M/V GUEMES
O.N. 601686

Ferry Replacement Plan

Prepared for: Skagit County Public Works • Mt. Vernon, WA

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REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	Initial issue	07/22/13	
A	Revised to include operating costs and replacement options	11/01/13	JWW
B	Revised to include mid-body extension summary, causes of ridership decreases, and clarify new construction capital cost estimate	11/22/13	JWW 24294

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1 EXECUTIVE SUMMARY

The M/V GUEMES (O.N. 601686) is a passenger ferry owned by Skagit County, Washington that operates between the City of Anacortes and Guemes Island. The vessel was designed by Nickum & Spaulding Associates and was built in 1979 at Gladding Hearn Shipbuilding in Somerset, Massachusetts [1]. It has a length overall of 124 ft, a beam of 33.5 ft, and a design draft of 6.5 ft.

This report is a Ferry Replacement Plan produced by Elliott Bay Design Group (EBDG) for Skagit County Public Works. The report is intended to address three major areas:

- Identify the service needs of the Guemes Island community
- Assess the remaining economic life of the M/V GUEMES
- Estimate the capital and operating costs for vessel replacement options

The historical growth trends in Skagit County and on Guemes Island, as well as the current projections and regulations, were studied to estimate the future demand on the Guemes Island ferry service. While the population within Skagit County continues to grow, data indicates that the rate of growth has been decreasing over the past 20 years. The current Skagit County population projection predicts a 27.5% increase in population from 2010 to 2025. On Guemes Island, population growth is controlled with zoning regulations to preserve the rural nature of the community. If the most recently observed growth rate on Guemes Island continues, the population will increase approximately 24% by the end of 2033.

The annual, monthly, and daily ferry ridership was also considered in the analysis. Annual ridership from 1980 to 2012 was investigated. A general reduction in passenger ridership since a 2007 high was observed. Vehicle ridership showed relatively little growth since the mid-1990s, suggesting that the practical vehicle capacity may have been reached. The weekday daily ridership was relatively balanced, however ridership tended to slow after 6:00 pm. Alternatively, weekend daily ridership was observed to be unbalanced with reduced demand during the morning and evening hours.

The Guemes Island ferry service was compared with the Lummi Island ferry service operated by Whatcom County. Both ferries serve islands of similar size; however, ridership is significantly less on the Lummi Island ferry. The Lummi Island ferry also has a greater annual operating budget. The Guemes Island ferry service operates fewer scheduled runs over a shorter period of operation each day. These factors lead to the Guemes Island ferry service having a much lower cost per vehicle delivered.

The condition of the vessel was assessed from previous condition and valuation surveys, hull condition surveys, field surveys, and meetings with Skagit County Public Works. The overall condition of the vessel is given and areas of concern are noted. The structural integrity of the ship is considered good, however improvements are needed to the engine foundations and areas of the engine housings. The azimuthing drives, as well as the navigation electronics are considered to be old and require replacement. New doors and interior paneling are also required in the wheelhouse, crew cabin, and passenger cabin.

While the overall condition of the vessel is fair, it is recommended that the M/V GUEMES not be operated for more than another ten years without a major overhaul. This is due to the advanced age of the vessel and the high cost of extending operation of the vessel beyond its

economic useful life of 30 to 40 years. Recognizing that the M/V GUEMES has limited remaining useful economic life, three replacement options were formulated.

The first option (Option A) is immediate vessel replacement. If this option is selected, it is estimated that a new vessel would enter service in approximately three years. This is due to the time required initially for vessel planning, including design development, and acquisition, including construction and commissioning. The second option (Option B) is to delay the acquisition of a new vessel for ten years and continue the use of the existing vessel. This option requires a moderate vessel overhaul in the near-term. The final option (Option C) is to extend the life of the existing vessel. This would require a major vessel overhaul, including insertion of a mid-body extension to increase the vehicle carrying capacity. It is estimated that this option would allow for continued vessel operation for an additional 18 years, at which time a new vessel would enter service.

A 23-year period for comparison of the vessel replacement options was chosen to accommodate a 20-year operation of the new vessel as described in Option A. Acquisition of a new vessel, including time to design and construct is estimated roughly to require three years. Therefore a 23-year planning period was identified to allow for uniform comparison of all options.

To determine the most economic replacement option, several costs are evaluated over the planning period. Capital costs related to new vessel construction, mid-body extension and vessel overhaul are estimated for each option. Annual maintenance costs and annual operational costs of fuel and lube oil consumption are also considered. Crew costs are not part of the estimated costs as they are likely to be the same for any of the options considered. The costs are summed in constant 2013 dollars over a 23-year planning period to determine the replacement option with the lowest cost of ownership. The total cost of ownership over the 23-year period for each option is given below in Table 1.

Table 1: Ownership Cost

Replacement Option	Total Ownership Cost
Option A – Immediate Vessel Replacement	$19.54 million
Option B – Delayed Vessel Replacement	$21.50 million
Option C – Mid-body Extension	$26.74 million

Based on the projections for population growth and the annual ridership statistics, it is recommended that a moderately larger ferry vessel be built. A vehicle capacity of 26 vehicles, four more than the current capacity, has been identified as one that would keep pace with the projected growth rates of the island. The analysis presented in this report results in a clear recommendation for selection of Option A. While all options are assumed to commence immediately, it is recognized that several factors, including agency approvals and available funding are necessary before the acquisition process can begin. Immediate or near term replacement of the M/V GUEMES with a new vessel will minimize the overall cost of ownership and provide environmental improvements in vessel operation.

2 DEMAND AND SERVICE

2.1 Population Growth

2.1.1 Skagit County

Population growth is an important indicator of future ferry demand. While the population growth on Guemes Island is a primary driver, the growth in the Skagit County region as well as County policies on future growth will impact ferry demand. The following section details the history of population growth and the regulation of future growth in Skagit County.

2.1.1.1 New Residences

Figure 1 shows the new residences in Skagit County from 1980 to 2010 [2]. New residences have generally been declining since 1993, although an increase in new construction is clearly evident in the early 2000's. While this figure does not indicate a reduction in Skagit County population, it does indicate a decrease in the rate of population growth.

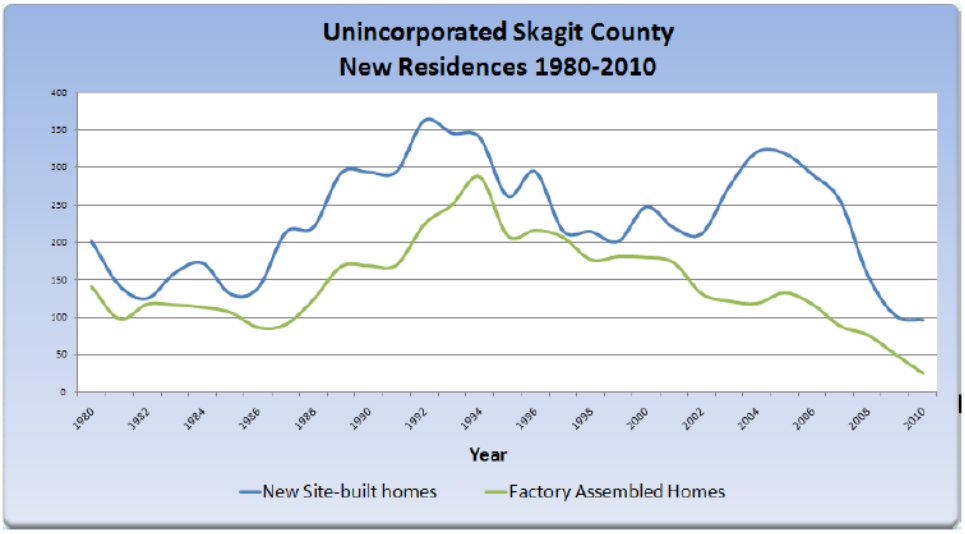

Figure 1: New Residences in Skagit County from 1980 to 2010

2.1.1.2 Growth Forecast

The Washington State Office of Financial Management (OFM) generates low, medium, and high population forecasts for each county. The Skagit County projections for 2015 and 2025 [3] are shown in Table 2. The population of Skagit County in 2010 was 116,901 [4]. The adopted OFM population forecast is 149,080 in 2025, or a 27.5% increase in population over 15 years.

