDO through fatalities with several levels of injury severity. At the high end, the cost of a fatal collision is the most expensive at $9,600,000 (in 2016 dollars) is shown in Table 4 of Appendix A of that document. At the low end, the cost of a PDO collision is identified as $4,252 as shown in Table 5. Table 4 also lists various levels of injury severity with corresponding costs. The average of these costs in 2016 dollars is $216,000, which is the assumed value for an injury collision for this study. Inflation-adjusted to 2018 dollars these costs are as follows:

- PDO = $4,439
- Injury = $225,485
- Fatal = $10,021,548

Since this area-wide study only identified the number of collisions by mode and did not identify the severity of a collision (e.g., whether or not it included serious injuries or resulted in property damage only (PDO)), additional research was conducted to identify the proportion of each type of collision along a given roadway segment. From a research paper entitled *Transportation Research Record 1467: Analyzing the Relationship Between Crash Types and Injuries in Motor Vehicle Collisions in Hawaii* (Kim, Nitz, Richardson and Li), the relative proportions of collisions is as follows: 0.1% fatal, 19.0% injury, and 80.9% property damage only. It is important to note that no vehicle collision fatalities were recorded in the study area between 2014 and 2016 for roadway segments where projects were selected for BCA. Thus, the proportion of PDO collisions on a given roadway is assumed to be roughly 81% of all collisions, and injury collisions are assumed to represent 19% of all collisions.

The challenge with determining the specific safety benefit of a project is that widening projects of existing roadways or even the construction of a new roadway does not necessarily result in fewer or less severe collisions. The most effective improvements are those that completely eliminate conflicts such as grade-separating two facilities or eliminating turning movement conflicts through median channelization or other physical means. However, it can be assumed that some safety enhancement will occur with: 1) widening of roadways to appropriate design standards and/or 2) reducing congestion or volume by providing new roadways. For the H-1 Corridor Study conducted for HDOT, the implementation of improvement projects was assumed to result in a potential 10% reduction in the number of collisions in a given corridor or area for purposes of prioritizing projects and establishing a potential safety benefit. No reduction in collision severity was assumed with this approach. **Table 18** shows the safety benefits for roadway projects.

Table 18. Safety Benefits for Roadway Projects

Project Number	Project Description	Safety						
		Fatalities Reduced	Fatality Value	Serious Injuries Avoided	Serious Injury Value	PDO Avoided	PDO Value	Total Annual Safety Benefit
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue		$10,021,548	0.02	$225,485	0.08	$4,439	$4,869
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	0.2	$10,021,548	0.11	$225,485	0.49	$4,439	$2,032,172
910	Roundabout at Kamehameha Highway and California Avenue		$10,021,548	0.11	$225,485	0.49	$4,439	$27,863
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing		$10,021,548	0.04	$225,485	0.16	$4,439	$9,288

2.3.4 Emission Reduction

In addition to reducing congestion, roadway improvement projects can also have the added benefit of reducing air pollutant emissions through lower VMT levels and travel speeds closer to optimal levels. Emissions are much greater under stop and go conditions and lower congested VMT can minimize vehicle output of these pollutants. While, the island of Oahu and the State of Hawaii does not have the air quality problems of numerous other states, emissions reductions can still be quantified and counted as a benefit for applicable roadway projects.

Use of the OahuMPO travel demand model allows for the direct calculation of various emissions. For this study, the pollutants used in the emissions reduction benefit calculation include the following: Volatile Organic Compounds (VOCs), nitrogen oxides (NOx), and particulate matter (PM). The model provides the output of these emissions in grams, and these weights are converted to short tons for purposes of quantifying annual emissions benefits. The corresponding damage costs per short ton in 2016 dollars are provided in Table 9 from Appendix A to the US DOT BCA guidance document for each of the pollutants items is $1,872, $7,377, and $337,459, respectively. Adjusted for 2018 dollars, these values are as follows:

- VOCs = $1,954
- NOx = $7,701
- PM = $337,459

The amount of each pollutant avoided is multiplied by the corresponding monetary value and then the savings are totaled to determine the total emissions reduction benefit, as shown in **Table 19**.

