

Lummi Island Ferry Replacement and System Modernization Project Benefit-Cost Analysis (BCA)



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Executive Summary

The ferry providing service to Lummi Island is 60 years old and, while continuing in full service, is well beyond its useful life by any accepted marine standard. The Lummi Island Ferry Replacement and System Modernization Project will replace the existing diesel propulsion ferry, which has capacity for up to 16 standard-size vehicles, with a 34-vehicle, battery hybrid electric propulsion ferry. The project also includes preserving and retrofitting the aging terminal marine structures to support the new ferry, including the electric battery-charging capability.

The primary problem being solved by this project is the increasingly untenable risk and cost associated with operating an old ferry that is already beyond its projected useful life span, is functionally obsolete, and that provides the only public access to a rural island community. Due to the existing vessel's age, service hours, lack of replacement parts/equipment, and operations in a corrosive saltwater environment, the vessel's life expectancy has already been exceeded.

Without this project, Lummi Island faces the real likelihood of frequent ferry service disruptions, cancellations, or complete loss of service. There are no viable alternatives to replace the regular and reliable access to essential services provided by the vehicle ferry to this isolated island community. This project is essential to the continued operation of the only publically funded and scheduled vehicle ferry service to Lummi Island and maintenance of the lifeline it provides to the rural island community. The project will deliver:

- Long-term, reliable vehicle ferry services in support of the economic and physical security of the island community
- Environmentally responsible ferry services, with minimal impacts on both air and noise pollution in keeping with organizational, local, state, and federal climate change emission reduction and marine mammal protection goals
- A state-of-the-art battery hybrid electric propulsion ferry that will reduce the risk of a service-ending failure to an aged ferry that would leave the community literally stranded on an island
- Reduced passenger, goods, and services travel and/or wait times, along with full access for legal load vehicles on a regular and full schedule
- Maintenance of, and improvements to, emergency services, and continuity of the critical connection between the Lummi Island community and necessary/essential services of Whatcom County

This Benefit-Cost Analysis (BCA) monetizes, when possible, and qualitatively discusses, when monetization is not possible, the benefits and costs of this project. The BCA assesses the economic benefits of the project over a 30-year analysis period, relative to project implementation costs. For the purposes of this BCA, and consistent with the US DOT BCA Guidance, the project is compared against a baseline or "no build" condition that includes:

- Continued operation of the current vessel until the planned delivery of the new vessel in 2027
- Retirement of the current vessel in 2027 at the age of 65 years old, thereby eliminating vehicle ferry service to and from Lummi Island

Applying a standard BCA to this investment decision does not fully capture the scope of the project benefits. Unlike the typical capital investment project, the proposed project replaces soon to fail critical infrastructure for which there are no alternative transportation options. Termination of the ferry service is not in line with Whatcom County's transportation mission, yet termination would eliminate all of the costs associated with operation of the service and all greenhouse gas emissions, representing major monetizable disbenefits to the project. Termination would also have severe and immediate adverse impacts to the island's residents; eliminating the only viable travel option and rendering life on the island impossible for most of the current permanent residents. However, the notable project benefits from retaining this lifeline ferry services are, by comparison, largely non-monetizable. To partly address this disparity, the BCA analysis monetizes the negative impact to property values resulting from the elimination of public access to the island.

Photo 1: Lummi Island Welcome Sign



The full scope of potential project benefits and disbenefits were considered in this analysis, with select elements monetized for the purposes of this BCA and other elements discussed qualitatively. The project benefits/disbenefits that have been monetized include operating and maintenance (O&M) costs, emissions, property valuations, tax revenues, and the long-life asset residual values. The net sum of these monetized benefits and/or disbenefits is the numerator of the Benefit to Cost Ratio (BCR).

The baseline, or no build, condition retires the existing ferry, eliminating ferry service to the island and reducing the O&M costs and emissions in the baseline condition to zero. Accordingly, even though the O&M costs and emissions for the replacement vessel will both be notably lower than the existing ferry, these costs associated with the replacement vessel are considered project disbenefits in the BCA.

Beyond the monetized benefits and disbenefits, this project has several other noteworthy benefits, including travel time savings, improved system reliability, benefits to existing and new users, reduced noise generation, better emergency services capabilities, as well as sustained and enhanced quality of life for island residents and visitors.

All anticipated project capital costs have been estimated and a project implementation timeline has been projected. The project costs are estimated in 2020 dollars and discounted to correspond with the planned project timetable to obtain the total discounted project cost of \$30.78 million, which is used to calculate the project net present value (NPV) and serves as the denominator of the BCR.

Using a 7 percent discount rate over a thirty year analysis period, the NPV of the Lummi Island Ferry Replacement & System Modernization Project is approximately \$1.1 billion and the discounted monetized BCR is 37.06. The following supplemental comments are offered to provide additional context to these values.

- These values are based on the assumption that a one-time across the board reduction in property values of 50% will occur in calendar year 2027 of the baseline condition, when the current ferry is retired and the lifeline ferry service is eliminated, with no escalation in property values throughout the analysis period in either the baseline or project cases.
- Historically property values on Lummi Island have increased at an average annual rate of 4.3 % since 2011 and 9% since 2018. If the loss in property value remains 50% but the long-term trend of increasing property values is taken into account at the very conservative annual rate of 2%, the NPV is \$1,568 billion and BCR is 51.94.
- Even assuming a lower, one-time 20% reduction in property values, with these values held constant throughout the analysis period, the resulting NPV and BCR, with zero property value escalation, are more than \$413 million and 14.44, respectively.
- The BCR of 37.06 is believed to significantly understate the actual project benefit due to the inability to monetize in a meaningful way the largest project benefits associated with sustaining reliable ferry service to the rural community of Lummi Island; the dislocation of many Lummi Island residents who would have to seek a residential location off the island for access to essential services and employment opportunities.

1. Project Introduction

1.1. Project Overview

The Lummi Island ferry route is currently served by a single 60-year-old twin diesel engine-powered vehicle ferry, the Motor Vessel (MV) Whatcom Chief, which is already well beyond the end of its expected useful life. It was built to different design standards from those that exist today, possesses narrow, curved, and inefficient vehicle lanes, does not meet current Americans with Disability Act (ADA) guidelines, is undersized to meet the ferry route's current and future ridership and service demands, and represents an increasing operational risk due to its age.

The Lummi Island community has expressed, and Whatcom County shares, an interest in modernizing the Lummi Island ferry system, including replacing the existing aged ferry with a new state-of-the-art battery hybrid electric ferry, as well as repairing, updating, and modernizing the route terminal facilities. The main goal of this project is to provide Lummi Island residents with continuing lifeline vehicle ferry services while keeping operating costs low, maintaining service reliability, right-sizing the ferry to service levels, and doing so in an environmentally responsible fashion.

Accordingly, Whatcom County Public Works is seeking capital project design and construction funding to build a battery hybrid electric vehicle ferry, with capacity for 34 standard-size vehicles, retrofit the terminal marine structures for the new ferry, install shoreside charging infrastructure and make uplands operational improvements.

1.2. Location

Lummi Island is a rural island community less than 10 miles west of the city of Bellingham, WA, and approximately 90 miles north of the metropolitan Seattle area.

The ferry route is approximately 0.8 nautical miles across the channel known as Hale Passage. The mainland terminus is located at Gooseberry Point, with the Lummi Island terminal located at the northeastern corner of the island.

This route crosses relatively sheltered waters. However, the vessel may experience winds of up to 40 knots and tidal crosscurrents of up to 5 to 7 knots.

Photo 2: Lummi Island Ferry Location



1.3. Ferry System

Lummi Island has long been served by ferry services. Beginning in 1926, the ferry Central, owned by Whatcom County, provided service between Lummi Island and Gooseberry Point on the mainland and was large enough to hold six small Model-T Fords. Service was expanded using the slightly larger ferry, the Chief Kwina, in 1929. In 1962, the ferry MV Whatcom Chief, with a maximum capacity of up to 16 standard size vehicles, began service and has operated as the primary vessel on this route ever since.

The Whatcom County Public Works Ferry Division operates the Lummi Island Ferry service, providing waterborne passenger and vehicle transportation to Lummi Island, WA, 7 days per week and 365 days per year. Whatcom County's ferry service is the only publicly available means of transit between Lummi Island and the mainland, functioning as a lifeline for the delivery of passengers, vehicles, goods, and emergency services to the island and its residents.

The one-way transit time between the two landings on this route is approximately 5 minutes, with the sailing schedule incorporating close-quarter maneuvering and in-dock dwell times to disembark and load passengers and vehicles. The ferry provides service of varying frequency between the approximate hours of 5:30 a.m. and 12:30 a.m. on weekdays and 6:20 a.m. and 12:40 a.m. on weekends with additional trips as needed.

Ferry system operating costs are met through a combination of passenger/vehicle fares, and the Whatcom County Public Works Road Fund. The majority of capital investments are typically funded through the Public Works Road Fund and various grants.

1.4. Vessel Details

The MV Whatcom Chief is the only vessel that provides passenger and vehicle ferry services to Lummi Island from the mainland at Gooseberry Point.

The MV Whatcom Chief is a double-ended, twin-screw, steel-hulled vehicle and passenger ferry. The vessel operates daily between Lummi Island and Gooseberry Point, accumulating approximately 6,400 operating hours per year. During annual maintenance availability and dry dock periods when the MV Whatcom Chief is out of service, a passenger-only ferry is contracted to provide some level of backup ferry services. During these planned services outages many of the typical services are suspended, limited parking is available for passengers riding the passengers only ferry and Whatcom Transit service to the location is very limited.

The MV Whatcom Chief measures 99 feet and 10 inches in length, and 44 feet in breadth, and has a 10-foot-8-inch molded hull depth. The vessel is U.S. Coast Guard-inspected and certificated under 46 CFR Subchapter T "Small Passenger Vessels (Under 100 Gross Tons)," and has a maximum capacity of 100 persons and carries an average of between 16 and 20 vehicles depending upon the vehicle sizes.

Vehicles are loaded in four open-deck lanes, two on either side of a centerline two-level deckhouse. The ferry vehicle lanes are narrow by today's standards and are curved, making it commonplace that vehicles are loaded inefficiently and in a manner that can block passenger access to/from vehicles when in transit and creating a safety hazard.

The deckhouse has two passenger compartments on the main deck, each capable of seating 18 people. The wheelhouse, located on the upper deck, is outfit with two control stations, one facing each end of the vessel.