Table 2: Skagit County Population Forecast

Forecast	2015	2025
High	154,785	198,992
Medium	135,717	164,797
Adopted	128,470	149,080
Low	121,467	139,253

While the potential for growth within Skagit County is moderate, it is important to note where new residents will likely reside. The Growth Management Act (GMA) directs that a majority of future growth be concentrated within urban growth areas (UGAs), to reduce urban sprawl and preserve the character of rural areas. Following these guidelines, the Countywide Planning Policy directs that 80% of the County's overall growth be within UGAs. Figure 2 shows the location of UGAs (in pink) within Skagit County [5]. As can be seen, there is no UGA on or adjacent to Guemes Island.

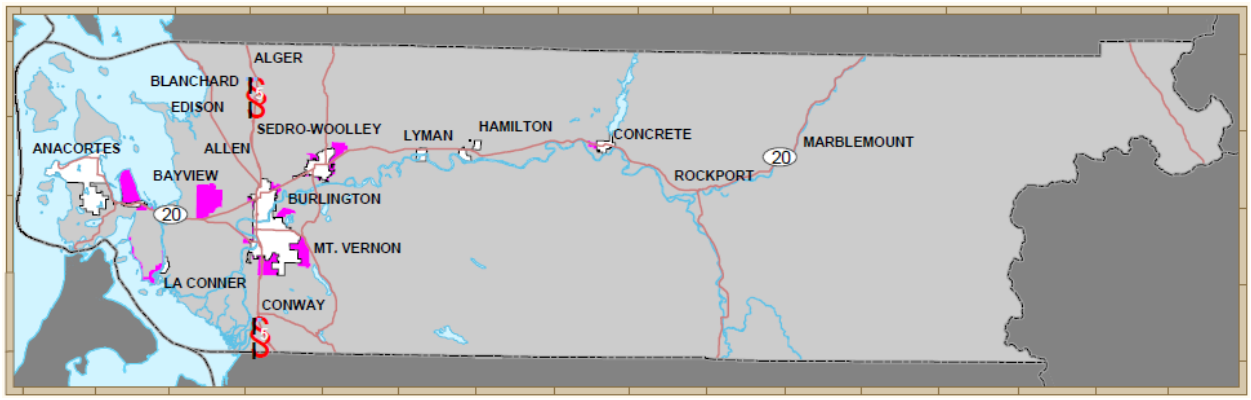

Figure 2: Urban Growth Areas in Skagit County (shown in pink)

2.1.2 Guemes Island

In 2010, it was estimated that there were 600-800 permanent residents living on Guemes Island [6]. However, during the summer, the population was estimated to be greater than 2,000 people due to part time residents and visitors.

2.1.2.1 Current Zoning

Current zoning ordinances on Guemes Island are designed to limit population growth and preserve the rural character of the island per the GMA. This is accomplished through control of new homes on the island by specifying the minimum plat size per dwelling unit (DU). Table 3 gives the zoning designations and the plat size requirements on Guemes Island [6].

Table 3: Guemes Island Plat Size Requirements

Zoning Designation	Maximum Permissible Density for New Subdivision	Total Acres	Percent of Total Land Base
Rural Resource (RR)	1 DU per 40 Acres	492	9.6
Rural Reserve (RRv)	1 DU per 10 Acres	3888	75.7
Rural Intermediate (RI)	1 DU per 2.5 Acres	722	14.1
Rural Center (RC)	NA	4	0.077
Small Scale Recreation & Tourism (SRT)	NA	16	0.31
Rural Business (RB)	NA	14	0.27

The maximum amount of development on Guemes Island can be determined from the plat size requirements in Table 3. Table 4 shows the existing development and maximum potential development on the island [6]. In 2008, there were 627 homes on Guemes Island and the land capacity to support an additional 957 homes. There is, therefore, the potential for a 150% increase in ferry traffic due to an increase in Guemes Island residents. While the potential for increased ferry ridership from new residents is high, it is highly unlikely that it will be reached in full by the end of the 20-year planning period.

Table 4: Existing and Potential Development on Guemes Island

	Existing Parcels		Existing Development		Potential Development
Group	Parcels	Acres	Homes	Acres	Max Homes
RR	15	492	1	40	15
RRv (Parks Easement)	39	308	7	135	9
RRv	556	3,580	192	820	617
RI	922	722	427	319	943
Total	**1,532**	**5,102**	**627**	**1,314**	**1,584**

2.1.2.2 Zoning Recommendations

The 2010 Guemes Island Sub-Area Plan recommends limiting building permits on Guemes Island to 20 per year. This includes new residential dwellings, additions exceeding 25% of the existing square footage, and additional dwelling units such as guesthouses or lofts. This recommendation was made based on a maximum build out in 50 years under current zoning rules.

If it is assumed Skagit County will follow these building permit recommendations, the maximum potential increase in Guemes Island homes over the 20-year planning period can be estimated. In 2010, there were 671 homes on the island. This results in a potential 1,131 homes in 2033; a 69% increase by the end of the 20-year planning period. While less than the maximum potential build out, this still represents a significant stress on ferry demand.

2.1.2.3 Home Construction

The expectation of future ferry demand can be decreased further if the trends in new home construction on Guemes Island are considered. Table 5 shows the new home construction statistics from 1951 to 2004 [6]. The average annual percentage increase has been decreasing steadily for the past four decades. If it is assumed that the annual percentage increase in new homes is constant throughout the 20-year planning period and is at the most recent rate of 1.1%, the number of new homes on Guemes Island would increase only 24% by the end of the planning period.

Table 5: New Home Construction on Guemes Island since 1951

Decade	New DUs	Total DUs	Percentage Increase	Average Annual Percentage Increase
1951-1960	67	101	197.1	19.7
1961-1970	74	178	72.6	4.4

Decade	New DUs	Total DUs	Percentage Increase	Average Annual Percentage Increase
1971-1980	146	329	84.8	4.5
1981-1990	136	472	43.5	3.2
1991-2000	178	666	41.1	2.9
2001-2004	28	695	4.4	1.1

2.1.2.4 Resident Preference

A survey of Guemes Island residents was conducted to aid in creation of the Guemes Island Sub-Area Plan [6]. In this survey, residents indicated that preserving the rural character of the island was highly important. In fact, nearly 75% of residents preferred future growth be slower than the past several years, some even preferring negative growth. Nearly 67% of residents favored a moratorium on land subdivision permits while the Guemes Island Sub Area Plan was developed, and 76% of residents favored large open spaces being permanently protected from development.

Zoning and building permit limits can be used by Skagit County to directly control growth on the island. However, ferry service also impacts population growth on Guemes Island. Building new residences on the island without increases in ferry service may lead to undesirable transportation circumstances. This would discourage potential new homebuilders from considering Guemes Island for their residence.

2.2 Tourism

Guemes Island is a key tourist destination in Skagit County and tourism is, therefore, responsible for a large amount of traffic on the island [6]. Particularly during the summer months, tourists enjoy activities such as boating, biking, kayaking, and special events such as art fairs and garden tours. There is also a small resort on the northern end of the island that attracts visitors.