Table 19. Roadway Project Emissions Reduction Savings

Project Number	Project Description	Emissions Savings			
		VOC Value Saved/Year[1]	NOx Value Saved/Year[1]	PM Value Saved/Year[1]	Total Annual Emissions Benefit
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	$50	$196	$4,495	$4,742
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	$(100)	$(393)	$(3,596)	$(4,089)
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	$50	$196	$4,495	$4,742
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	$75	$628	$1,798	$2,501
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	$50	$196	$4,495	$4,742
910	Roundabout at Kamehameha Highway and California Avenue	$50	$196	$4,495	$4,742
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	$50	$196	$4,495	$4,742
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	$50	$196	$4,495	$4,742

[1] Negative number indicates increase in vehicle miles traveled; thus, negative benefit amount indicates increased cost for drivers.

2.3.5 Sum of Benefits for Roadway Projects

Table 20 provides the summary of the total benefit value for all applicable roadway projects. This includes benefits associated with the following: travel time savings (**Table 16**), automobile operating cost savings (**Table 17**), safety (**Table 18**), and emissions reduction (**Table 19**).

Table 20. Sum of Benefits for Roadway Projects

Project Number	Project Description	Total Annual Roadway Project Benefit Value
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	$643,193
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	$1,487,370
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	$2,817,206
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	$826,671
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	$98,938
910	Roundabout at Kamehameha Highway and California Avenue	$669,759
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	$767,672
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	$299,865
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	$112,608

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3.0 COST ANALYSIS: CONSTRUCTION, LAND, AND OPERATIONS & MAINTENANCE

The cost of transportation projects is a combination of the resources, such as land, labor, and materials, expended on the project by the entity (e.g., agency) providing the project. These costs are agency costs and do not include costs borne by the users of the facility once complete. Unlike Benefits, which have to be assigned a value based on the unit of measure, costs represent goods or services that already have an associated value. The following sections provide the construction costs for each project, the land cost for those projects requiring right-of-way (ROW), and the operations and maintenance (O&M) cost for a single year.

3.1 Transit Projects

3.1.1 Construction Costs

Planning level construction or initiation costs listed for **Projects 701, 702, and 704** include costs for the initial purchase of buses. Project 704 also includes bus rapid transit facility treatments along 3.2 miles in Wahiawa. Project 705 also includes six new bus stops.

The planning level initiation costs for Transit Projects are shown in **Table 21**.

Table 21. Construction Costs for General Transit Projects

Project Number	Project Description	Timing	Construction/Initiation Cost
		Year Open	
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	$865,000
702	Increase bus service to/from Schofield and Wahiawa	2025	$865,000
703	Expanded Late Night Service, Routes 51/52	2025	N/A
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	$22,560,000
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	$90,000

3.1.2 Land Costs

No ROW is required for the transit projects.

3.1.3 Operations and Maintenance Costs

The development of annual O&M costs for bus transit service is based on a cost model with three cost centers:

1. Fixed costs including facilities and administration
2. Costs assigned to bus hours includes operator wages
3. Costs assigned to bus miles includes wear items such as tires

Bus hours and miles are an output of a Service Model. The service model is based on the following inputs:

1. Route mileage by direction

2. Number of trips by time period and direction
3. Headway by time period and direction
4. Running time by time period and direction
5. Layover time by time period and direction

These inputs provide mileage, hours of service and vehicle requirements as outputs which are then applied to costs. Also calculated are miles per hour by time period and direction for reasonableness tests. Deadhead time, the time the bus takes to travel to the start of revenue service from the operating base or back to the operating base is applied as an overall factor for planning level purposes. For bus services, it was determined that cost per hour would be used as the study is adding a limited number of bus hours.

O&M costs for transit projects are shown in **Table 22**. These costs include inflation rates to the year of open for each project. All of the projects except for Project 705 are projected for year open in 2025. Project 705 is dependent upon a new road in Road Project 906 which has a later implementation year.

Table 22. Transit Project O&M Costs

Project Number	Year Open	Description	Unit of Measurement	Cost per Unit	O&M Annual Subtotal
701	2025	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	3,393 annual hours	$143	$486,000
702	2025	Increase bus service to/from Schofield and Wahiawa	3,132 annual hours	$143	$450,000
703	2025	Expanded Late Night Service, Routes 51/52	4,176 annual hours	$143	$600,000
704	2025	Bus Rapid Transit to Pearl Highlands Rail Station	5,400 annual hours	$165	$900,000
705	2028	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	1,696 annual hours	$143	$243,000

3.2 Bicycle and Pedestrian Projects

3.2.1 Construction Costs

The estimating methodology was based on the parametric methods which are typically applied to projects in the planning, scoping, or early design stage. These methods involve techniques that use historical data to define the cost of the typical transportation facility using measurements that are easily determined, such as cost per lane mile, cost per interchange, cost per square foot and cost per intersection.