At 60 years old, the MV Whatcom Chief has exceeded its anticipated useful life, with maintenance costs increasing significantly commensurate with vessel age. Over its life, the MV Whatcom Chief has replaced its engines five times. While maintenance costs will continue high, and the risk of costly system failures will stay high, it is believed that the vessel can be kept in service for another five years. However, beyond this date for the purposes of this analysis, it is considered prudent to retire the MV Whatcom Chief, rather than invest additional capital funds in another engine replacement, major vessel overhaul and refurbishment considered the minimum necessary to maintain acceptably safe, reliable service during the next decade.

1.5. Terminal Details

The existing Gooseberry Point ferry terminal area is leased from the Lummi Nation, currently through 2046. It possesses limited passenger amenities, has limited parking and vehicle queuing space, and incorporates limited security. The terminal on Lummi Island consists of the basic elements necessary to support passenger and vehicle ferry operations, with vehicle queuing occurring along South Nugent Road, which runs along the island waterfront and supports access to the ferry.

The existing bridge structure at Gooseberry Point is anticipated to need significant structural improvements in the next 10 years to sustain safe operations. The terminal on Lummi Island will also need maintenance and repair into the future to support safe, reliable service to the island. As currently configured, there are administrative load restrictions placed on the vessel

and terminals which do not allow for some legal vehicle loads to cross to the island. The new vessel and the terminal upgrades would remove these restrictions. Further, to accommodate the larger replacement vessel and meet service demand, the marine structures must be modified at both the Gooseberry Point and Lummi Island ferry terminals.

Finally, to support the battery hybrid electric vessel propulsion system on the new ferry, shoreside electrical charging capability that aligns with the ferry and allows for in-dock charging of onboard batteries is considered an essential component of this project.

1.6. Passengers

Passengers to and from Lummi Island are comprised of residents, guests, and visitors, with ridership levels varying significantly by season. In 2016, just over a thousand permanent residents made the island their home on a year-round basis. They rely almost exclusively on the ferry for transit. Based on zoning restrictions, the 2009 Subarea Plan suggested that the peak island buildout population could be around 3,000 residents.

There is a significant influx of island goers during the peak summer season. Daily ridership levels experienced in July and August more than double those seen during the slower winter periods. Surveys indicate that vehicle riders often experience summer month waits of longer than two boats, and are occasionally subject to a three- to four-boat wait during the peak summer months at high demand travel times.

1.7. Goods and Services

All goods and services essential to a vibrant community are supplied by the Lummi Island vehicle ferry. This includes the provision of a full spectrum of both essential and desired goods/services, such as water, power, and septic servicing; mail and package delivery; food and provisions; home construction and repair materials and services; heating fuels delivery and servicing; electronic and internet services, and basic subsistence components. The Lummi Island vehicle ferry directly supports the delivery of these goods and services, whether through the carriage of personal automobiles or delivery/service vans and/or trucks.

In addition, key emergency services such as medical/ambulance and firefighting are also dependent upon the vehicle ferry to transit to/from the island in support of these critical services. In an emergency, these services can indeed be lifesaving.

2. Methodology

This Benefit-Cost Analysis (BCA) quantified and monetized the potential benefits/disbenefits and costs associated with the Lummi Island Ferry Replacement and System Modernization Project. In cases where the benefits or costs could not be appropriately monetized for comparison purposes, as much detail and quantification as possible was provided, along with a qualitative description of the applicable benefit or cost.

The BCA was completed following the guidelines contained in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs issued by the DOT. Wherever possible, the assumptions and methodologies outlined in that document, issued March 2022 (Revised), were used. In instances when additional assumptions and methodologies were used, they have been documented and described in detail in this report.

Applying a standard BCA to this investment decision has unintended consequences. Unlike with the typical capital investment project, the proposed project replaces soon to fail critical infrastructure for which there are no alternative transportation options. The baseline case for this project is discontinuation of a ferry service that has been in place since 1926, providing longstanding, and the only public, access to the island. Termination of the ferry service is clearly not in line with Whatcom County's transportation mission.

Typically reductions in operating and maintenance costs and emissions are project benefits, yet in this case, service termination in the baseline condition would eliminate all of the cost associated with ferry operations and all greenhouse gas emissions, making these project expenses project disbenefits. However, service termination would have severe and immediate adverse impacts to the island's residents; rendering life on the island impossible for most of the current permanent residents. These disbenefits attributable to a baseline condition that terminates ferry service when the current vessel must be retired, while significant, are largely non-monetizable. For example, there are no alternative travel options that could be used to calculate travel time savings or increased travel time costs. To partly address this unintended consequence, the BCA considers the negative impacts to property values resulting from the loss of public access to the island.

2.1. Impacts of Transportation Infrastructure Improvements

The Lummi Island Ferry Replacement and System Modernization Project acknowledges that the existing transportation infrastructure that provides the link to Lummi Island residents and visitors has aged beyond its useful life expectancy. Therefore, the goal of this capital improvement project is to rebuild and modernize this infrastructure (both ferry and facilities) to ensure continued operation of this essential transportation service.

Without a new vessel and improved facilities Whatcom County will be unable to continue ferry service to the Lummi Island community. Absent the proposed capital expenditures, the impact on the community will be severe.

2.2. Analysis Scope

The scope of the Lummi Island Ferry Replacement and System Modernization Project BCA includes the replacement of the MV Whatcom Chief with a new battery hybrid electric ferry, as well as the terminal repairs and improvements needed to support operations of the new vessel including electric charging infrastructure.

2.3. Analysis Period

Following the DOT guidelines, calendar year 2020 was established as the start/base year for the analysis period. This allowed the direct use of values provided in the tables for monetized values contained in the appendices, which are stated in 2020 dollars.

Multiple factors contributed to the selection of the analysis period duration used for this BCA. These factors include: (1) vessel and terminal life expectancy projections, (2) the overall project timetable, and (3) available demand forecasting along with the challenges of accurately modeling over a long time scale.

2.3.1. Vessel and Terminal Life Expectancy Impacts on the Analysis Period

The life expectancy of vessels in ferry service varies dramatically based on several factors, including the nature of service, operating parameters and conditions, hull construction type and materials, and maintenance practices. It is common for oceangoing vessels to be designed around an expected life of 25 years, at which time vessels may be scrapped due to hull and mechanical deterioration. However, ferry operators in the Pacific Northwest often make additional capital investment to prolong the life of their steel-hulled vessels to 50 years and beyond, as is the case with the ferry on the Lummi Island route.

Given the design characteristics of the planned 34-vehicle, steel-hulled, battery hybrid electric replacement ferry, it is reasonable to assume a life expectancy of 50 years, consistent with the typical economic life of a steel vessel operating in ferry service in the Pacific Northwest.

Similarly, the terminal support infrastructure is aging, with some components needing repair and upgrades to continue safe operations into the future. This project also proposes modifications to select terminal components as required to accommodate the new vessel, including the power grid modifications necessary to support electric ferry operations. The life expectancy of these upgraded components is forecast at 30 years, as is typically experienced with these types of structures supporting ferry service in the area.

2.3.2. Project Timetable Impacts on the Analysis Period

In 2017 the Whatcom County Council directed the Lummi Island Ferry Advisory Committee (LIFAC) to develop a Level of Service (LOS) Action Plan for the Lummi Island Ferry System. The LOS Alternatives Analysis projected future ridership, established a desired LOS, evaluated vessel and terminal alternatives, outlined a financial forecast, and included an extensive community engagement process.

The resulting LOS Action Plan was used to determine the scope of the Lummi Island Ferry Replacement and System Modernization Project, including what vessel should replace the MV Whatcom Chief. The project needs identified in the plan included the:

- Construction of a battery hybrid electric vessel with capacity for 34 standard-size vehicles and 150 passengers
- Replacement/upgrade of marine terminal structures to accommodate the new vessel, including electric charging capability
- Modification of operational components such as the reconfiguration of queuing lanes
- Installation of ADA restrooms, queuing lane cameras, and ticketing machines.

Initial planning and design work on the Lummi Island Ferry Replacement and System Modernization Project has already begun, with project completion anticipated by 2027. The project schedule, provided in additional detail in Section 2.8 was used to determine the application of costs and benefits.

2.3.3. Demand Forecasting Impacts on the Analysis Period

Demand forecasting, described in more detail in Section 2.5, was completed in 2018 as part of the LOS Alternatives Analysis. This ridership forecasting was generated to 2040, or just over a 20-year planning horizon. In addition, the forecasts were linearly extrapolated another 20 years, out to 2060, as part of the alternative analysis in recognition of a much longer expected vessel life and as a means to provide some measure of demand when analyzing replacement vessel alternatives.

Based on these factors discussed above, and the guidance contained in the DOT guidelines, this BCA has assumed an analysis period of 30 years, out to calendar year 2050. This period, while less than the 50-year new vessel life expectancy, aligned with the 30-year limitation recommended in the grant guidelines, limited the demand forecast extrapolation to approximately 10 years from 2040 to 2050, and allowed for the incorporation of the planning, construction, and implementation of the full project.

BCA benefits were accrued and costs identified over a 30-year time horizon, from 2020 to 2050. Because the useful new vessel life and terminal enhancement life both extend beyond this period, a project residual value was calculated for these components, as allowed for in the DOT guidelines.

2.4. Baseline Alternative

The Lummi Island Ferry route is currently served by the single 60-year-old, diesel-powered, steel-hulled ferry - MV Whatcom Chief. With regular maintenance and several major re-engine updates over the years, the vessel has remained in continuous service in an arrangement largely unchanged since entering service in 1962. However, the Whatcom Chief has now exceeded its anticipated service life, with maintenance costs experiencing notable and unsustainable increases and the risk of a life-ending system failure escalating significantly with advanced vessel age.

For the purposes of the BCA, an assumption was made that the baseline or “no-build” alternative would incorporate the retirement of the MV Whatcom Chief in year 2027 at the age of 65 years old. While Whatcom County has no interest in eliminating the essential lifeline ferry services currently provided by the Whatcom Chief, this assumption was considered the most realistic baseline alternative for comparison purposes in the BCA. Given the increasingly untenable risk of operating a ferry of an advanced age, this approach better aligns with the DOT guidance of having the baseline condition define the world without the proposed project.

The assumption of any other baseline scenario would be contrary to the BCA guidance, as each would necessarily involve the implementation of an alternative capital investment/project at some point during the analysis period. Even the alternative of contracting with a private operator to provide some lesser level of passenger and freight service would involve a sizable capital investment project to become a reality. Accordingly, for analysis purposes, the baseline condition retires the existing ferry, eliminating ferry service to Lummi Island.