The number of tourists visiting Washington State grew by 2.8% in 2010, 1.6% in 2011 [7], and 2.1% in 2012 [8]. If the trend continues, it could result in approximately a 54% increase in statewide tourist traffic by the end of the 20-year planning period. Statistics were not available to determine the correlation of Guemes Island tourism trends to statewide tourism trends. This figure intends only to give a very approximate scale of tourism growth.

2.3 Ferry Ridership

The trends in ferry ridership are perhaps the greatest indication of future demand. The following sections show the history of annual ferry ridership since the purchase of the M/V GUEMES, as well as recent monthly and daily ridership statistics.

2.3.1 Annual Ridership

Ferry ridership statistics since the purchase of the M/V GUEMES in 1979 are shown in Figure 3 [6]. Until 1995, both passenger and vehicle ridership increased steadily. However since then, vehicle ridership has been steady and even decreased slightly in recent years. The largest vehicle ridership occurred in 2003 with 208,723 vehicles served. After 1995, passenger ridership continued to grow at a slower rate until it peaked in 2007 at 422,257. Since then, it has

decreased to only 370,465 in 2012. Ridership was especially low in 2011 due to dock rehabilitation which left the ferry out of service for two months. Additionally, ridership was low in 2005 due to a prolonged vessel haul-out.

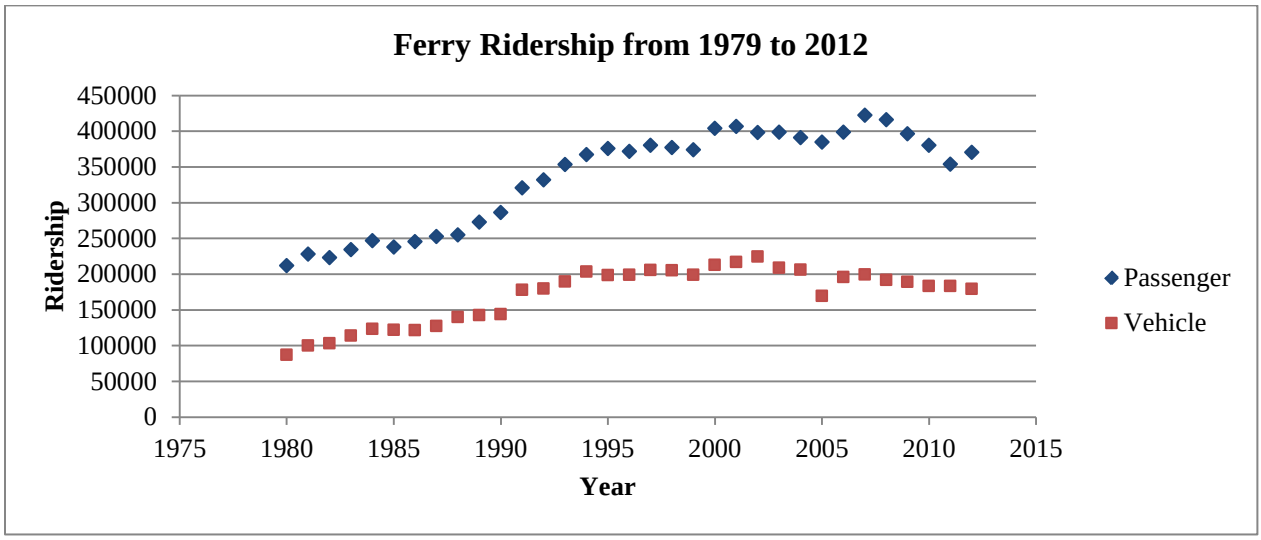

Figure 3: Annual Ferry Ridership from 1979 to 2011

While passenger ridership may increase over the 20-year planning period, it will likely show only a moderate increase over previously experienced levels. If passenger ridership increases at a rate similar to the period of growth from 1993 to 2007, total passenger ridership in 2033 will be ten percent greater than the ridership seen in 2007. This is due to the low passenger ridership levels experienced from 2010 to 2012.

The leveling off of vehicle traffic may indicate the practical capacity of the ferry, given the current schedule, has been reached. Problems with parking and traffic detailed in further sections support this claim.

2.3.1.1 County Projections

In 2009, Skagit County made projections of ferry ridership from 2010 to 2030 [6]. The County's projection showed both passenger and vehicle ridership increasing steadily over that time period. By 2030, vehicle ridership was projected to increase 21% to approximately 230,000 vehicles. Passenger ridership was projected to increase 7.5% to approximately 430,000 passengers.

Skagit County's projection overestimated ferry ridership from 2010 to 2012. The projected passenger ridership in 2012 was nearly 11% greater than the actual passenger ridership.

2.3.2 Monthly Ridership

Ferry ridership fluctuates throughout the year [9]. It is typically at a minimum in January or February and peaks in July or August. This is likely due to the increased traffic from part time residents. The change in ridership between these two extremes can be significant. The peak passenger ridership is approximately 78% greater than the minimum, and the peak vehicle

ridership is approximately 58% greater than the minimum. Currently, the peak sailing schedule is from May 20 to September 30. It is important that future ferry capacity be capable of supporting the demand during the peak months of July and August.

The monthly ridership statistics from 2010 to 2012 are shown in Figure 4. The lower ridership indicated in April and May of 2011 was due to a prolonged ferry service outage during dock refurbishment. The low ridership indicated in October of 2010 and 2012 was due to regularly scheduled vessel maintenance.