The estimates of probable construction costs have been prepared based on the overall project description to define the major parameters, including the overall length of the project, the major elements such as bike lane or multi-use path extents, traffic signal installation and intersection modifications. Detailed quantity estimates were not prepared as this would occur at a later phase.

Where available, the historical data based on prices from recent projects of similar nature and scope were used in the parametric estimating. Where historical data from analogous projects was not available, the British Columbia Ministry of Transportation and Infrastructure *Construction and Rehabilitation Cost Guide* (2013) was used for parametric estimating of project such as interchanges, bridge widening, and lane-mile costs, in which quantification of the major items was not possible. The costs were converted to current US dollars and adjusted to reflect the local construction conditions in Hawaii.

Since the estimated costs and project definition is limited to the functional approach and broad concept approach, a contingency amount of 30% was included within each project to provide for some allowance of unknown factors, and inherent project risks.

Although the actual costs may vary due to market conditions and economy of scale, or other factors, these costs are considered reasonable for Planning-Level cost estimating purposes. These costs are based on 2018 dollars and do not include taxes.

Estimated construction costs for bicycle and pedestrian projects are provided in **Table 23**.

Table 23. Construction Costs for Bicycle and Pedestrian Projects

Project Number	Project Description	Construction Cost (2018 $Values)
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	$23,181,900
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	$4,364,600
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	$6,356,900
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	$893,000

3.2.2 Land Costs

Project 802, proposes the construction of a new bridge over an existing stream/gulch, connecting Wahiawa and Whitmore Village. The proposed alignment is over portions of private land and therefore additional right-of-way (ROW) may be required to build the bridge and connection. This section describes the methodology utilized to develop preliminary ROW acquisition cost estimates for planning purposes.

Iowa Department of Transportation's ROW Design Manual suggests to establish a minimum of 20' row from outboard projection of each side of the bridge. Per this, the proposed bridge would require a minimum 60' ROW for a length of approximately 3,700', resulting in the acquisition of 222,000 sq. ft (approximately 5 acres). The proposed alignment passes through multiple parcels with industrial or agricultural zoning. Cost of the various parcels was estimated by using the City and County of Honolulu's real property tax information, collected from the Department of Budget and Fiscal Services, Real Property Assessment Division website on June 28, 2019.

Land right-of-way costs were determined by applying unit (acre) costs to each project based on location and ROW needs. **Table 24** shows the estimated land costs.

Table 24. Land Costs for Bicycle and Pedestrian Projects

Project No.	Land Use	Project ROW (sq. ft)	Estimated Land Cost
802	Agricultural & Industrial	222,000	$182,000

3.2.3 Operations and Maintenance Costs

As reported in NCHRP Report 552, operations costs for bicycle facilities typically includes the cost of securing or policing the facility. Maintenance of stand-alone bicycle facilities (paths and trails) includes pavement (sweeping and repair), drainage (cleaning and repair of storm drains), traffic control (pavement marking, signs, and traffic signal maintenance), and landscape maintenance. However, when bicycle facilities are elements of other, larger facilities, such as bike lanes and marked/signed routes, the maintenance costs are often included in the cost of the maintenance of the larger facility. Often the marginal or incremental costs of added maintenance are so modest that they are not accounted for as discrete facility costs. NCHRP Report 552 quotes $6,500 in 2002 dollars ($8,523 in 2018 dollars) per mile per year for trail maintenance which includes drainage maintenance, sweeping, trash removal, weed control, mowing, minor repairs, supplies and fuel. An inflation of 1% per year is applied as suggested by HDOT.

Shared use paths and pedestrian/bicycle bridges are each separate infrastructure that requires maintenance. Therefore, as noted in NCHRP Report 552, operations and maintenance costs are included in the total cost of these facilities. Bicycle lanes are assumed to be taken care of as a part of the overall roadway facility maintenance and therefore aren't included under operations and maintenance costs.

Operations and maintenance costs for projects are shown in **Table 25**.