2.5. Demand Forecasting

To provide information relevant to the forecast level of service and associated vessel sizing, a detailed ridership demand forecast was completed by Steer Davies Gleave as part of the Lummi Island Ferry LOS Alternatives Analysis completed in 2018. Their work included ridership and freight data collection and the use of a series of econometric demand models that explored passenger and vehicle ridership varying by payment type. The analysis related ferry ridership to demand generators and costs, and generated ridership projections through 2040. Select key findings of this study included:

- Ridership on the MV Whatcom Chief generally declined between 2007 and 2017, after strong growth through the mid-1990s and overall flat-lining in the early 2000s. Starting in 2009, pedestrians/passengers declined but rebounded in 2016. Vehicle counts declined for the 10 years following 2004, but started to recover in 2014.
- Following strong population growth through the end of the 1990s, the population of Lummi Island continued to increase, but at a decreased rate of growth. Further, the population showed signs of rapid aging, because of longtime residents getting older and additional middle-aged individuals and retirees migrating in.
- Fares increased considerably following 2007. For example, the vehicle cash fare went from \$4 in 2007 to \$13 in 2011, an increase of more than threefold. The demographic shifts and fare policy changes have driven ridership patterns.
- Statistical models based on the total Lummi Island population, working-age Lummi Island population, and historic fares were developed to generate unconstrained ridership forecasts to 2040. Using a projected population (0.5% growth per year) and constant fares in 2017 dollars, pedestrian/passenger ridership was forecast to grow 1.74% per year and vehicles (w/driver) at 0.87% annually to 2040 (from a 2016 base).
- Under these conditions, current daily profile, and existing level of service, weekday hourly demand from Gooseberry Point to Lummi Island in 2040 is projected to be higher than capacity between 5 and 7 p.m. in the spring and summer months.

Using the generated future populations as input into the ridership models, future ridership (one-way trips) was forecasted. The underlying model was calibrated to 2016 ridership data and island demographics and 2016 was considered the base year. The 2017 ridership was included in the table but did not change the behavior of the model.

Table 1, on the next page, shows the summary of passenger and vehicle ridership through 2040 along with projected Compound Annual Growth Rates (CAGRs). All fares were assumed to stay constant in 2017 dollars throughout (i.e. fares would stay constant with inflation).

TABLE 1 FUTURE RIDERSHIP FORECAST

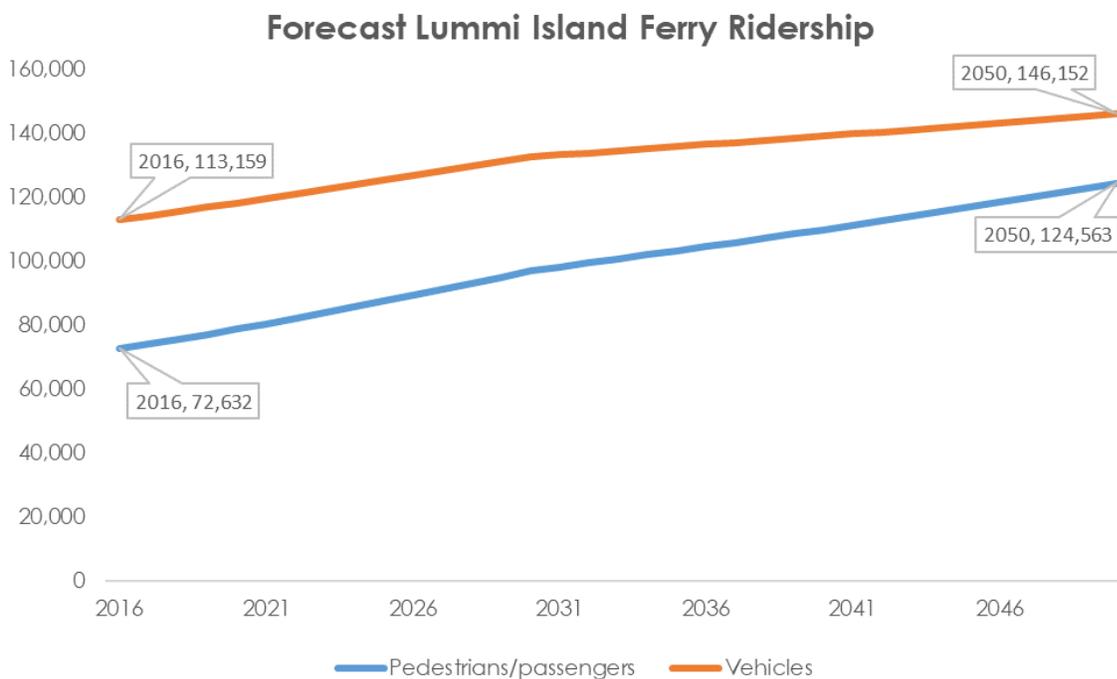
	2016	2017	2030	2040	16-30 CAGR	30-40 CAGR
Pedestrians/Passengers	72,632	79,084	97,134	109,964	2.10%	1.25%
Vehicles (w/driver)	113,159	119,961	132,854	139,421	1.15%	0.48%
Trailers	763	856	1,137	1,219	2.89%	0.70%

The model projection was unconstrained. That is, the demand model did not consider how demand would change because of capacity or level of service changes. The total demand was then distributed based on observed 2017 profiles of demand and aggregated to time periods, which did not feature scheduled time-level constraints.

From this analysis, it became evident that vehicle demand is governing in terms of sizing the new ferry. Using this analysis as the basis, vehicle ridership projections for the 30-year analysis period were generated. The ridership projections between 2040 and the end of the analysis period in 2050 were extrapolated in a linear fashion assuming the same annual growth rate as determined for the years 2030 through 2040.

This forecast ridership data was used to determine the optimal size for the new vessel of 34 vehicles and 150 passengers, which would accommodate the ferry service's current and projected ridership while keeping the vessel below thresholds that would generate additional crewing costs or regulatory burdens. Projected passenger and vehicle ridership for the duration of the analysis period are summarized as shown in Figure 1.

FIGURE 1 FUTURE LUMMI ISLAND FERRY RIDERSHIP FORECAST



There is the possibility of additional induced vehicle demand for the new vessel case. This demand would be due to a surge in vehicle ridership to absorb the extra vehicle capacity because driving on would be more convenient than parking and walking on. Not incorporating this added vehicle demand builds in some level of conservatism to the BCA by under reporting the forecast ridership demand in the project scenario.

Ridership demand forecasts would theoretically apply equally to both the baseline and modernization project alternatives. However, because the baseline condition eliminates ferry service, this ridership demand does not get quantified in the BCA. It is worthy to note that all of the identified ridership would be impacted directly either in a positive manner by the project, or in a severely negative manner in the baseline condition.

2.6. Inflation Adjustments

Following DOT guidelines, all monetized values used in this BCA must be converted to real dollars, using the calendar year 2020 as the basis for all values and the indexes provided in the appendices of the DOT guidance. For this analysis, no capital costs occurred before the 2020 baseline year, so no inflation adjustments were required.

However, the estimated value for ongoing maintenance costs of the replacement vessel were developed using 2018 cost experience. Therefore, for this analysis ongoing operating and maintenance costs were escalated to 2020 dollars using the inflation factor contained in Table A-7 of Appendix A to the BCA Guidance document.

2.7. Discounting

In this BCA, all monetized values were discounted 7 percent per year consistent with the DOT guidelines to discount benefits and costs to their present value in the base calendar year of 2020. The following formula was used to discount future benefits and costs:

$$PV = FV / (1 + i)^t$$

Where: PV = Present discounted value of a future payment from year t

FV = Future value of the payment in real dollars (i.e., dollars that have the same purchasing power as in the base year of the analysis, see the next section for further discussion on this topic) in year t

i = Real discount rate applied (for this analysis held constant at 0.07, with the exception of the use of 0.03 when discounting the benefit of CO₂ emissions, consistent with the BCA guidance)

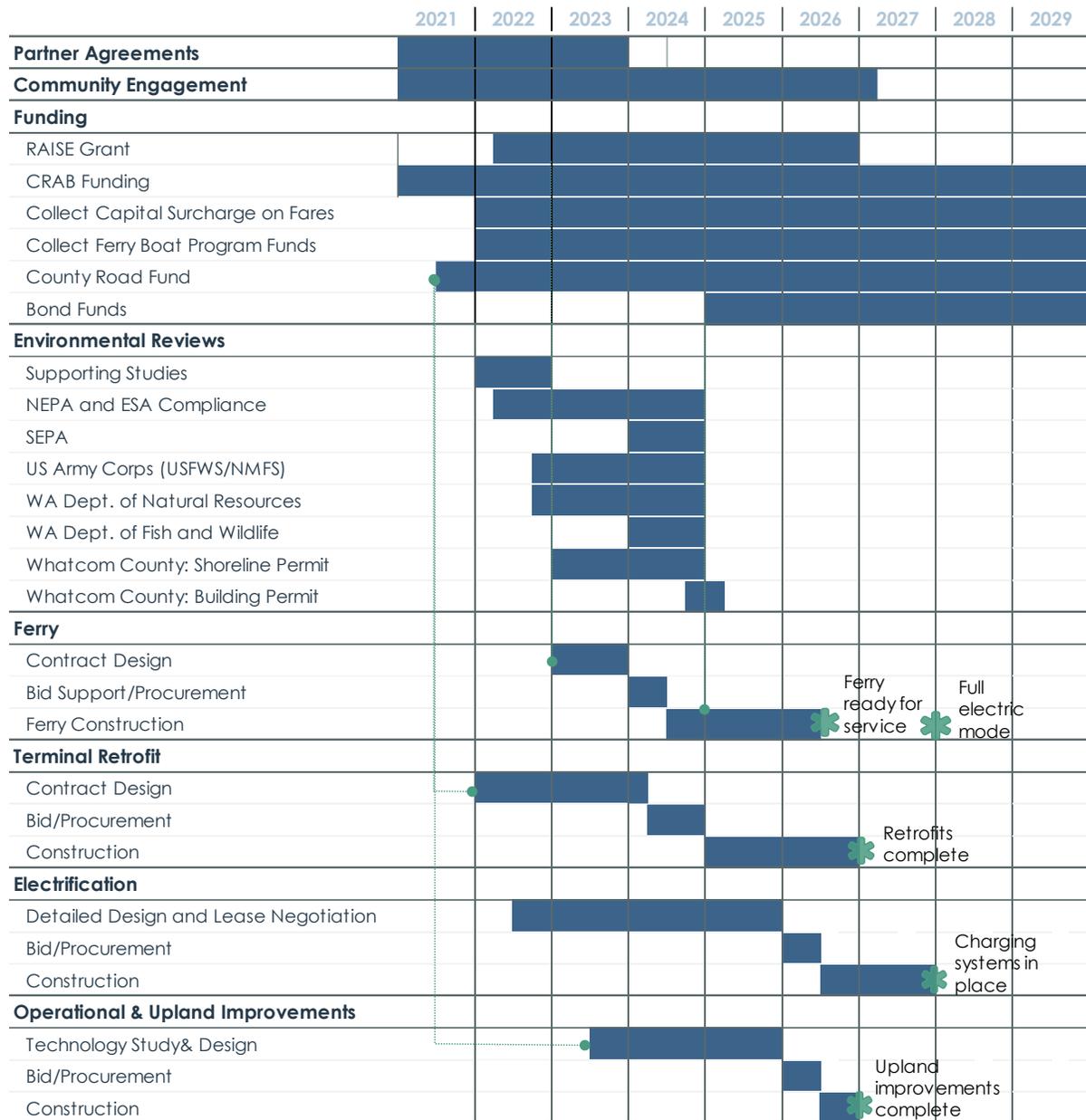
t = Years in the future for payment (where the base year of analysis is t = 0)

2.8. Project Schedule

The project schedule, shown in Figure 2 below, addresses all of the tasks necessary to successfully deliver the project, such as: entering into partner agreements, community outreach, assembling the funding portfolio, completion of vessel and terminal engineering design, environmental reviews and construction permitting, vessel construction, terminal upgrades, electrification, and shore-side improvements.