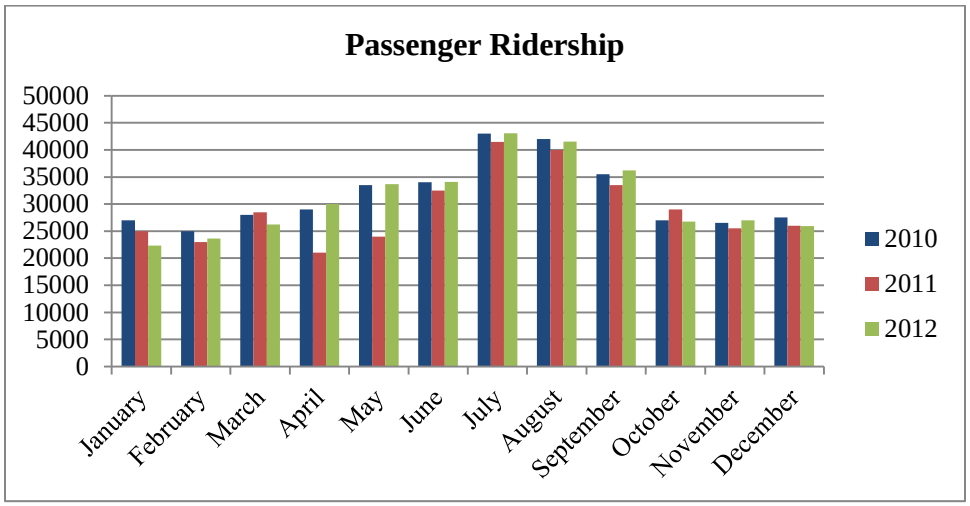

Figure 4: Monthly Ferry Passenger Ridership from 2010 to 2012

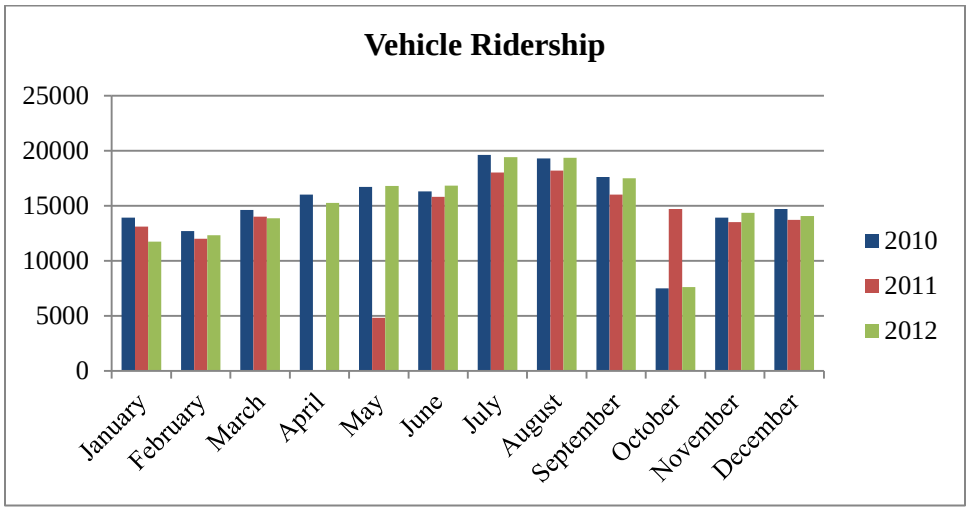

Figure 5: Monthly Ferry Vehicle Ridership from 2010 to 2012

2.3.3 Daily Ridership

The daily weekday ridership is relatively well balanced. Round trip ridership is consistent throughout a majority of the day. However, ridership begins to decrease during the evening and nighttime runs after 6 p.m. Furthermore, there is a spike in ridership during the 4 p.m. and 4:30 p.m. runs indicating that the schedule could be better balanced. This could be done through pricing incentives to encourage use of the ferry later into the evening.

The daily passenger ridership statistics for May 6 through May 9, 2013 are shown in Figure 6 [10]. This week was chosen as an example of typical trends in daily ridership as it was representative of many other weeks that were examined. The vehicle ridership showed trends similar to the passenger ridership.

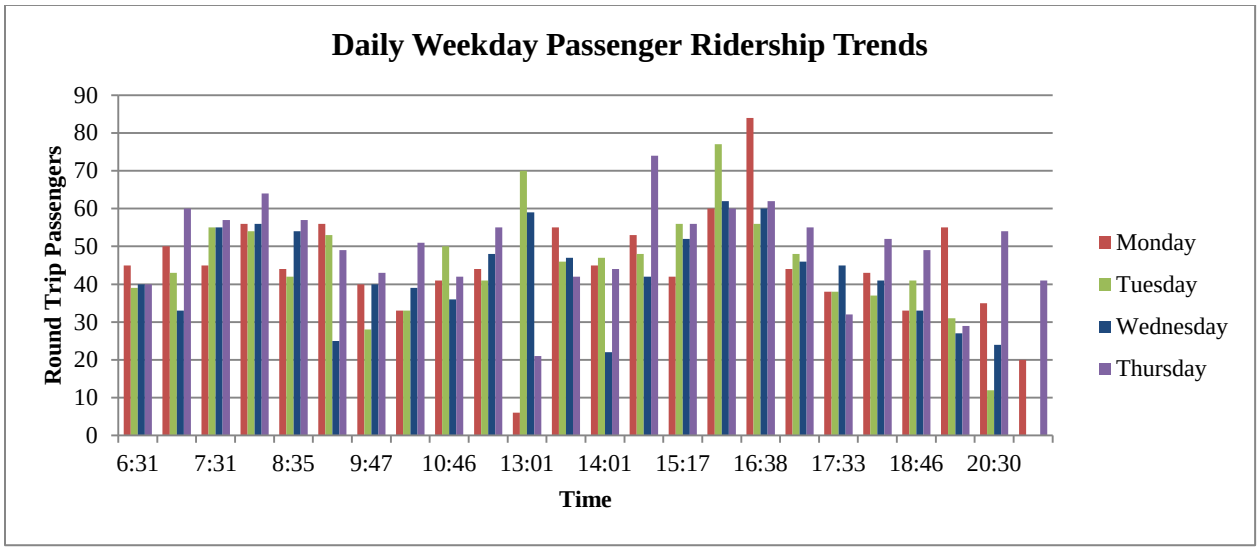

Figure 6: Daily Passenger Ridership Trends from May 6 to May 9, 2013

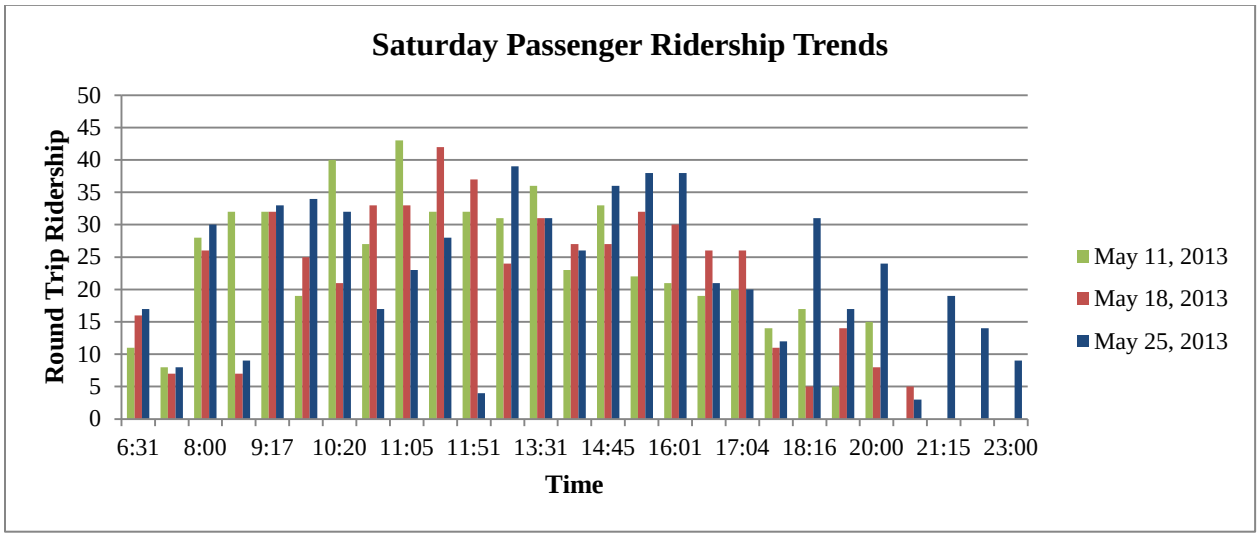

Figure 7: Saturday Passenger Ridership Trends for Three Saturdays in May 2013

While weekday runs are well balanced overall, weekend runs show a high amount of ridership imbalance. Figure 7, above, shows the passenger ridership from several Saturdays in May 2013 [10]. As can be seen, ridership is much greater midday than in the morning or evening. Again, pricing incentives could be used to better balance ridership throughout the day.

2.4 Service Comparison

2.4.1 Lummi Island Ferry Service

A service comparison was made between the Guemes Island and Lummi Island ferry services. Lummi Island is located several miles north of Guemes Island and has approximately the same land area. Similar to Guemes Island, Lummi Island has approximately 900 year round residents and a population of over 2,000 during the summer months. The Guemes Island route is 0.7 miles one way and the Lummi Island route is 0.8 miles one way. Table 6 shows a comparison of key statistics for both ferry services. The data was compiled from a number of sources listed in Section 7.