Table 25. Operations and Maintenance Costs for Bicycle and Pedestrian Projects

Project Number	Year Open	Description	Length of Facility (miles)	Cost per Mile (2018 dollars)	O&M Annual Subtotal (2018 dollars)
801	2023	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	7.50	$8,523	$63,923
802	2028	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	0.70	$8,523	$5,966
803	2023	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	4.50	$8,523	$38,354

3.3 Roadway Projects

3.3.1 Construction Costs

The estimating methodology for planning level work use historical data to define the cost of the typical transportation facility using measurements that are easily determined, such as cost per lane mile, cost per interchange, cost per square foot and cost per intersection.

The major parameters include the overall length of the project, the major elements such as bike lane or multi-use path extents, traffic signal installation and intersection modifications. Based on the nature and scope of the project planning documents, detailed quantity estimates were not completed for the various items.

Where available, the historical data based on prices from recent projects of similar nature and scope were used in the parametric estimating. Where historical data from analogous projects was not available, the British Columbia Ministry of Transportation and Infrastructure *Construction and Rehabilitation Cost Guide* (2013) was used for parametric estimating of project such as interchanges, bridge widening, and lane-mile costs, in which quantification of the major items was not possible. The costs were converted to current US dollars and adjusted to reflect the local construction conditions in Hawaii.

Since the estimated costs and project definition is limited to the functional approach and broad concept approach, a contingency amount of 30% was included within each project to provide for some allowance of unknown factors, and inherent project risks.

Although the actual costs may vary due to market conditions and economy of scale, or other factors, these costs are considered reasonable for Planning-Level cost estimating purposes. These costs are based on 2017 dollars and do not include taxes.

Estimated construction costs for roadway projects are provided in **Table 26**.

Table 26. Construction Costs for Roadway Projects

Project Number	Project Description	Construction Cost (2018 $Values)
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	$3,519,700
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	$17,999,000
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	$7,303,048
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	$30,289,000
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	$1,974,000
910	Roundabout at Kamehameha Highway and California Avenue	$3,134,000
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	$60,000
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	$45,000
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	$175,000

3.3.2 Land Costs

The COTS identifies two (2) roadway projects which may require additional right-of-way (ROW) ranging from 0.3 to 12.7 acres. **Table 27** shows the estimated land cost for roadway projects.

Table 27. Land Cost for Roadway Projects

Project No.	Land Use	Unit (Acre) Cost	Project ROW (acres)	Land Cost
906	Urban	$3,471,568	12.7	$44,178,508
910	Urban	$3,471,568	0.3	$867,792

3.3.3 Operations and Maintenance Costs

Operating and maintaining roadways involves a variety of costs associated with paving material quality, traffic signals, drainage, safety features where applicable (e.g. guardrails), landscaping etc. In the Central Oahu study area, roadways are operated and maintained by either the City & County of Honolulu Department of Facilities & Maintenance (DFM) or by the State Hawaii Department of Transportation – Highways Division (HDOT). HDOT maintains both freeways including H-1 and H-2, as well as arterial roadways including Kamehameha Highway. DFM is responsible for arterial roadways such as Ka Uka Boulevard and other minor arterial/major collector facilities that are the subject of some of the roadway projects identified in the COTS area.

The O&M costs for roadways vary depending on the facility type, number of bridge structures, number of lanes, curb/shoulder design, etc. To account for the variation in overall facility width, a common unit of O&M costs for roadways is cost per lane-mile. For purposes of this Benefit Cost analysis, an average cost per lane-mile would be sufficient to compare roadways since no new substantive freeway segments are proposed. Ideally, the cost per-lane mile would be provided by both agencies for use in this study. Both state and county offices were contacted for this report but were unable to provide an average cost per lane-mile for operations and maintenance. In lieu of agency-specific information, data from a recent national study that examined O&M costs by state was consulted as part of this effort. The *21st Annual Report on the Performance of State Highway Systems (1984–2012): State Summaries* (Policy Report 134, Reason Foundation, September 2014) identified that the State of Hawaii spent $63,482 per lane mile of highways in 2013. Adjusting this number for inflation results in an annual per lane mile cost of $68,275. This value was applied to all roadway projects to determine the annual O&M cost for purposes of determining the Benefit Cost ratio calculations. **Table 28** provides the annual O&M cost for roadway projects.