Once crew training and final vessel inspections by the U.S. Coast Guard are complete, the replacement ferry is expected to begin service before the end of 2026, making 2027 the first full year of anticipated replacement vessel operations. However, during this year the new vessel will be operated in the diesel-electric mode. Following completion of the shoreside electrification component in 2027, the full benefits from the project will be realized, with all electric operations.

FIGURE 2 LUMMI ISLAND FERRY REPLACEMENT AND SYSTEM MODERNIZATION SCHEDULE



Project costs were identified, allocated, and discounted based upon this schedule. Further, the operating and maintenance costs incurred, and to be incurred, for both the baseline and project scenarios were developed using this schedule between the base year of 2020 and the end of calendar year 2027, marking the end of the project.

3. Benefits

Benefits from the Lummi Island Ferry Replacement and System Modernization Project will be realized by several groups, including:

- Lummi Island residents and visitors are the largest beneficiaries of this project because they will be assured of ongoing operation of this lifeline ferry service.
- The communities of Lummi Island and Bellingham, Washington, benefit from the increased ferry capacity and mobility provided between Lummi Island and mainland Washington.
- Lummi Nation residents will have access to Bellingham and surrounding communities during severe flooding events which have become increasingly common; two in the last three years.
- Lummi Island and Whatcom County residents benefit from increased economic competitiveness and activity on Lummi Island.
- Lummi Island businesses and property owners benefit from improved island access and sustained property values due to the continued reliable access to their property and continued tourism that supports their businesses.
- Regional residents benefit from improved access to Lummi Island for business, recreational, and leisure activities.
- The environmental benefits with reduced noise pollution and the conversion to alternative energy/fuel sources that reduced harmful exhaust emissions and moves ferry operations toward becoming carbon-neutral.

The benefits in this report are divided into those that are quantifiable and monetized for inclusion in the benefit to cost comparison (discussed in detail in section 3.1 below) and those that are predominantly qualitative in nature providing important, but non-monetizable, benefits (explained in section 3.2).

3.1. Quantifiable Monetized Benefits

This analysis monetized benefits associated with the baseline and project scenarios in five categories:

Categories of Quantifiable Monetized Benefits		
Category	Benefit	Disbenefit
Vessel and terminal operating and maintenance (O&M) costs		✓
Property valuations	✓	
Property tax revenue generation	✓	
Exhaust emissions		✓
Residual asset value and remaining service life	✓	

Because the baseline, or no build, scenario for this BCA eliminates the longstanding ferry service, the ongoing operating and maintenance costs, as well as the exhaust emissions, tied to the project scenario and continued ferry service to Lummi Island, will be considered disbenefits

when compared against the zero costs in the baseline case. This is true even though the O&M costs after project implementation are forecast to be comparable with the existing O&M costs.

The remaining categories, property valuations, property tax revenue, and residual value, are all direct benefits tied to project implementation. A detailed description of the five monetized benefits is shared in sections 3.1.1 through 3.1.5. The net monetized benefit from the five categories summed are the numerator in the benefit-cost ratio shared in section 5.

3.1.1. Operating and Maintenance Costs

Operating and maintenance (O&M) costs for the Lummi Island Ferry system cover a wide array of costs required to support continued operations. This BCA incorporates the projected ongoing O&M costs throughout the analysis period for both the baseline and modernization scenarios.

The O&M costs for the new ferry scenario are projected in many cases to be equal or less than the existing ferry. However, because the BCA assumes a baseline condition without ferry service, the O&M cost upon project implementation in 2027 incorporates only the costs for the project condition, becoming a project disbenefit when compared against the baseline condition of zero O&M costs.

Many of the O&M costs, like personnel and other non-discretionary operating and administrative expenses, are unchanged by the project and will be used to forecast the vessel O&M costs for the project scenario through the end of the analysis period. Some vessel O&M costs such as maintenance, diesel fuel, and electric costs are specific to the new vessel, and are captured accordingly.

The BCA also incorporates estimated terminal/shoreside O&M cost for the project that are greater than the current terminal costs. This cost increase is due to the expected increase in terminal maintenance costs for facility modernization and new equipment. Again, similar to vessel costs, these terminal costs will only be incurred in the project scenario, representing a disbenefit to the project.

The BCA incorporates ongoing O&M costs in the following broad categories, which can be used to summarize similarities and differences between the project vessel replacement and terminal upgrades and the current operation.

Categories of O&M Costs		
Category	Same	Different
Salaries & Benefits	✓	
Diesel and Lube Oil		✓
Electricity Usage		✓
Vessel Maintenance & Repair		✓
Terminal Maintenance & Repair		✓
Other O&M Expense	✓	

These differences are described in sections 3.1.1.1 through 3.1.1.6 below. A summary of all O&M costs for both the project and baseline scenarios is contained in section 3.1.1.7.

3.1.1.1.Vessel Personnel - Salary & Benefits Costs

The vessel personnel costs are taken directly from actual calendar year 2020 Whatcom County expense summaries. These costs are assumed to be the same for both the baseline and project scenarios prior to project implementation and are carried forward only for the project scenario throughout the analysis period. Therefore, these post-project implementation costs are considered a disbenefit to the project.

It should be noted that the baseline scenario represents the elimination of family wage jobs, which is considered a significant drawback to this alternative. An argument can be made that this job loss would represent a notable disbenefit to the baseline condition, or conversely a benefit to the project scenario. While this is true, the BCA does not add this cost to the baseline condition as an offset to the project scenario, which is believed to represent a notable degree of conservatism build into the BCA.

3.1.1.2.Annual Vessel Fuel and Lube Oil Costs

The new vessel is designed to operate predominantly by onboard batteries that are charged using the shore-based power grid. This mode of operation provides for highly efficient vehicle ferry services, with relatively low operating costs and very limited fuel consumption.

The new vessel is also equipped with onboard diesel generators that allow for vessel operations to be conducted independent of the shoreside infrastructure, providing the distinct advantage of superior operational resiliency and emergency response capabilities. Operating in this diesel mode is expected to be rare, on the order of five percent of the time. For the new vessel's size/capacity, it is considered very fuel efficient, but when operating in the diesel mode the fuel consumption would be larger than the existing vessel due predominantly to increased vessel size.

Even though a larger capacity vessel, the new ferry's electric propulsion results in fuel consumption that is reduced dramatically when compared against the existing ferry. However, because the baseline condition eliminates ferry service, the limited amount of fuel used in the project scenario will be considered a disbenefit to the project. In calendar year 2027, the fuel cost will be higher in the project scenario because the shoreside charging infrastructure will not be complete. The notable cost difference will be realized after the shoreside electrification process is complete, with the new normal starting in 2028 and extending throughout the analysis period.

Actual fuel consumption in calendar year 2020 was low compared to typical annual averages, due to service limitations resulting from the COVID pandemic. To adjust for this anomaly a 3-year average fuel consumption level from calendar years 2018, 2019, and 2020 was used as the basis for fuel costs. To adjust for the fluctuations in fuel prices, the basis for the price of diesel per gallon was taken as the average price of diesel fuel paid for calendar years 2018 through 2020 by Whatcom County. This was applied to both the baseline and project scenarios.

3.1.1.3.Electricity Usage Costs

The new vessel will operate predominantly as an electric ferry using onboard batteries charged by the shoreside power grid. The cost of electricity to charge the batteries is considered an ongoing operating cost for the project scenario that would not be present in the baseline condition. The design electrical usage and power rates for the area provided by Puget Sound Energy have been used to estimate this ongoing cost. Again, because the baseline condition assumes no ferry service, this cost will be considered a disbenefit to the project.

The forecast cost of electricity to charge the batteries used to propel the replacement vessel is anticipated to be less than the comparable expense associated with a similar vessel using

diesel fuel to propel the vessel. While this fact positively contributes to the choice to pursue a hybrid electric ferry in lieu of a replacement diesel ferry, the ongoing annual operating electricity costs will only show up in the BCA as a project disbenefit because of the assumed baseline condition.

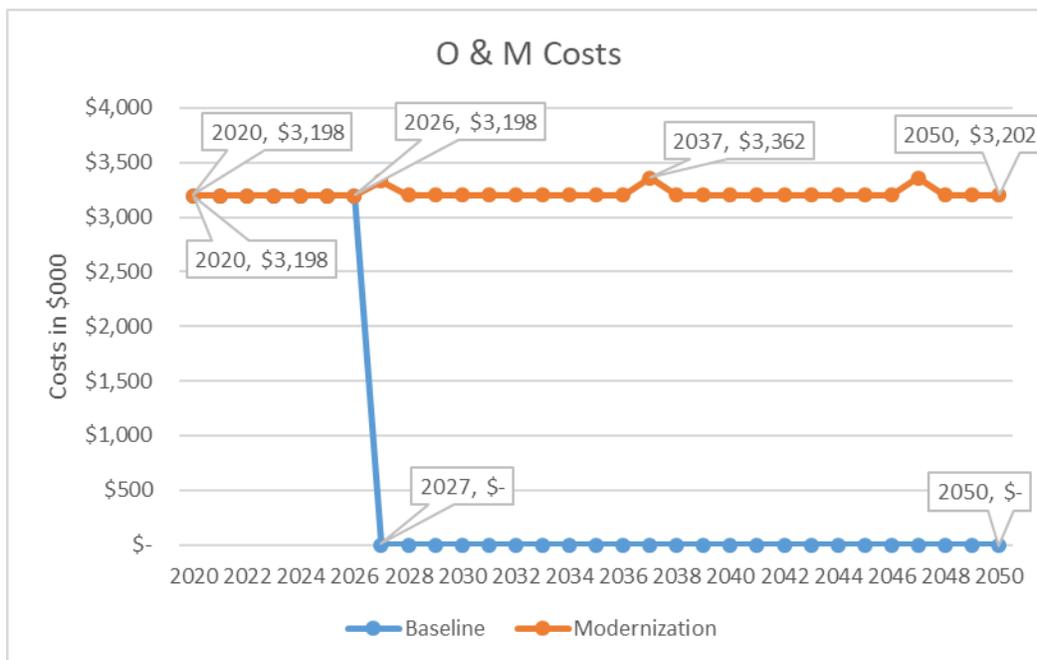
3.1.1.4. Annual Vessel Maintenance and Repair Costs

The proposed new vessel is expected to experience much lower annual maintenance and repair costs than the Whatcom Chief. The new vessel will on average have lower ongoing maintenance, drydock, and repair work costs. The new vessel maintenance costs have been estimated based on the design of the proposed vessel and anticipated maintenance cycles and associated costs. The basis for the baseline and project costs for the years leading up to the implementation of the new vessel have been assumed at the actual 2020 levels.