Table 6: Comparison of Guemes Island and Lummi Island Ferries

	Guemes Island Ferry	Lummi Island Ferry
Vessel	M/V GUEMES	M/V WHATCOM CHIEF
Length	124.0 ft	93.5 ft
Beam	46.0 ft	44.1 ft
Passenger Capacity	99	100
Vehicle Capacity	22	16
2012 Total Passengers	370,465	182,484
2012 Total Vehicles	179,042	109,156
Round trips per day*	23	39
Earliest Departure*	6:30 a.m.	5:40 a.m.
Latest Departure*	8:30 p.m.	12:00 a.m.
Standard Passenger Fare	$3.50	$7
Standard Vehicle Fare	$10	$13
2012 Expenditures	$1,786,750	$2,488,023
Facilities Lease[1]	$0	$200,000
2012 Fare Box Revenue	$955,670	$1,447,131
2012 Fare Box Recovery	53.5%	63.2%

*Weekday peak sailing schedule

2.4.2 Analysis

As Table 6 indicates, both the M/V GUEMES and M/V WHATCOM CHIEF are of similar passenger capacity. Given the similar population [11] [6] and size of the islands they serve, it is

[1] For comparison purposes, the cost of the Gooseberry Point Lease was removed from the 2012 Expenditure during the analysis.

expected that ridership would also be similar. However, the M/V GUEMES typically carries approximately 100% more passengers and 65% more vehicles than the M/V WHATCOM CHIEF. It supports this ridership despite having only 59% of the peak weekday trips of the M/V WHATCOM CHIEF.

While the decreased number of daily trips leads to a diminished level of customer service, it provides for substantial cost savings. The M/V GUEMES' cost per vehicle delivered is $9.98. This is substantially less than the M/V WHATCOM CHIEF's cost per vehicle delivered of $20.96. These savings are passed on to the ferry customers. The standard passenger fare on the M/V GUEMES is 50% that of the M/V WHATCOM CHIEF and the standard vehicle fare is only 77%.

Despite this difference, fare box recovery is similar for both ferry services. The M/V WHATCOM CHIEF had a better fare box recovery of 63.2% than the M/V GUEMES at 53.5%. A study of fare box recovery of the Washington State Ferries (WSF) was completed in 2010 [12]. The study found that WSF fare box recovery in 2009 was 68.3%, better than 14 other publicly owned ferry services which had an average recovery of 48.8% [12]. This indicates that the Guemes Island fare box recovery is on par with other publicly owned ferry services.

The differences in fare price and ridership between the Guemes Island and Lummi Island ferry services also indicate an important feature of the ferry market: ferry ridership can be substantially modified with changes in fare price. This shows that future ferry demand from population growth could be regulated with fare changes, and does not necessarily require a larger vessel.

2.5 Other Considerations

2.5.1 Customer Satisfaction

A survey of Guemes Island ferry customers was conducted in March 2012. It asked residents to rate their satisfaction with several areas of ferry service including the ferry manager, crew, public meetings, reliability, schedule, and cost. Approximately 345 responses were received and divided into two groups: residents who reside on Guemes Island more than six months a year, and residents who reside on Guemes Island less than six months a year.

Overall, customers were satisfied with or neutral to most categories in the survey. In these categories, there was not more than 13% dissatisfaction and a majority of these categories had less than 5% dissatisfaction. However, there were two areas that had substantially more negative responses: current sailing schedule and the cost to use the ferry. Amongst residents who reside on Guemes Island less than six months per year, dissatisfaction was still low at 17% for schedule and 15% for cost. Amongst residents who reside on Guemes Island more than six months per year, dissatisfaction was high at 47% for schedule and 36% for cost.

2.5.2 Terminal

Upgrades have recently been made to the ferry slips both on Guemes Island and in Anacortes. In 2010, aging creosote dolphins were upgraded to steel pilings at the Guemes Island slip. Wing walls were also replaced at both the Guemes Island and Anacortes slips. The remaining creosote dolphins at the Anacortes slip are scheduled to be replaced in 2014 [13].

The costs associated with these upgrades are substantial. The 2014 upgrades alone are budgeted to be $1.5 million. If an increase in ferry demand were to be accommodated with a larger ferry, care should be taken to prevent upgrading recently replaced pilings.

2.5.3 Traffic

During holidays and peak weekends traffic becomes congested leading to both ferry terminals [6]. On Guemes Island, ferry lines can extend beyond the dedicated waiting lane causing disruptions on Guemes Island Road creating dangerous situations when emergency vehicles must pass. Traffic also extends beyond the waiting lanes in Anacortes. Ferry traffic can fill parking areas resulting in congestion that can cause delays as much as several hours [6].

While current traffic delays typically occur only during holidays and summer weekends, an increase in ferry capacity could lead to more frequent and greater traffic congestion both in Anacortes and on Guemes Island. Any expansion in ferry capacity must coincide with significant improvements to shore side ferry traffic management.

2.5.4 Parking

Parking near the ferry terminals is also of concern. On Guemes Island, a lot adjacent to the terminal can accommodate approximately 100 vehicles. In Anacortes, there is parking capacity to accommodate 148 vehicles. However, Lot 3, which is farthest from the Anacortes terminal, is typically underutilized. Ferry passengers typically park in the neighborhood surrounding the terminal in order to park closer. This is a source of tension with Anacortes residents.

A committee was formed to find solutions to this problem. A volunteer driven community shuttle bus, provided by the County, was the primary solution, along with increased education and signage. If ferry capacity is to be increased, further solutions may be required to ensure neighborhood parking is not impacted.

2.6 Recommendations

The population of Skagit County is projected to grow, albeit at a lesser rate than in the past. Therefore, it is likely that growth will also occur on Guemes Island. Based on the single-family home growth rates experienced over the past several decades and the recent focus on maintaining the rural quality of the island, it is expected that this growth will be moderate. There is the potential for a 69% increase in residences on the island by 2033. However, it is expected that the actual growth rate will be closer to 25% based on data from 2000 to 2004. It is also anticipated that tourist traffic will increase on the island.

Vehicle ridership indicates that the ferry has been operating at maximum practical capacity for some time. This is due to both ferry capacity and shore side facility and transit limitations. Furthermore, given the expectations of future growth, passenger ridership also has the potential to reach ferry capacity. It is therefore recommended that ferry service be increased to accommodate current and future demand for vehicle transportation.

Several methods can be used to accommodate the expected increase in ferry traffic. EBDG recommends that a moderately larger ferry be built to support the moderate growth in ferry demand. The new vessel should increase the vehicle capacity by four vehicles to a total of 26 or

18%. The new vessel should also be designed to accommodate the current terminal facilities. Adjustments in fare prices should also be used to control ferry demand. Price incentives can be used to encourage a more balanced ferry demand throughout the day, especially on weekends.

3 CONDITION REPORT

The condition of the M/V GUEMES was assessed from previous condition and valuation surveys, hull condition surveys, field surveys, and meetings with Skagit County Public Works. The vessel condition was organized by the Ship Work Breakdown System (SWBS) into the following categories:

Table 7: SWBS Number Breakdown

SWBS	Item
100	Structure
200	Propulsion Systems
300	Electrical Systems
400	Command, Control, and Communication Systems
500	Auxiliary Systems
600	Outfit
800	Engineering Information

Each SWBS category is documented in the following sections of this report. The overall condition of the vessel is described and areas of concern are noted.

3.1 Structure

The overall structural integrity of the hull is considered good. An ultrasonic thickness (UT) survey of the hull conducted in October 2010 indicated a large majority of the hull is sound with little corrosion [14]. Wastage in the shell plating was generally less than 4%. One segment of shell plate near the keel coolers was accidentally constructed with 5/16 in plate instead of the intended 3/8 in plate. This also occurred with the skeg plating. According to Skagit County Public Works, this difference in plate thickness has been recorded with the USCG.

The main engine foundations show signs of excessive corrosion. There are high amounts of visible corrosion (shown in Figure 8) and the structure surrounding the foundations has been observed to flex under load [15].

Figure 8: No. 2 Engine Foundation

Figure 9: Structure at Engine Housing Base

There is also excessive corrosion at the base of the engine housings as seen in Figure 9. In many areas at the bottom of the engine housing, including the outer wall, the plate has corroded completely through. This has created holes leading into the engine housing. A majority of the upper portions of the engine housing structure appear to be in good condition. However, there is evidence of corrosion above the door of engine housing #1.