Table 28. Operation and Maintenance Costs for Roadway Projects

Project Number	Year Open	Description	Length of Facility (lane-miles)	Cost per Mile (2018 dollars)	O&M Annual Subtotal (2018 dollars)
901	2024	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	0.66	$68,275	$45,258
902	2028	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	1.59	$68,275	$108,619
903 (303.1)	2022	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	0.47	$68,275	$32,327
906	2028	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	3.50	$68,275	$238,963
909	2024	Kamehameha Highway at Whitmore Avenue Intersection Improvements	0.14	$68,275	$9,698
910	2024	Roundabout at Kamehameha Highway and California Avenue	0.36	$68,275	$24,362

3.4 Signal Optimization/Prioritization Projects Operation and Maintenance Costs

The operations and maintenance costs for the TDM projects have been packaged for estimation purposes. A TDM Program with a Coordinator position is included in the O&M costs to ensure success in implementing the projects. It is anticipated that the TDM Program would be under the DTS. The project would be implemented islandwide. Funding for the islandwide program, identified in the ORTP, is $1 million per year through 2029. The ORTP increases funding to $2 million per year in 2030 through 2040. Planning level O&M costs are based on:

Description	Unit Cost	Total Cost
Kamehameha Hwy Optimization (4 signals)	$1,125/ea	$4,500
California Ave Optimization (3 signals)	$1,100/ea	$3,300
Transit Signal Prioritization (4 signals)	$1,125/ea	$4,500
Total		**$12,300**

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4.0 COSTS AND BENEFITS OVER TIME

Up to now in this analysis, the benefits and costs have been provided in dollars for a single year. The next step is to stream these over multiple years using inflation and discounting factors. For purpose of analysis, all projects were taken out to the year 2040, although many would have residual value beyond that year. The purpose of this part of the analysis is to normalize all values into the same terms and years so they can be compared.

The base year being used is 2018. If any project has a different start year than 2018, that is explained. Assuming a project is constructed in 2018, then the cost is as shown in Chapter 4. But if it is constructed, say in 2028, then the construction cost needs to be inflated using the factor of 1% per year. This follows HDOT guidance.

Similarly, the dollar value of the benefits for a single year is as shown in Chapter 2 is in 2018 dollars. If the project does not start accruing benefits until some year in the future, then the benefit dollars must be discounted. Two discount factors are used. The first is 7%, which is required under the USDOT BCA Guidance (2017). The guidance also allows use of a 3% factor to account for public projects. This report does both.

This chapter presents the roll-up value of several years of benefits and future year costs. Any values that apply specifically to a particular project (for example, year of start) are explained in the text.

4.1 Project Start and End Year

The start and end year for all projects is provided in **Table 29**. The start year for projects is based on the year for which construction is assumed to be completed as per the State Transportation Improvement Program (STIP). For projects that are not included in the STIP, a start year of 2028 was assumed.

Table 29. Start and End Year for COTS Projects

Project Number	Project Description	Start Year	End Year	Number of Years
700 Transit Projects				
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	16
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	16
703	Expanded Late Night Service, Routes 51/52	2025	2040	16
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	16
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	13
800 Bicycle and Pedestrian Projects				
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Rose Street • Anoni Street • Whitmore Avenue • California Avenue • Ihiihi Avenue	2023	2040	18
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	13

Project Number	Project Description	Start Year	End Year	Number of Years
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	18
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	18
900 Roadway and Traffic Operations Projects				
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	17
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	13
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	19
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	13
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	17
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	17
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	19
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	19
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	19

4.2 Cumulative Benefits

Table 30 shows the cumulative benefits over the life of the project for each of the COTS projects. Cumulative benefits were calculated using both a 7% and a 3% discount rate per year for the life of the project through 2040.

4.3 Cumulative Costs

Table 31 shows the cumulative costs over the life of the project for each of the COTS projects. For transit projects, the construction/equipment cost column includes the construction/initiation cost provided in **Table 21**, plus the cost of replacement buses that would be required approximately 12 years into the life of the project.