Even though the reduction in maintenance costs between the replacement and existing vessel will be on the order of \$130,000, or 28%, annually, this difference will not be shown in the BCA, as the existing vessel will be retired in the baseline scenario. Rather, the full cost of ongoing maintenance associated with the new vessel’s continued operations throughout the analysis period will be represented as a disbenefit to the project.

In addition to the ongoing O&M costs, the project scenario includes periodic “one-time” maintenance costs associated with battery replacement, anticipated at ten year intervals. Specifically, the \$160,000 cost of batteries has been integrated into the project alternative at years 2037 and 2047. The total vessel maintenance costs have been incorporated into the analysis and are illustrated in Figure 3.

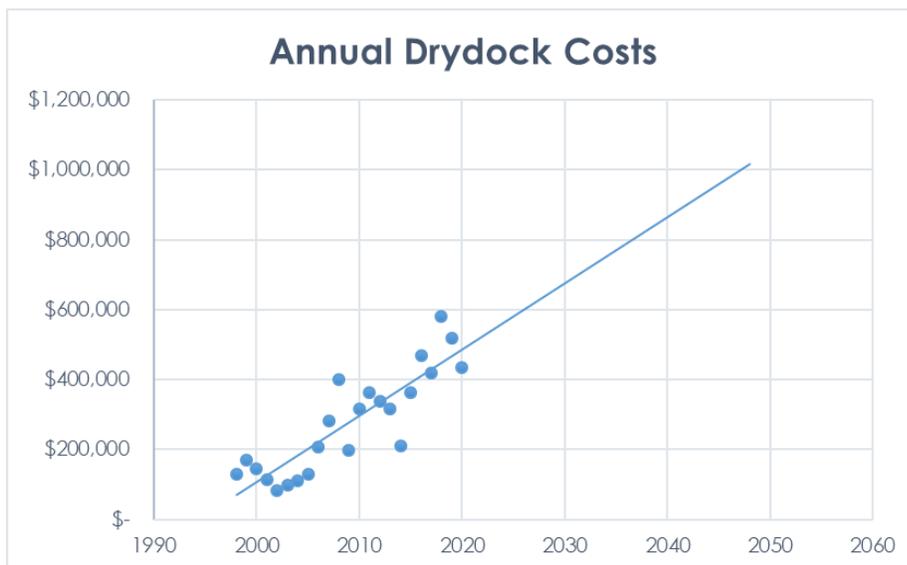
FIGURE 3 VESSEL MAINTENANCE O&M COSTS OVER TIME



These costs formed the basis for the ongoing monetization of the O&M costs throughout the analysis period.

To provide some additional context to the anticipated benefits of the replacement vessel compared to the existing vessel, an analysis of historical maintenance-related cost data was performed. Because of its age, the Whatcom Chief has been drydocked annual. Historical trends show that the annual out-of-the-water (drydock) expenses have not remained constant, even when corrected for inflation. Rather, because of the MV Whatcom Chief's age, costs have increased for the past 23 years above normal inflation, with a linear projection of these costs demonstrated in Figure 4.

FIGURE 4 ANNUAL DRYDOCK COSTS 1998-2020



Designed specifically to be eligible for an underwater survey in lieu of drydocking, in conjunction with an internal structural inspection on an interval of twice in every five years, the new vessel would drydock far less often and for a shorter duration, dramatically cutting drydock expense. It is conservatively estimated that the new ferry would only be taken out of the water once every five years with an underwater inspection occurring between the second and third years, saving costs and reducing out of service periods by conservatively a factor of four.

Further, with each vessel out-of-service period, Whatcom County incurs additional expenditures, including passenger-only ferry lease and fuel expense, use of floats to serve as loading platforms for the replacement vessels, as well as employee housing, per diem, and wage expense. These combined costs averaged nearly \$8,000 per day for the five year span between 2015 and 2019, and apply for the duration of the out-of-service period. The new replacement vessel is anticipated to have seven fewer out-of-service days, representing a cost O&M savings of approximately \$55,000 compared to the existing vessel on those years that a drydock is performed. Again, however, because the baseline alternative eliminates ferry service, these costs will not be monetized as a project benefit.

3.1.1.5. Annual Terminal Maintenance Costs

The O&M costs at the shoreside terminals are expected to increase due to the increased maintenance costs associated with the operational improvements such as new cameras, electronic fare collection system, and ferry electrification. These added costs will be encountered starting in 2028, upon project completion, and will be carried throughout the analysis period for the project scenario.

3.1.1.6. Other O&M Expenses

The “other O&M expenses” category of costs is a calculated value representing the remaining costs beyond those specifically highlighted in the analysis due to their differences. These costs, such as admin, support, and miscellaneous operating expenses, have been assumed to be the same whether operating the existing or the new vessel. Accordingly, the other O&M expenses category is held constant, with the cost discounted throughout the analysis period.

3.1.1.7. Summary of Operations and Maintenance Costs

The ongoing O&M costs, identified in 2020 dollars and projected for both the baseline and the proposed modernization project, along with their differences, are summarized in Table 2.

TABLE 2 LUMMI ISLAND FERRY ANNUAL OPERATING & MAINTENANCE COSTS

	Baseline	Modernization	Difference
Vessel Operating			
Personnel - Salaries & Benefits	\$ 1,456,000	\$ 1,456,000	\$ -
Fuel and Lube Oil	\$ 114,000	\$ 10,000	\$ 104,000
Maintenance & Repair	\$ 469,000	\$ 337,000	\$ 132,000
Electricity Costs	\$ 4,000	\$ 144,000	\$ (140,000)
Terminal Operating			
Operations & Maintenance	\$ 265,000	\$ 365,000.00	\$ (100,000)
Other Operating			
Other O&M Expenses	\$ 890,000	\$ 890,000	\$ -
Annual Operating/Maintenance Costs	\$ 3,198,000	\$ 3,202,000	\$ (4,000)

It is instructive to note that the forecast O&M costs for the new and markedly larger replacement ferry are comparable to the existing O&M costs. The reductions in vessel fuel and maintenance costs are essentially offset by the addition in electricity and terminal maintenance costs, thereby retaining O&M subsequent to project implementation similar to the existing the existing costs.

In turn, the monetization and discounting of O&M costs are summarized in Table 3.

TABLE 3 MONETIZED VALUES OF OPERATION & MAINTENANCE COSTS

Year	Baseline	Modernization	Difference (+ Savings)	Discounted (at 7% Rate)
2020	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2021	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2022	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2023	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2024	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2025	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2026	\$ 3,198,000	\$ 3,198,000	\$ -	\$ -
2027	\$ -	\$ 3,331,000	\$ (3,331,000)	\$ (2,074,000)
2028	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,864,000)
2029	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,742,000)
2030	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,628,000)
2031	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,521,000)
2032	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,422,000)
2033	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,329,000)
2034	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,242,000)
2035	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,161,000)
2036	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (1,085,000)
2037	\$ -	\$ 3,362,000	\$ (3,362,000)	\$ (1,064,000)
2038	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (947,000)
2039	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (885,000)
2040	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (827,000)
2041	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (773,000)
2042	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (723,000)
2043	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (675,000)
2044	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (631,000)
2045	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (590,000)
2046	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (551,000)
2047	\$ -	\$ 3,362,000	\$ (3,362,000)	\$ (541,000)
2048	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (482,000)
2049	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (450,000)
2050	\$ -	\$ 3,202,000	\$ (3,202,000)	\$ (421,000)
Total	\$ 22,386,000	\$ 99,683,000	\$ (77,297,000)	\$ (24,628,000)

As stipulated in the DOT guidance, O&M costs have been included in the numerator along with other project benefits, and/or disbenefits, when calculating the benefit-cost ratio for this project under the discretionary grant program.

3.1.2. Property Valuations

The proposed ferry replacement and system modernization project is essential to retention of lifeline ferry services to Lummi Island. Absent the existing ferry services, island residents' access to the island will be limited to recreational boats and there will be no ready access to basic services. Under these circumstances, it is reasonable to assume that many/most of the existing permanent residents will have to leave the island to be near basic services and employment opportunities, leading to a precipitous decline in property values.

The rate and timing of property value declines is hard to predict exactly. For this analysis, a one-time, across the board reduction of property values of 50% was assumed. This reduction in property values was incorporated into the baseline scenario in calendar year 2027 to coincide with the retirement of the Whatcom Chief and held constant throughout the analysis period. The details are depicted in Table 4

TABLE 4 MONETIZED PROPERTY VALUES WITH A 50% DECLINE IN PROPERTY VALUES IN 2027

Year	Baseline	Modernization	Difference (+ Savings)	Discounted (at 7% Rate)
2020	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2021	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2022	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2023	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2024	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2025	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2026	\$ 301,052,000	\$ 301,052,000	\$ -	\$ -
2027	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 93,740,000
2028	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 87,608,000
2029	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 81,876,000
2030	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 76,520,000
2031	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 71,514,000
2032	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 66,835,000
2033	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 62,463,000
2034	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 58,377,000
2035	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 54,558,000
2036	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 50,988,000
2037	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 47,653,000
2038	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 44,535,000
2039	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 41,622,000
2040	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 38,899,000
2041	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 36,354,000
2042	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 33,976,000
2043	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 31,753,000
2044	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 29,676,000
2045	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 27,734,000
2046	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 25,920,000
2047	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 24,224,000
2048	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 22,639,000
2049	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 21,158,000
2050	\$ 150,526,000	\$ 301,052,000	\$ 150,526,000	\$ 19,774,000
Total	\$ 5,719,988,000	\$ 9,332,612,000	\$ 3,612,624,000	\$ 1,150,396,000

The project scenario retains property values, without change, as continuation of ferry services will have no deleterious impact on property values. In fact, a strong argument can be made that the property values will escalate at an increased rate with the implementation of a new larger-capacity ferry. However, a choice was made to not incorporate any increase in property values into the analysis, building conservatism into the resulting benefit-cost ratio.