The condition of the deck structure is unknown as it is hidden under the non-skid coating; however, deck deflections have been observed under the maximum vehicle load of 105,000 pounds [15]. A UT survey is to be completed in 2014.

3.2 Propulsion Systems

The vessel was originally powered by Detroit Diesel engines connected to Murray Tregurtha azimuthing drive units. The original engines were replaced in 1990 along with the two azimuthing thrusters (EBDG Job Number 89057).

The vessel propulsion is currently provided by two Cummins KTA19-M3 engines delivering 530 horsepower each at 1800 rpm. The engines are mounted on deck in individual housings. Skagit County purchased three of these engines and installed two of them in 2005. In October 2010, the #1 engine was replaced after approximately 20,000 hours with the spare engine which had remained unused since 2005. In October 2012, the #2 engine was replaced after approximately 30,000 hours with the re-built #1 engine that was removed from the vessel in 2010. Approximately one month after this replacement, an oil leak was discovered and this engine had to be re-exchanged. The oil leak has since been fixed and the re-built engine was re-installed in November 2013. However, the replacement delay caused by the oil leak led to the original #2 engine going over 30,000 hours.

The United States Environmental Protection Agency (EPA) sets limits on allowable emissions from non-road diesel engines. The engines currently on the M/V GUEMES are compliant with EPA Tier II emission standards, which are sufficient given the engines were installed in 2005 when emissions standards were lower. However, if new engines are installed on the vessel, they would need to comply with the latest emissions standards from the EPA. Currently for the range

of engine sizes likely to be replacement candidates for this vessel, Tier III emission standards will apply.

Each engine drives a ZF 550 hydraulic transmission connected to an Ulstein DF-370 azimuthing thruster with a 52" x 38" bronze fixed pitch propeller. The transmissions are rebuilt each time the engines are overhauled, and the oil is replaced every 250 hours. The drives were rebuilt in 2005 and a spare drive was installed in 2012. The drives are now obsolete and no longer supported by the manufacturer. It is difficult to locate bearings and replacement parts must be custom made. There are chronic issues plaguing the drive seals requiring maintenance every two years. New propellers are installed every five years, with reconditioned propellers installed all other years.

Exhaust stacks have been added to the engine housings in order to reduce exhaust fumes on deck and in the pilothouse. Air quality problems within the wheelhouse persist due to the engine exhaust; but have been improved with the introduction of an air purifier under the chart table. An UltraBurn Combustion Catalyst System is also used to eliminate black smoke and carbon emissions. Emissions testing have shown more than a 42% reduction in black smoke and an average reduction in exhaust gases between 7% and 28% [16]. The device is also said to provide fuel savings of up to 20%. The system requires a catalyst refill every 200 hours.

There are four freestanding, cylindrical steel fuel oil tanks below deck with a total capacity of 6,352 gallons and no lube oil tanks.

3.3 Electrical Systems

There is a single Caterpillar C4.4 generator that provides 40 kW of power at 115/208/480 VAC, 60 Hz. The generator was installed in July 2013. The generator is fully utilized during the winter months, but is typically underutilized during the summer. The 110/220 VAC breakers are in good condition but there are no spare breakers available in the panel. Most of the 110/220 VAC wiring is considered old, being original to the vessel.

The electronics and some lighting operate on a 24 VDC system. The 24V breakers are in good condition, but again there are no spares in the panel. In 2005, new batteries and a battery charger were installed and wiring was replaced to the panel. However, the wiring from the panel to the equipment was not replaced and is assumed original.

3.4 Command, Control, and Communications Systems

3.4.1 Radar

There are two Simrad RA-40C radar arrays on the vessel. The radars were installed in March 2003 and require replacement.

3.4.2 GPS and AIS

The current AIS system is obsolete and needs replacement. The current system is incapable of recognizing sufficient AIS target during periods of high vessel traffic. The current GPS system is unknown.

3.4.3 VHF Radio

There are two SEA-157 VHF radios located in the wheelhouse that have recently been replaced and do not need to be upgraded. One handheld VHF radio is also on the vessel.

3.4.4 Depth Gauge

There is one Furuno FCV-620 depth gauge that was installed in June 2008.

3.4.5 Public Address

There is a SEA-857 intercom system with speakers forward of the passenger cabin and under the pilothouse awning. They are in good condition and sufficient for communication aboard the vessel [17].

3.4.6 Alarms

There are sufficient alarms aboard the vessel [17]. The temperature and oil pressure of the engines is monitored and there are smoke detectors in both engine compartments. There are also bilge alarms in voids 1, 2, 7, and 8.

3.5 Auxiliary Systems

3.5.1 Piping

A UT survey was conducted on the piping in 2007, which found the piping was in good condition except near the fire pumps.

3.5.2 Fire Fighting Equipment

All fire pumps were replaced in 2012. Two are located below the main deck and one is located at the engine housing deck. EBDG typically estimates that fire detection and extinguishing systems are upgraded every ten years.

3.5.3 Tanks

There is a single potable water tank with a capacity of 275 gallons. There are also two 11,000-gallon freshwater tanks that are used as ballast.

3.5.4 Heating, Ventilation, and Air Conditioning (HVAC)

There is no forced ventilation system in the engine compartments. Ventilation to the engine compartments occurs naturally through vents in the housing. All fans and pumps were replaced in 2013.

3.6 Outfit

3.6.1 Paint

The last major painting of the vessel from bare metal occurred in 2007. However, maintenance has been regular and the coating is therefore considered in good condition.

Overall, the non-skid coating on the deck is in good condition. There are areas where the non-skid coating has become detached from the deck plating, but these areas are small and not located in areas of heavy traffic.

3.6.2 Joiner Work

A hazardous materials survey of the vessel found the paneling within the wheelhouse, crew cabin, and passenger cabin contained asbestos. This paneling therefore requires replacement.

3.6.3 Lighting Fixtures

The lighting in the interior areas is fluorescent and original to the ship. The lighting elsewhere has been upgraded to more modern LED lights.

3.6.4 Doors

The doors on the vessel contain balsa wood cores, which have been noted to be susceptible to rot. Furthermore, the locks on the doors are considered obsolete.

3.7 Conclusions

The overall condition of the vessel is considered fair. However, given its age, it is recommended that the life of the vessel not be extended beyond the next 15 to 18 years. As a vessel reaches over 50 years of age, it becomes economically impractical to preserve the vessel. At such an age, many systems must be replaced, salt-water corrosion to the hull makes maintaining the vessel expensive, and the vessel may no longer be capable of meeting the service needs of the route.

While the life of the vessel can be extended for another 15-18 years, it will require diligent maintenance to ensure the vessel can be operated safely and efficiently. Table 8 shows the typical maintenance cycles for various ship systems. The repair and replacement cycles are based on estimates for a 177 ft passenger ferry designed by EBDG and the maintenance records of the Washington State Ferries' M/V HIYU. The given maintenance cycles are for reference only and are not intended to dictate future work schedules on the M/V GUEMES. Maintenance requirements to keep a vessel operating safely and efficiently must be made on a case-by-case basis.