Table 30. Cumulative Benefits for Wahiawa-Whitmore Village Area Projects in the COTS

Project Number	Project Description	Start Year	End Year	Travel Time Saving	Vehicle Operating Cost Saving	Safety	Emissions Reduction	Congestion Reduction	Mobility & Equity	Noise Reduction	Recreational	Health	Reduced Auto Use/ Parking Cost	TOTAL BENEFITS (7%)	TOTAL BENEFITS (3%)
700 Transit Projects															
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$187,680	$489,768	$222,225	$30,125	$1,562,595	$130,050	$2,530	--	$223,670	$115,796	$22,054,892	$34,293,521
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$225,216	$587,722	$266,670	$36,150	$1,875,113	$156,060	$3,037	--	$268,404	$138,956	$26,465,871	$41,152,225
703	Expanded Late Night Service, Routes 51/52	2025	2040	$168,912	$440,791	$200,003	$27,112	$1,406,335	$117,045	$2,277	--	$201,303	$104,217	$19,849,403	$30,864,169
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$1,313,760	$1,313,760	$777,789	$105,436	$5,469,079	$446,250	$8,857	--	$782,845	$405,287	$107,494,471	$143,516,933
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$123,831	$323,149	$146,624	$21,159	$1,030,998	$85,807	$1,670	--	$147,577	$76,402	$10,458,648	$17,423,351
800 Bicycle and Pedestrian Projects															
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	--	--	--	--	--	$43,206	--	$1,386,781	$290,373	$12,338	$14,165,783	$22,775,944
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	--	--	--	--	--	$32,608	--	$743,067	$141,185	$691	$4,368,304	$7,868,811
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	--	--	--	--	--	$35,054	--	$430,700	$27,482	$2,975	$5,986,608	$9,604,225
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	--	--	--	--	--	$13,402	--	$258,420	$10,872	$468	$2,402,974	$3,880,095
900 Roadway and Traffic Operations Projects															
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$633,583		$4,869	$4,742							**$6,599,887**	**$8,900,235**
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$1,589,348	$(97,889)		$(4,089)							**$13,594,531**	**$17,298,759**
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$780,292		$2,032,172	$4,742							**$29,999,778**	**$44,130,149**
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$402,624	$421,546		$2,501							**$7,555,753**	**$9,614,539**

Project Number	Project Description	Start Year	End Year	Travel Time Saving	Vehicle Operating Cost Saving	Safety	Emissions Reduction	Congestion Reduction	Mobility & Equity	Noise Reduction	Recreational	Health	Reduced Auto Use/ Parking Cost	TOTAL BENEFITS (7%)	TOTAL BENEFITS (3%)
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$94,197			$4,742							**$1,015,217**	**$1,369,064**
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$637,155		$27,863	$4,742							**$6,872,484**	**$9,267,843**
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$753,643		$9,288	$4,742							**$8,174,761**	**$12,025,203**
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$295,123			$4,742							**$3,193,189**	**$4,697,231**
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$112,608										**$1,199,137**	**$1,763,949**

Table 31. Cumulative Costs for Wahiawa-Whitmore Village Projects in the COTS

Project Number	Project Description	Start Year	End Year	Construction	Land	Operation & Maintenance	TOTAL COSTS
700 Transit Projects							
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$1,897,000	--	$8,387,322	$10,284,322
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$1,897,000	--	$7,766,039	$9,663,039
703	Expanded Late Night Service, Routes 51/52	2025	2040	$3,095,000	--	$10,354,719	$13,449,719
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$26,686,100	--	15,532,100	$42,218,200
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$3,310,200	--	$3,457,345	$6,767,545
800 Bicycle and Pedestrian Projects							
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$23,181,900	--	$64,000	$23,245,900
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$4,364,600	$182,000	$6,000	$4,552,600
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$6,356,900	--	$38,400	$6,395,300
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$893,000	--	--	$893,000
900 Roadway and Traffic Operations Projects							
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$3,519,700	--	$45,258	$3,564,958
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$17,999,000	--	$108,619	$18,107,619

Project Number	Project Description	Start Year	End Year	Construction	Land	Operation & Maintenance	TOTAL COSTS
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$7,303,048	--	$32,327	$7,335,375
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$30,289,000	$44,178,508	$238,963	$74,706,470
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,974,000	--	$9,698	$1,983,698
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$3,134,000	$867,792	$24,362	$4,026,154
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$60,000	--	$4,500	$64,500
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$45,000	--	$3,300	$48,300
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2024	2040	$3,519,700	--	$45,258	$3,564,958

5.0 COMPARE AND CONTRAST

Having calculated benefits and costs for a single year in Chapters 2 through 4, and having normalized future years in Chapter 5, it is now possible to do the benefit cost comparison.