In addition, historical records would indicate that property values have escalated at a rate consistently above inflation. A review of the data found in the “Statement of Assessed Valuations, Tax Rates and Taxes Levied within the Various Taxing Districts of Whatcom County,” also known as the “Whatcom County Tax Book,” indicates that Lummi Island property valuations over the period from 2011 through 2022 have increased at an average rate of more than 4.3% (more than double the average consumer price index of 2.03 for a comparable period). In fact, the last five year’s average shows a nearly 9% annual increase. The decision to hold property values constant at the 2020 valuation level throughout the analysis period likely understates the actual value assigned to the properties.

The two notable assumptions in this analysis were, (1) the choice of level of decline in property values, and (2) the decision to not escalate property values throughout the analysis period. To test the sensitivity of these two assumptions regarding property valuation over time, further analysis was performed.

First, the level of decline in property values was varied, holding other factors constant. Second, the analysis was performed for two assumed rates of value escalation: (1) 0%, holding property values constant at the 2020 valuation throughout the analysis period, for both the baseline and project scenarios, and (2) 2%, as a rate less than half of the amount the property values have historically escalated. The results of this evaluation are shown in Tables 5.

TABLE 5 MONETIZED PROPERTY VALUES AT A VARIOUS LEVELS OF DECLINE, AND WITH 0% & 2% ESCALATION

Level of Decline	Property Escalation	Baseline	Modernization	Difference	Discounted
2.0%	0.0%	\$ 9,188,107,000	\$ 9,332,612,000	\$ 144,504,000	\$ 46,016,000
5.0%	0.0%	\$ 8,971,350,000	\$ 9,332,612,000	\$ 361,263,000	\$ 115,040,000
10.0%	0.0%	\$ 8,610,087,000	\$ 9,332,612,000	\$ 722,525,000	\$ 230,079,000
20.0%	0.0%	\$ 7,887,562,000	\$ 9,332,612,000	\$ 1,445,050,000	\$ 460,158,000
50.0%	0.0%	\$ 5,719,988,000	\$ 9,332,612,000	\$ 3,612,624,000	\$ 1,150,396,000
2.0%	2.0%	\$12,345,842,000	\$12,758,454,000	\$ 412,612,000	\$ 123,433,000
5.0%	2.0%	\$12,036,428,000	\$12,758,410,000	\$ 721,982,000	\$ 215,986,000
10.0%	2.0%	\$11,520,727,000	\$12,758,410,000	\$ 1,237,683,000	\$ 370,262,000
20.0%	2.0%	\$10,489,372,000	\$12,758,454,000	\$ 2,269,082,000	\$ 678,814,000
50.0%	2.0%	\$ 7,395,095,000	\$12,758,454,000	\$ 5,363,359,000	\$ 1,604,484,000

Review of the tables demonstrates that a modest change in increased property value of 2% per year makes a considerable difference in the monetized and discounted value, confirming that the assumption of zero property value escalation in the analysis is very conservative. Plus, even at a one-time level of decline of 20%, compared to the selected 50%, the discounted savings is still over \$460 million in the 0% escalation example, and above \$679 million in the 2% escalation example. Consequently, the use of a one-time 50% decline in property values with zero escalation over time is a reasonable assumption for this project analysis.

3.1.3. Property Tax Revenue Generation

Whatcom County collects property taxes that support a variety of critical support services and projects. If the property values decline there is a proportionate reduction in the tax revenue collected. This means that for the decline in property values discussed in the previous section, there is a corresponding reduction in the tax revenue generated. For the purposes of this BCA, this amount of lost revenue is considered a disbenefit to the baseline condition. The calendar year 2020 tax rates are depicted in Table 6 below.

TABLE 6 LUMMI ISLAND ASSESSED PROPERTY VALUATION, TAX RATES AND COLLECTIONS

2020 Valuation		\$ 301,052,000
	Rate	Tax Collected
County Property Tax	0.000872840	\$ 263,000
Road District	0.001249915	\$ 376,000
State Property Tax	0.003125706	\$ 941,000
School District	0.003421336	\$ 1,030,000
Combined Taxes Collected	0.008669599	\$ 2,610,000

Given the property values identified in section 3.1.2, and assuming that the tax rates stipulated in Table 5 remain constant throughout the analysis period, the tax collected for both the baseline and project scenarios can be calculated and discounted over the analysis period. The results of that analysis are captured in Table 7 below.

TABLE 7 MONETIZED VALUE OF PROPERTY TAX REVENUE LOSS

Year	Baseline		Modernization		Difference (+ Savings)	Discounted (at 7% Rate)
	Property Value	Tax Collected	Property Value	Tax Collected		
2020	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2021	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2022	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2023	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2024	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2025	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2026	\$ 301,052,000	\$ 2,610,000	\$ 301,052,000	\$ 2,610,000	\$ -	\$ -
2027	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 813,000
2028	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 760,000
2029	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 710,000
2030	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 663,000
2031	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 620,000
2032	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 579,000
2033	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 542,000
2034	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 506,000
2035	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 473,000
2036	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 442,000
2037	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 413,000
2038	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 386,000
2039	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 361,000
2040	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 337,000
2041	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 315,000
2042	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 295,000
2043	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 275,000
2044	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 257,000
2045	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 240,000
2046	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 225,000
2047	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 210,000
2048	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 196,000
2049	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 183,000
2050	\$ 150,526,000	\$ 1,305,000	\$ 301,052,000	\$ 2,610,000	\$ 1,305,000	\$ 171,000
Total	\$ 5,719,988,000	\$ 49,590,000	\$ 9,332,612,000	\$ 80,910,000	\$ 31,320,000	\$ 9,972,000

Note that these values assume a property value escalation of 0%. Similar to property values, the analysis can be performed assuming a reasonable 2% escalation in property values, with a corresponding increase in the benefit realized.

3.1.4. Emission Reductions Benefit

Consistent with the BCA guidance this analysis quantifies the benefits associated with the emissions components of nitrogen oxides (NO_x), particulate matter (PM_{2.5}), sulfur oxides (SO_x), and carbon dioxide (CO₂). Using the damage costs for emissions per metric ton contained in Table A-6 in the DOT guidance, the monetary benefits were calculated throughout the analysis period. The economic value associated with emissions during each year of the project’s lifetime was then discounted at a rate of 7% to its present value for use in the overall BCA evaluation. As stipulated in the guidance, the values associated with the CO₂ have been shown discounted at a rate 3%, with these values used in the BCA.

However, because the baseline condition eliminates ferry service, for analysis purposes the only difference in emissions will be those generated by the new ferry upon service implementation starting in calendar year 2027, with these reduced emissions a project disbenefit. The monetized value tied to emissions is shown below in Table 8.

TABLE 8 MONETIZED VALUE OF EMISSIONS BENEFIT

Year	NO _x	SO _x	PM _{2.5}	Subtotal	Discounted (at 7% Rate)	CO ₂	Discounted (at 3% Rate)	Total Annual Savings	Discounted Savings
2020	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2021	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2027	\$ (5,000)	\$ (9)	\$ (3,000)	\$ (8,000)	\$ (5,000)	\$ (2,000)	\$ (2,000)	\$ (10,000)	\$ (7,000)
2028	\$ (5,000)	\$ (9)	\$ (3,000)	\$ (8,000)	\$ (5,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (7,000)
2029	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (4,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (6,000)
2030	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (4,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (6,000)
2031	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (4,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (6,000)
2032	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (4,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (6,000)
2033	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (3,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (5,000)
2034	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (3,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (5,000)
2035	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (3,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (5,000)
2036	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (3,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (5,000)
2037	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (3,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (5,000)
2038	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2039	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2040	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2041	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2042	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2043	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (2,000)	\$ (11,000)	\$ (4,000)
2044	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (2,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (3,000)
2045	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (2,000)
2046	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (2,000)
2047	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (2,000)
2048	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (2,000)
2049	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (3,000)	\$ (1,000)	\$ (11,000)	\$ (2,000)
2050	\$ (5,000)	\$ (10)	\$ (3,000)	\$ (8,000)	\$ (1,000)	\$ (4,000)	\$ (2,000)	\$ (12,000)	\$ (3,000)
Total	\$ (120,000)	\$ (235)	\$ (72,000)	\$ (192,000)	\$ (61,000)	\$ (72,000)	\$ (42,000)	\$ (264,000)	\$ (103,000)

To provide some context to the benefits that the project will actually realize, a comparison of existing to planned emissions is offered here. The MV Whatcom Chief is powered by a diesel-propulsion engine that produces exhaust emissions and corresponding air pollution. The 34-vehicle replacement ferry will be powered by a hybrid electric propulsion system using batteries charged by electricity from the shoreside power grid, which will lead to significant emissions reduction when compared to the existing ferry. A comparison of one category of emissions between the existing ferry and the new ferry was analyzed to demonstrate the dramatic reduction in both fuel consumption and emissions.

Specifically, based on the EPA estimate of emissions from diesel engines and the actual fuel consumption levels of the existing ferry, a decline in CO₂ emissions from more than 523 Metric Tons/Year for the existing ferry to approximately 42 Metric Tons/Year for the new ferry, or a 92% reduction, would be realized. These emissions reductions are directly supportive of current organizational, state, and federal goals.

3.1.5. Residual Value

This project encompasses both vessel and terminal components, and in both cases, the service life would last beyond the analysis period. Accordingly, the project residual value was estimated using the total value of the project assets and their remaining service life at the end of the analysis period.

A service life of 50 years was assumed for the new vessel, which would begin when the vessel is delivered. The first full year of service begins in 2027 and last full year of expected life in 2077. This represents 23 years within the analysis period and 27 years beyond the end of the analysis period.

For the terminal infrastructure, a service life of 30 years is assumed, with the terminal upgrade completion planned for 2027 and the expected life extending to 2057, 7 years past the end of the analysis period.

The corresponding vessel and terminal residual values were calculated separately using the applicable completion dates of the components, which align with the project schedule shared in Section 2.8. The residual value of the project was defined as:

$$RV = [(U-Y) / U] * PC$$

Where: RV = Residual Value
 U = Useful Service Life of Project
 Y = Years of Analysis Period Project Operation
 PC = Project Cost

The residual value benefits occur in the final year of the analysis and have been discounted similarly to other project benefits in this BCA. The residual value benefit details for this project are captured in Table 9.