Table 8: Typical Maintenance Cycles for Vessel Systems

Item	Typical Maintenance Cycle
SWBS 100 - Structure	
Hull Cleaning and Zinc Replacement	5 years
Hull Painting	9 years
Machinery, Bilge, & Void Space Painting	11 years
Hull Steel Replacement	21 years
Deckhouse Steel Replacement	21 years
Auto Deck Steel Replacement	11 years
Wet Space Steel Replacement	11 years

Item	Typical Maintenance Cycle
SWBS 200 - Propulsion Systems	
Top Level Engine Overhaul	5 years
Major Engine Overhaul	15 years
Engine Replacement	31 years
Engine Controls	31 years
Reduction Gears	31 years
SWBS 300 - Electrical Systems	
Auxiliary Generator Replacement	21 years
Auxiliary Switchboard and Power Distribution	21 years
SWBS 400 - Command, Control, and Communications Systems	
Radar System Replacement	10 years
GPS and AIS System Replacement	10 years
VHF Radio System Replacement	11 years
Public Address Systems Replacement	13 years
Alarm System Replacement	13 years
Communication System Replacement	13 years
SWBS 500 - Auxiliary	
Bilge Piping Replacement	16 years
Firemain Piping Replacement	16 years
Potable Water Piping Replacement	13 years
Potable Water Tank Steel Replacement	21 years
HVAC Repair and Replacement	10-13 years
Rudder Replacement	21 years
SWBS 600 - Outfit	
Topside Painting	5-7 years
Lighting Fixture Replacement	12 years
Furnishing Repairs	5 years

With the end of the existing vessel's useful life approaching, options for vessel replacement must be considered. The following section details three options for vessel replacement to aid in planning and selection of an economic vessel replacement strategy.

4 REPLACEMENT OPTIONS

In order to determine the optimal timetable for replacing the M/V GUEMES, three scenarios for vessel replacement were developed. The three scenarios were designed to provide replacement options with various levels of capital investment in the existing vessel and scheduled to fully utilize those capital investments. For example, the first option was designed to minimize the required capital investment in the existing vessel. This requires replacing the vessel as soon as possible while still allowing sufficient time for planning and design. The second replacement option was designed around a moderate investment in the existing vessel, thereby extending the life ten years at which time a replacement vessel would be constructed. The third option was

designed around a major investment in the existing vessel, thereby extending the life of the vessel the maximum recommended amount. A replacement vessel would therefore be required after 18 years.

To determine the most economic vessel replacement scenario, the total cost of ownership over the planning horizon was estimated. The costs considered in the analysis were:

New Vessel Construction-

A parametric estimate of the construction cost of a new vessel was made based on the construction cost estimate of a similar ferry. Details of the estimate can be found in Appendix A.

Existing Vessel Overhaul-

Two detailed cost estimates for overhauling the existing vessel were made based on the expected remaining service life of the existing vessel. Details of the estimates can be found in Appendix B.

Annual Maintenance-

The annual maintenance cost of the existing vessel was projected based on maintenance records from 1990 to 2012. The annual maintenance cost of a replacement vessel was projected based on the construction cost. Details of the estimates can be found in Appendix C.

Fuel and Lube Oil-

The annual cost of fuel and lube oil was estimated based on engine consumption specifications and the current schedule. Details of the estimates can be found in Appendix D.

Crew costs were not considered as it was assumed that manning requirements would be similar for both vessels. Furthermore, no change in revenue was assumed due to the operation of a larger ferry and the possible sale of the existing vessel was not considered.

The replacement options are detailed in the following sections along with the estimated total cost of ownership in constant 2013 dollars. A 23-year period for comparison of the vessel replacement options was chosen to accommodate a 20-year operation of the new vessel as described in Option A. Acquisition of a new vessel, including time to design and construct is estimated roughly to require three years. Therefore a 23-year planning period was identified to allow for uniform comparison of all options.

4.1 Option A – Immediate Vessel Replacement

This option was designed to minimize investment in the existing vessel and to begin operating a replacement vessel in the shortest practical time. The implementation schedule for Option A is shown in Figure 10.

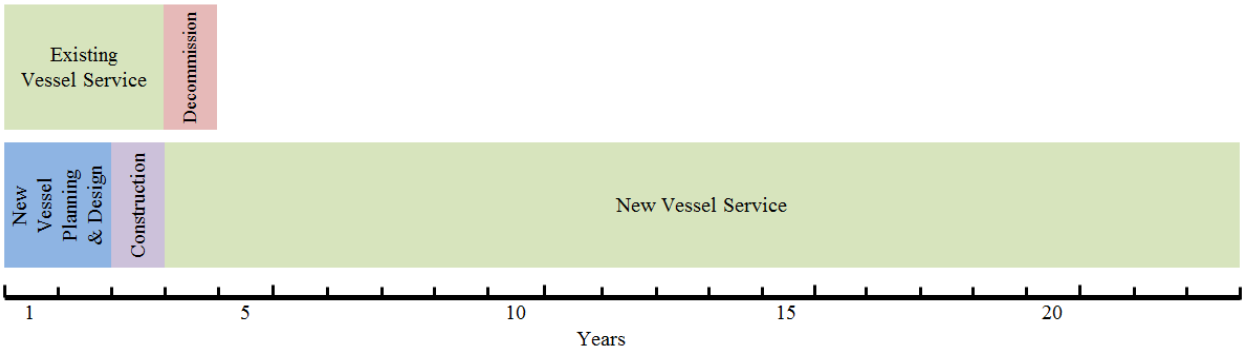

Figure 10: Option A Implementation Schedule

The existing vessel must remain in service for a minimum of three years to allow for time for planning, design, and construction of a new vessel. The typical new vessel acquisition process is outlined in Table 9.

Table 9: Typical Vessel Acquisition Timeline

Activity	Typical Time Period
Owner organizes and issues a Request for Proposal (RFP)	6 months
Review responses to design RFP and award design contract	2 months
Design development, preliminary and contract design	12 months
Review shipyard responses to construction RFP and award contract	2 months
Construction	12 months
Commissioning and crew training	2 months
Total	**36 months**

4.1.1 Existing Vessel Overhaul

No overhaul of the existing vessel is necessary due to the short remaining service life outlined in the schedule. However, annual maintenance activities must continue to ensure the vessel operates safely and efficiently. For details on typical maintenance cycles, see Section 3.7.

4.1.2 Total Cost

The total 23-year cost of ownership for Option A is estimated to be $19,535,000 (in 2013 dollars). This cost includes the cost of new vessel construction, annual maintenance for the existing and new vessels, and fuel and lube oil consumption for the existing and new vessels. The total cost breakdown is shown in Table 10. An annual breakdown is shown in Appendix E where the annual cost for the new and existing vessel is shown with capital expenses distributed evenly throughout the estimated time period.

Table 10: Option A Cost Breakdown

Cost	Existing Vessel	Replacement Vessel	Total
New Construction	-	$8,400,000	$8,400,000
Annual Maintenance	$717,000	$3,156,000	$3,873,000
Fuel & Lube Oil	$822,000	$6,440,000	$7,262,000
		23-Year Total	**$19,535,000**

4.2 Option B – Delayed Vessel Replacement

This replacement scenario was designed to provide the option of a moderate extension of the existing vessel's life. With this schedule, the construction of a new vessel is delayed ten years. This length of time was selected as it is the longest reasonable life extension achievable with a minimal overhaul of the existing vessel's systems. The implementation schedule for Option B is shown in Figure 11.