Two methods of comparison are used.

- First, the benefit cost ratio is calculated by dividing total cost into total benefits. Any project with a ratio higher than 1.0 is said to have a positive BCA. Any project with a BCA ratio less that 1.0 is said to have a negative BCA.
- Second, the net present value is calculated by subtracting the total cost from the total benefits. Any project with a positive net present value is said to be a net benefit; any project with a negative net present value would not.

5.1 Benefit Cost

As discussed in **Section 5.0**, two discount factors are used when calculating benefits: 7% and 3%. The following tables calculate the Benefit Cost ratio using both benefit discount rates. As shown in **Table 32**, which uses a benefit discount rate of 7%, there are 12 projects with a positive Benefit Cost Ratio (over 1.0).

Table 32. Benefit Cost Ratio for COTS Projects (7% Discount Rate for Benefits)

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
700 Transit Projects						
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$22,054,892	$10,284,322	2.1
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$26,465,871	$9,663,039	2.7
703	Expanded Late Night Service, Routes 51/52	2025	2040	$19,849,403	$13,449,719	1.5
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$107,494,471	$46,503,204	2.8
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$10,458,648	$6,767,545	1.6
800 Bicycle and Pedestrian Projects						
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$14,165,783	$23,245,900	0.61
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$4,368,304	$4,552,600	0.96

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$5,986,608	$6,395,300	0.94
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$2,402,974	$893,000	2.69
900 Roadway and Traffic Operations Projects						
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$6,599,887	$3,746,771	1.76
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$13,594,531	$19,802,492	0.69
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$29,999,778	$7,557,637	3.97
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$7,555,753	$81,698,996	0.09
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,015,217	$2,084,867	0.49
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$6,872,484	$4,231,488	1.62
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$8,174,761	$66,454	123.01
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$3,193,189	$49,763	64.17
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$1,199,137	$184,939	6.48

Table 33 provides the BCA ratio for all COTS projects using a 3% discount rate for benefits. There are 14 projects with a BCA of 1.0 or greater.

Table 33. Benefit Cost Ratio for COTS Projects (3% Discount Rate for Benefits)

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
700	**Transit Projects**					
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$34,293,521	$10,284,322	3.33
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$41,152,225	$9,663,039	4.26
703	Expanded Late Night Service, Routes 51/52	2025	2040	$30,864,169	$13,449,719	2.29
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$143,516,933	$46,503,204	3.09
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$17,423,351	$6,767,545	2.57
800	**Bicycle and Pedestrian Projects**					
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$22,775,944	$23,245,900	0.98
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$7,868,811	$4,552,600	1.73
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$9,604,225	$6,395,300	1.50
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$3,880,095	$893,000	4.35
900	**Roadway and Traffic Operations Projects**					
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue - Nani Ihi Avenue	2024	2040	$8,900,235	$3,746,771	2.38

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	BCA Ratio
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$17,298,759	$19,802,492	0.87
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$44,130,149	$7,557,637	5.84
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$9,614,539	$81,698,996	0.12
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,369,064	$2,084,867	0.66
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$9,267,843	$4,231,488	2.19
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$12,025,203	$66,454	180.95
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$4,697,231	$49,763	94.39
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$1,763,949	$184,939	9.55

5.2 Net Present Value

Net Present Value was calculated using both benefit discount rates. As shown in **Table 34**, there are 12 projects with a positive Net Present Value when using a 7% discount rate for benefits. As shown in **Table 35**, there are 14 projects with a positive Net Present Value when using a 3% discount rate for benefits.

Table 34. Net Present Value for COTS Projects (7% Discount Rate for Benefits)

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	Net Present Value
700 Transit Projects						
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$22,054,892	$10,284,322	$11,770,570
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$26,465,871	$9,663,039	$16,802,832
703	Expanded Late Night Service, Routes 51/52	2025	2040	$19,849,403	$13,449,719	$6,399,684
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$107,494,471	$46,503,204	$60,991,267
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$10,458,648	$6,767,545	$3,691,103