TABLE 9 LUMMI ISLAND FERRY REPLACEMENT & SYSTEM MODERNIZATION RESIDUAL VALUES

	Cost	Residual Value	Discounted Residual Value
Vessel Total	\$ 21,929,000	\$ 11,842,000	\$ 1,906,000
Terminal Total	\$ 21,175,000	\$ 4,941,000	\$ 3,077,000
Total Project Capital Costs	\$ 43,104,000	\$ 16,783,000	\$ 4,983,000

3.2. Qualitative Benefits

Consistent with the DOT guidelines regarding project benefits that cannot be monetized, this section addresses in a qualitative manner those benefits that would be realized by the Lummi Island Ferry Replacement and System Modernization Project but are not monetized and do not contribute directly to the benefit to cost ratio. The six project benefits that have not been monetized are:

- Travel Times Savings

- System Reliability
- Benefits to Existing and Additional Users
- Loss of Emergency Services
- Noise Reduction, and
- Quality of Life.

A detailed discussion related to these six benefits is shared in sections 3.2.1 through 3.2.6.

3.2.1. Travel Time Savings

The US DOT guidance stipulates the approach for monetizing the benefit from travel time savings. However, it is exceedingly difficult, if not impossible, to capture travel time savings for this project compared to the baseline because there are no alternative ways to travel to the island that could be used to calculate travel time durations for the baseline case.

Compared to the existing ferry service, there will be significant benefits with the project. The operation of a larger capacity replacement vehicle ferry will reduce the wait times tied to vehicles missing sailings due to space limitations on the existing smaller capacity vessel. Survey data from Lummi Island Ferry users indicates that during the summer peak season, it is commonplace for vehicle users to experience a two-boat wait, with as much as a four-boat wait occurring during high demand periods. There is no single source of reliable data to support a quantitative analysis of wait time experienced by vehicle travelers. However, it is reasonable to conclude that a 70% increase in vehicle capacity (from 20 to 34 vehicles) will result in a significant decline in vehicles waiting for the next available sailing and markedly cut travel times.

With the elimination of ferry services in the baseline condition, travel times from the island will be dramatically impacted. Quantification of this impact is not possible due to the wide variety of potential outcomes. Therefore, the following qualitative description of the impacts is offered in an attempt to appropriately highlight the tremendous benefit realized from the proposed project for travel time savings.

Passenger-only travel will change between the modernization and baseline scenarios from the ability to board a ferry on regularly schedule service to having to find a private means to transit across the water. This would likely involve the possession of a private vessel, which would have to be moored on both the island and mainland. This type of moorage is not readily available nor would it be linked to any other form of transportation. Consequently, passenger travel times from island residences to mainland destinations, and vice versa, would be drastically increased, or more realistically routine passenger travel would be eliminated.

Vehicle transits to/from the island will be completely eliminated in the baseline condition. Consequently, travel times increase associated with anyone, or anything, transiting to/from the island via vehicle in this scenario cannot be quantified. Any attempt to quantify the travel time increase, and corresponding benefit to the proposed project, was not possible as no alternative means to move vehicles to/from the island exists. An entirely new set of infrastructure projects would be required to restore some level of vehicle and large goods movement to the island.

3.2.2. Reliability Benefit

For a single-ferry system such as the Lummi Island Ferry, vessel reliability is paramount. Reduction in out-of-service time will be a major benefit to ferry users in the project scenario. Because the baseline condition in the BCA eliminates the existing ferry service, the associated service reliability would be reduced to zero, a far cry from the reliability currently maintained at levels above 95 percent. However, even when compared against the existing service, the replacement of the 60-year-old diesel ferry with a new hybrid electric ferry would directly decrease vessel out-of-service time and ensure that reliable vehicle and passenger transportation to the island is maintained. The following discussion offers quantitative evidence in support of this assertion.

Due to vessel age, Whatcom County must pull the MV Whatcom Chief out of the water to be inspected annually. From 2009 to 2019, the MV Whatcom Chief averaged 28 days per year out of service for shipyard work, including both planned (average of 21 days) and unplanned or emergency dry-docking availabilities (average of 7 days).

The replacement vessel would drydock less often and for a shorter duration. Specifically, the new vessel is designed to be eligible for an underwater survey in lieu of drydocking, in conjunction with an internal structural inspection on an interval of twice in every five years. Even in a conservative scenario, it is estimated that the new ferry would only be taken out of the water once every five years with an underwater inspection occurring between the second and third years.

Further, in the years the new vessel is not taken out of the water, a reduced duration maintenance period of approximately two weeks is anticipated annually at a dockside facility or at the Whatcom County terminal. The resulting out-of-service days planned per year for heavy maintenance work would represent at least a 7-day, or 33%, reduction in planned out-of-service days, equating directly to a marked increase in reliability.

In addition, beyond the degradation of service with a passenger only ferry substituting for the vehicle ferry, the smaller ferry does not have the same seakeeping characteristics as the vehicle ferry, with service disruptions from service delays and cancellations much more common. For example, during the most recent drydock period when passenger only ferry service was substituted, there were several instances of sailing cancellations due to inclement weather that would not have occurred if the vehicle ferry were operating on the route. This new vessel will positively impact service reliability, reducing unexpected travel wait times and greatly enhancing quality of life for island residents.

3.2.3. Benefit to Existing and Additional Users

The existing Lummi Island ferry is functionally obsolete and has exceeded its expected service life. It is undersized to meet the existing ridership and future ridership demand projections, does not meet current reliability expectations and needs, does not accommodate full sized vehicles, marginally meets emergency service's needs, and is potentially hindering economic activity and vitality on Lummi Island and surrounding areas.

The Lummi Island Ferry Replacement and System Modernization Project addresses each of these shortcomings and makes a major improvement to the Lummi Island lifeline. It will replace the existing aged ferry with a new state-of-the-art battery hybrid electric ferry operating in full battery mode by 2028. It will address the vessel capacity shortcomings with added passenger and vehicle capacity for both existing and additional users. It will upgrade the supporting infrastructure to allow for the transit of full-sized vehicles. It will dramatically improve ferry system reliability by cutting down on maintenance demands associated with the aged ferry MV Whatcom Chief. It will meaningfully support the requisite emergency service's needs for the isolated community on Lummi Island. And, it will facilitate a vibrant island economy now and into the future.

3.2.4. Loss of Emergency Services

Immediately-available emergency response assets located on Lummi Island are limited to a volunteer fire department, with no medical facilities. As the sole means of public transportation between Lummi Island and the mainland, the Lummi Island ferry provides a critical emergency service function for residents and visitors of Lummi Island by supporting the transport of emergency vehicles and personnel from the mainland. Further, the island population is aging, with nearly half of the island's residents over 60 years old, with the ferry playing a crucial role in connecting residents to medical and other necessary services.

Over the previous five year period, an average of 32 Emergency Medical Services (EMS) transports per year, or almost 3 times per month, occurred on the ferry, demonstrating the critical nature of the emergency service the ferry provides to the island community. Further, viable alternatives to replace this service is very limited. For example, in 2021, the medivac helicopter was unable to fly on 15 occasions due to limiting weather conditions, leaving the ferry as the only transport option for extreme medical emergencies.

The capability of the ferry to operate in an emergency is vital to the safety of island residents and visitors. The Lummi Island ferry ties up overnight on Lummi Island, with the crew prepared at all times, even outside of service hours, to make special runs for law enforcement, utility crews, and emergency first responders providing critical care for medical emergencies. In the absence of this project, these services will all be lost. Vessel replacement is essential to ensure emergency response services are provided in a rapid, reliable manner in support of maintaining the community's welfare.

3.2.5. Noise Reductions

The MV Whatcom Chief has a traditional engine room with diesel engines and corresponding exhaust that exits the vessel through the centerline stack adjacent to the small passenger area and the second level pilothouse. This old design, along with the lack of modern sound insulation, makes to the MV Whatcom Chief a quite noisy vessel. Relatively high noise levels impact both passengers and crew, as well as the marine environment in which the ferry operates.

While noise exposure is not above the Occupational Safety & Health Administration (OSHA) hearing conservation program standards for an 8-hour time-weighted average of 85 decibels, these existing noise levels do make it difficult for crewmembers to communicate. The noise levels also create an unpleasant experience for passengers, making it difficult to carry on a

conversation in the onboard passenger areas. Noise pollution underwater can also interfere with marine mammal communication, when exposed to the ferry noise in proximity to the ferry.

Particular attention shall be paid to design and construction of the new vessel to minimize noise, with the Contractor responsible for locating and correcting unsatisfactory conditions arising during tests or trials. Allowable limits, commensurate with noise levels associated with comfortable communications, will be prescribed as stipulated in Table 10.

TABLE 10 LUMMI ISLAND FERRY NOISE LEVEL SPECIFICATIONS

34-Vehicle Ferry Noise Specifications	
Space	Desired dB(A)
Interior Passenger Areas	65
Car Deck	65
Crew Lounge	60
Pilot house (doors & windows closed)	55
EOS	60

Noise levels will be reduced with the new ferry, operating predominantly on electric motors, with the new design separating the pilothouse from the engines and exhausts, and arranging the passenger areas such that they are separated from the engines when they are in use. Further, the new vessel will be designed to modern standards for noise generation, incorporating sound dampening insulation to keep the operating noises to a minimum. The reduction in noise with the new vessel will also benefit marine mammal habitat, reducing underwater noise pollution and mitigating impacts to aquatic life.

3.2.6. Quality of Life

Lummi Island is a rural community with a population of approximately 1,000 year-round residents. On-island services available to residents are limited to one general store, two restaurants, a small library, a post office, a volunteer fire station, and two churches. An elementary school is located on Lummi Island for both on island and mainland students. Middle and high school students rely on the ferry to attend schools in nearby Ferndale, WA. The island has a volunteer fire station, but supporting fire stations, law enforcement, and all other emergency services reach the island by ferry. The ferry is also the only means to transport goods, materials, equipment, and service providers to the island.

In addition to providing the only commute option for Lummi Island residents to access off-island jobs, the ferry brings visitors to the island to enjoy recreation and tourism. Lummi Island has many opportunities for visitors to enjoy the outdoors including hiking trails, art installations, and nature preserves. The short ferry trip makes these opportunities easily accessible to visitors from nearby cities including Bellingham and Seattle, WA, and Vancouver, BC.

Replacing the 60-year-old ferry MV Whatcom Chief will directly contribute to the quality of life for residents and visitors by increasing the reliability of lifeline services, providing an improved level of service, and enhancing the connection between Lummi Island and neighboring communities. The increased vehicle and passenger capacity of the 34-vehicle battery hybrid electric propulsion replacement ferry ensures that Whatcom County's ferry service can accommodate

the expected growth in ridership throughout the ferry's anticipated service life and contribute directly to the island's economic vitality.