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	Net Present Value
800 Bicycle and Pedestrian Projects						
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$14,165,783	$23,245,900	$(9,080,117)
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$4,368,304	$4,552,600	$(184,296)
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$5,986,608	$6,395,300	$(408,692)
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$2,402,974	$893,000	$1,509,974
900 Roadway and Traffic Operations Projects						
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$6,599,887	$3,746,771	$2,853,117
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$13,594,531	$19,802,492	$(6,207,962)
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$29,999,778	$7,557,637	$22,442,141
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$7,555,753	$81,698,996	$(74,143,243)
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,015,217	$2,084,867	$(1,069,650)
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$6,872,484	$4,231,488	$2,640,996
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$8,174,761	$66,454	$8,108,306
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$3,193,189	$49,763	$3,143,425
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$1,199,137	$184,939	$1,014,198

Table 35. Net Present Value for COTS Projects (3% Discount Rate for Benefits)

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	Net Present Value
700	**Transit Projects**					
701	Increase bus service to/from Whitmore Village and Wahiawa Transit Center	2025	2040	$34,293,521	$10,284,322	$24,009,199
702	Increase bus service to/from Schofield and Wahiawa	2025	2040	$41,152,225	$9,663,039	$31,489,186
703	Expanded Late Night Service, Routes 51/52	2025	2040	$30,864,169	$13,449,719	$17,414,450
704	Bus Rapid Transit to Pearl Highlands Rail Station	2025	2040	$143,516,933	$46,503,204	$97,013,729
705	Align Express Route 83 on proposed Leilehua High School-Kahelu Road Connection	2028	2040	$17,423,351	$6,767,545	$10,655,806
800	**Bicycle and Pedestrian Projects**					
801	New off-street bicycle and pedestrian paths connecting to schools and parks: • Kilani Avenue • Anoni Street • California Avenue • Rose Street • Whitmore Avenue • Ihiihi Avenue	2023	2040	$22,775,944	$23,245,900	$(469,956)
802	New pedestrian/bicycle bridge connecting Wahiawa and Whitmore Village	2028	2040	$7,868,811	$4,552,600	$3,316,211
803	New bike and pedestrian connection between Wahiawa, Whitmore Village, and NCTAMS: • Wilikina Drive • Kamehameha Highway	2023	2040	$9,604,225	$6,395,300	$3,208,925
804	New and upgraded bike lanes in Wahiawa Commercial District: • Kamehameha Highway • California Avenue • Lehua Street	2023	2040	$3,880,095	$893,000	$2,987,095
900	**Roadway and Traffic Operations Projects**					
901	Whitmore Avenue widening from end of Saipan Drive to east of Ihiihi Avenue-Nani Ihi Avenue	2024	2040	$8,900,235	$3,746,771	$5,153,465
902	Kamehameha Highway widening from north of Whitmore Avenue to Kilani Avenue	2028	2040	$17,298,759	$19,802,492	$(2,503,734)
903	California Avenue Complete Streets Project from Kamehameha Highway to Wahiawa District Park	2022	2040	$44,130,149	$7,557,637	$36,572,512
906	New roadway at Leilehua High School-Kahelu Road connection between California Avenue and Higgins Road	2028	2040	$9,614,539	$81,698,996	$(72,084,457)
909	Kamehameha Highway at Whitmore Avenue Intersection Improvements	2024	2040	$1,369,064	$2,084,867	$(715,803)
910	Roundabout at Kamehameha Highway and California Avenue	2024	2040	$9,267,843	$4,231,488	$5,036,356

Project Number	Project Description	Start Year	End Year	Total Benefits	Total Costs	Net Present Value
911	Kamehameha Highway between Kilani Avenue and Avocado Street Traffic Signal Timing	2022	2040	$12,025,203	$66,454	$11,958,748
912	California Avenue between Kamehameha Highway and Wahiawa District Park Traffic Signal Timing	2022	2040	$4,697,231	$49,763	$4,647,468
915	Transit Signal Priority on Kamehameha Highway between Kilani Avenue and Avocado Street	2022	2040	$1,763,949	$184,939	$1,579,010

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6.0 NEXT STEPS

The next step in this project is to recommend projects for the two sub-areas in COTS. The work involves taking the results of the technical analysis and performance, as well as public input on different scenarios.

Public input has been sought through a series of public events, meetings with neighborhood boards, and through an online survey.

Recommendations for the Wahiawa-Whitmore Village area will be combined with those for the Mililani-Waipio area and presented in a final report (Deliverable H-2) addressing priorities, funding, and implementation. Timeframe for implementation will be considered at this point. These recommendations are meant to help guide the cooperating agencies for this study as well as OahuMPO leadership.

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