4. Costs

Current ferry service operating expenditures have been extracted from Whatcom County expenditure reports and adjusted as necessary for operating changes driven by the replacement ferry and other improvements such as the shift from diesel propulsion to hybrid electric propulsion. These operating and maintenance costs, discussed in more detailed in section 3.11 are all captured in the benefit/disbenefit portion of the analysis.

Comprehensive capital cost estimates have been prepared for all elements of the proposed project. All costs have been identified regardless of funding source, and regardless of whether the funding source(s) has/have even been identified. Project capital costs were developed based on calendar year 2020 projections for use in the BCA expressed in common terms.

Project capital costs used in this BCA, when discounted are summed to form the denominator in the Benefit to Cost ratio. These estimated costs include project design and engineering work, environmental review and permitting efforts, and costs associated with project construction such as labor, materials, and construction management. These are the total costs necessary to implement both the vessel and terminal project elements. All capital funds for project design, support, and construction are expected to be paid using competitive bid processes in accordance with applicable buy America provisions.

Both the vessel and terminal capital costs for the project will be expended over several years, as depicted in the project schedule. These costs have been monetized over time and discounted to calendar year 2020 dollars for use in the benefit to cost comparison. Table 11 provides the monetized values of vessel and terminal project costs, as well as the discounted project costs.

TABLE 11 MONETIZED VALUE OF LUMMI ISLAND FERRY REPLACEMENT AND SYSTEM MODERNIZATION PROJECT COSTS

	2020	2021	2022	2023	2024	2025	2026	2027	Total
Shoreside									
Pre-Construction									
Geotechnical		50,000	100,000						150,000
Design - Marine structures			345,000	345,000					690,000
Design - Electrification		176,000		264,000	264,000	176,000			880,000
Environmental Permitting			31,000	172,000	81,000	13,000	0	0	297,000
Bid & Award - Marine Structures			0	0	25,000	25,000	0	0	50,000
Bid & Award - Electrification			0	0	0	280,000	280,000	0	560,000
Total Pre-Construction		50,000	652,000	781,000	370,000	494,000	280,000	0	2,627,000
Construction									
Direct Construction -Marine		0	0	0	1,889,000	4,165,000	4,165,000	0	10,219,000
Construct & Management - Electrification		0	0	0	0	0	2,624,000	3,936,000	6,560,000
Construction Management - Marine		0	0	0	67,000	67,000	67,000	0	201,000
Total Construction		0	0	0	1,956,000	4,232,000	6,856,000	3,936,000	16,980,000
Terminal Operations									
Pre-construction		50,000	154,000	154,000	0	0	0	0	358,000
Construction		0	0	0	0	0	1,212,000	0	1,212,000
Total Terminal Operations		50,000	154,000	154,000	0	0	1,212,000	0	1,570,000
Total Shoreside		100,000	806,000	935,000	2,326,000	4,726,000	8,348,000	3,936,000	21,177,000
Discounted Total (at 7% Rate)		\$ 93,000	\$ 704,000	\$ 763,000	\$ 1,774,000	\$ 3,370,000	\$ 5,563,000	\$ 2,451,000	\$ 14,718,000
Vessel									
Pre-Construction									
Design				375,000	125,000				500,000
Bid & Procurement				0	100,000				100,000
Total Pre-Construction		0	0	375,000	225,000	0	0	0	600,000
Construction									
Direct Construction					8,252,000	11,346,000	1,031,000		20,629,000
Owner's Representative					282,000	348,000	70,000		700,000
Total Construction		0	0	0	8,534,000	11,694,000	1,101,000	0	21,329,000
Total Vessel		0	0	375,000	8,759,000	11,694,000	1,101,000	0	21,929,000
Discounted Total (at 7% Rate)		\$ -	\$ -	\$ 306,000	\$ 6,682,000	\$ 8,338,000	\$ 734,000	\$ -	\$ 16,060,000
Total Expenditures									
Discounted Total (at 7% Rate)		\$ 93,000	\$ 704,000	\$ 1,069,000	\$ 8,457,000	\$ 11,707,000	\$ 6,296,000	\$ 2,451,000	\$ 30,777,000

The total vessel discounted cost of \$16.06 million and terminal discounted cost of \$14.72 million when summed provide the total project costs of \$30.78 million, which is the denominator in the benefit to cost ratio for the Lummi Island Ferry Replacement and System Modernization Project.

5. Benefit-to-Cost Comparison

5.1. Net Present Value

Net present value (NPV) measures the projected value of the Lummi Island Ferry Replacement and System Modernization Project as an investment for Whatcom County. The NPV was calculated by discounting the costs and benefits of the project over the assumed analysis period and then subtracting the discounted costs from the discounted benefits. The NPV of this project calculated at a 7 percent discount rate is \$1.1 billion a notably positive NPV.

5.2. Benefit-to-Cost Ratio

The benefit-to-cost ratio compares the benefits of a project to its costs. It was calculated by dividing the sum of five discounted project benefits identified in section 3.1 by the discounted project costs identified in section 4. The benefit-cost ratio of this project at a 7 percent discount rate is 37.06.

The monetized costs and benefits associated with the Lummi Island Ferry Replacement and System Modernization Project are summarized in Table 12.

TABLE 12 LUMMI ISLAND FERRY REPLACEMENT AND SYSTEM MODERNIZATION BENEFITS-TO-COST COMPARISON

Category	Description	Total Value	Discounted Value (at 7% Rate)
Costs			
Vessel Project Costs	Cost of replacement vessel	\$ 21,929,000	\$ 16,060,000
Terminal Project Costs	Cost of terminal upgrades to support new vessel	\$ 21,177,000	\$ 14,718,000
Total Cost		\$ 43,106,000	\$ 30,778,000
Benefits			
O&M Cost Savings	Cost savings associated w/reduced maintenance	\$ (77,297,000)	\$ (24,628,000)
Property Valuations	Reduction in property values of 50% in 2027	\$ 3,612,624,000	\$ 1,150,396,000
Property Tax Revenue	Reduction in Tax Revenue @ 50% decline in Value	\$ 31,320,000	\$ 9,973,000
Emissions *	Added emissions due to Project	\$ (264,000)	\$ (103,000)
Residual Value	Additional operating life of vessel and infrastructure	\$ 16,783,000	\$ 4,983,000
Total Benefit		\$ 3,583,166,000	\$ 1,140,621,000
Net Present Value			\$ 1,109,843,000
Benefit to Cost Ratio			37.06

6. Summary of BCA Findings

This BCA monetized the benefits from vessel operating and maintenance cost savings, property valuations, property tax revenue, emissions, and the residual value of the 34-vehicle hybrid electric replacement ferry and terminal infrastructure after the analysis period. It provided qualitative descriptions of the project benefits related to travel times savings, system reliability, existing and additional users, loss of emergency services, noise reductions, and quality of life.

The total project costs of \$30.78 million and accrued benefits of more than \$1.14 billion discounted at a rate of 7 percent resulted in a positive benefit-cost ratio of more than 37.06. This ratio is lower than it would be if more data were available and if more key project benefits could be accurately monetized. Despite the limitation to fully monetizing project benefits, the benefit to cost comparison demonstrates very strong benefits for this essential transportation service sustaining project.

Beyond those benefits that could be monetized, this project offers several other benefits that should be noted, including:

- **Retention of Family-Wage Jobs.** While not monetized as a project benefit, this ferry replacement project would retain the family-wage jobs required to support and maintain ferry operations.
- **Fuel & Emissions Reductions.** The new ferry's electric propulsion system results in drastically lower fuel consumption and reduced emissions when compared against the existing ferry. Because the baseline condition eliminates ferry service, these benefits do not positively contribute to the BCA. However, these fuel usage and emissions reductions are directly supportive of current organizational, state, and federal goals for environmental sustainability.
- **Maintenance Cost Reductions.** Ongoing and necessary maintenance costs in the BCA are considered a project disbenefit. However, the proposed replacement ferry will have reduced annual maintenance costs compared to the existing vessel of approximately \$130,000 or 28%, annually.
- **Travel Time Savings.** Travel time savings is a significant benefit associated with the proposed project, with benefits realized in two broad areas, including the time savings associated with the operation of a larger vehicle ferry reducing the wait times tied to missed sailings, and time savings associate with a baseline condition that eliminates ferry service altogether. While not quantified, the first category is estimated to annually save thousands of hours when compared to existing service. The second category recognizes that with the termination of service to Lummi Island there will be a dramatic increase in travel time, but monetizing that impact is not possible because there are no existing travel alternatives available to quantify the additional travel time. Any future travel alternatives will require a separate capital investment.
- **Reliability.** Replacement of the MV Whatcom Chief with a new 34-vehicle ferry will significantly improve the reliability of the Lummi Island ferry route for residents and visitors traveling between the island and mainland Washington State. This is particularly significant as the ferry is the single public option to access the island.
- **Benefits to Existing and Additional Users.** The MV Whatcom Chief is undersized and is unable to meet the ferry route's current and future ridership demand projections. The existing service limitations are hindering the expansion of economic activity on the island and in neighboring communities and dampens Lummi Island community's vitality. The ferry replacement and system modernization project will meaningfully support existing and new user needs and the adopted level of ferry service needed to sustain the community into the future.
- **Noise Reduction.** The new ferry is anticipated to significantly reduce noise levels in general, and in the passenger and crew spaces onboard the vessel in particular. This is due to both the benefits of operating an electric ferry, as well as modern vessel design and sound insulation, which will keep noise levels at a very comfortable level. This will directly benefit the passengers and will facilitate quick and easy communications between crewmembers for both routine and emergent operations. The underwater noise reduction will also benefit marine mammal habitat.

- **Loss of Emergency Services.** The existing Lummi Island ferry provides a critical emergency service function for residents and visitors of Lummi Island by transporting emergency vehicles and personnel to and from the mainland. The existing experience with the degradation in these services during periods when the MV Whatcom Chief is out of service, making it exceedingly clear what the impact would be should these services be eliminated, which would be the case in the baseline condition. Over the last five years there have been, on average, 32 EMS transports per year on the ferry. In 2021, the medivac helicopter was unable to fly 15 times due to weather conditions leaving the ferry the only transport option for extreme medical emergencies. The benefits to the proposed project in this regard, while not quantifiable, are extreme for island residents.
- **Quality of Life.** Created by the Whatcom County Council, LIFAC was thoroughly engaged in the development of a Level of Service Action Plan for the Lummi Island Ferry System since 2017. LIFAC identified a shared community goal of keeping operating costs low, maintaining service frequency and reliability, right-sizing service levels, and doing so in an environmentally sound fashion. While difficult to monetize, there is broad agreement and support among residents regarding the overall importance of ferry service in maintaining Lummi Islanders' way of life and the contributions that the Lummi Island Ferry Replacement and System Modernization Project will make toward this end.