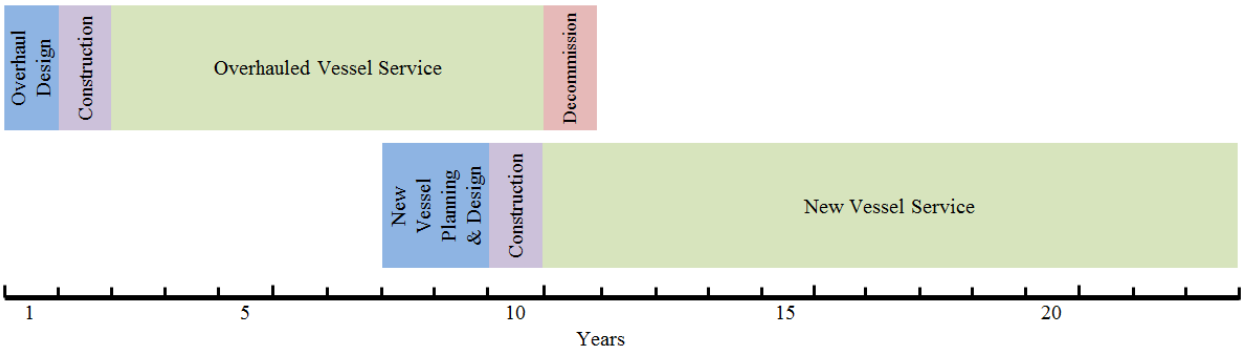

Figure 11: Option B Implementation Schedule

4.2.1 Existing Vessel Overhaul

Extending the service life of the M/V GUEMES for an additional ten years will require an overhaul of vessel systems that are aging and require repair or replacement for safe and efficient operation. A list of such systems was developed based on previous condition and valuation surveys, hull condition surveys, field surveys, and meetings with Skagit County Public Works. The recommended overhaul items are:

- Replace engine foundations
- Replace azimuthing thrusters
- Update navigation electronics with AIS
- Repair engine housing
- Replace all paneling
- Replace doors and locks

The above items are recommended on top of the typical maintenance procedures such as painting and engine maintenance. Estimates of the costs of repair or replacement are made based on previous experience and sourcing of applicable products. It is estimated that this overhaul will

cost a total of $929,000. The assumptions used in estimating the overhaul cost and detailed cost breakdown are given in Appendix B.

4.2.2 Total Cost

The total 23-year cost of ownership for Option B is estimated to be $21,499,000 (in 2013 dollars). This cost includes overhauling the existing vessel, new vessel construction, annual maintenance for the existing and new vessels, and fuel and lube oil consumption for the existing and new vessels. The cost of leasing a vessel during the overhaul construction period is also included. For conservatism, the cost of leasing is based on a one-year construction period and the cost of fuel and lube oil is estimated to be equal to the existing vessel. The total cost breakdown is shown in Table 11. An annual breakdown is given in Appendix E where the annual cost for the new and existing vessel is shown with capital expenses distributed evenly throughout the estimate time period.

Table 11: Option B Cost Breakdown

Cost	Existing Vessel	Leased Vessel	Replacement Vessel	Total
Overhaul	$929,000	-	-	$929,000
Lease	-	$1,095,000	-	$1,095,000
New Construction	-	-	$8,400,000	$8,400,000
Annual Maintenance	$2,295,000	-	$1,854,000	$4,149,000
Fuel & Lube Oil	$2,466,000	$274,000	$4,186,000	$6,926,000
			23-Year Total	**$21,499,000**

4.3 Option C – Mid-body Extension

This replacement scenario was designed to provide the option for maximum utilization of the existing vessel. This schedule postpones the construction of a replacement vessel for 18 years and requires extending the life of the existing vessel for the maximum recommended length of time. The implementation schedule for Option C is shown in Figure 12.

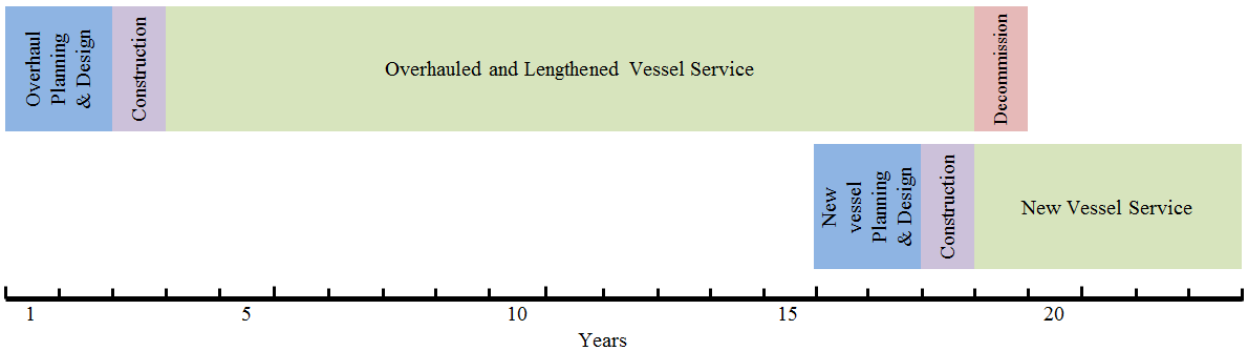

Figure 12: Option C Implementation Schedule

4.3.1 Existing Vessel Overhaul

In order for the M/V GUEMES to continue safe and efficient operation for an additional 18 years, a major vessel overhaul is required. Additionally, to meet the growing service needs of the Guemes Island community, the capacity of the vessel will need to be increased. Therefore, the recommended overhaul items are:

- Replace engine foundations
- Replace propulsion system
- Update navigation electronics with AIS
- Replace all paneling
- Replace doors and locks
- Mid-body extension of 20 feet
- Refurbishment of hull steel
- Refurbishment of piping systems

The recommended mid-body extension length was based on a study conducted by Art Anderson Associates in 2006 [18]. The study found that a mid-body extension of 20.0, 22.0, or 24.0 ft was feasible to increase capacity while staying within the gross tonnage limit to be certified under Subchapter T or Subchapter K. It was recommended that any mid-body extension be limited to 20 ft in order to provide a margin for increased tonnage after the actual measurement of the vessel. This mid-body extension length required an increase in structural members in order to maintain a tonnage less than 100 gross tons. The depth of floors was increased 6 in, the depth of frames was increased 6 in, and the depth of deck beams was increased 8 in. Furthermore, longitudinal bulkheads in line with existing longitudinal bulkheads were required to create a seawater ballast tank at the center of the vessel.

The above overhaul items are recommended on top of the typical maintenance procedures such as painting and engine maintenance. Estimates of the costs of repair or replacement are made based on previous experience and sourcing of applicable products. It is estimated that this overhaul will cost a total of $4,794,000, including the cost of the mid-body extension. The assumptions used in estimating the overhaul cost and detailed cost breakdown are given in Appendix B.

4.3.2 Total Cost

The total 23-year cost of ownership for Option C is estimated to be $26,737,000 (in 2013 dollars). This cost includes the cost of overhauling the existing vessel, new vessel construction, annual maintenance for the existing and new vessels, and fuel and lube oil consumption for the existing and new vessels. The cost of leasing a vessel during the overhaul construction period is also included. For conservatism, the cost of leasing is based on a one-year construction period and the cost of fuel and lube oil is estimated to be equal to the existing vessel. The total cost breakdown is shown in Table 12. An annual breakdown is given in Appendix E where the annual cost for the new and existing vessel is shown with capital expenses distributed evenly throughout the estimated time period.

Table 12: Option C Cost Breakdown

Cost	Existing Vessel	Leased Vessel	Replacement Vessel	Total
Overhaul	$4,794,000	-	-	$4,794,000
Lease	-	$1,095,000	-	$1,095,000
New Construction	-	-	$8,400,000	$8,400,000
Annual Maintenance	$4,622,000	-	$564,000	$5,186,000
Fuel & Lube Oil	$5,378,000	$274,000	$1,610,000	$7,262,000
			23-Year Total	**$26,737,000**

5 RECOMMENDATIONS

Elliott Bay Design Group recommends that Skagit County Public Works begin replacement of the M/V GUEMES as shown in Option A at the time when funding is available and the acquisition process can begin. This recommendation is based on several factors. First and foremost, immediate vessel replacement provides the least cost of ownership over the next 23 years. Additionally, a replacement vessel will be equipped with new, higher efficiency engines and designed with a higher efficiency hull form. This will make a replacement vessel more environmentally friendly than the existing vessel.

For additional comparison of the ownership costs associated with each replacement option over the planning horizon, the cumulative cost of ownership is plotted annually for each replacement option. This plot is shown in constant 2013 dollars. The savings provided by Option A are clearly evident at the end of the planning horizon.

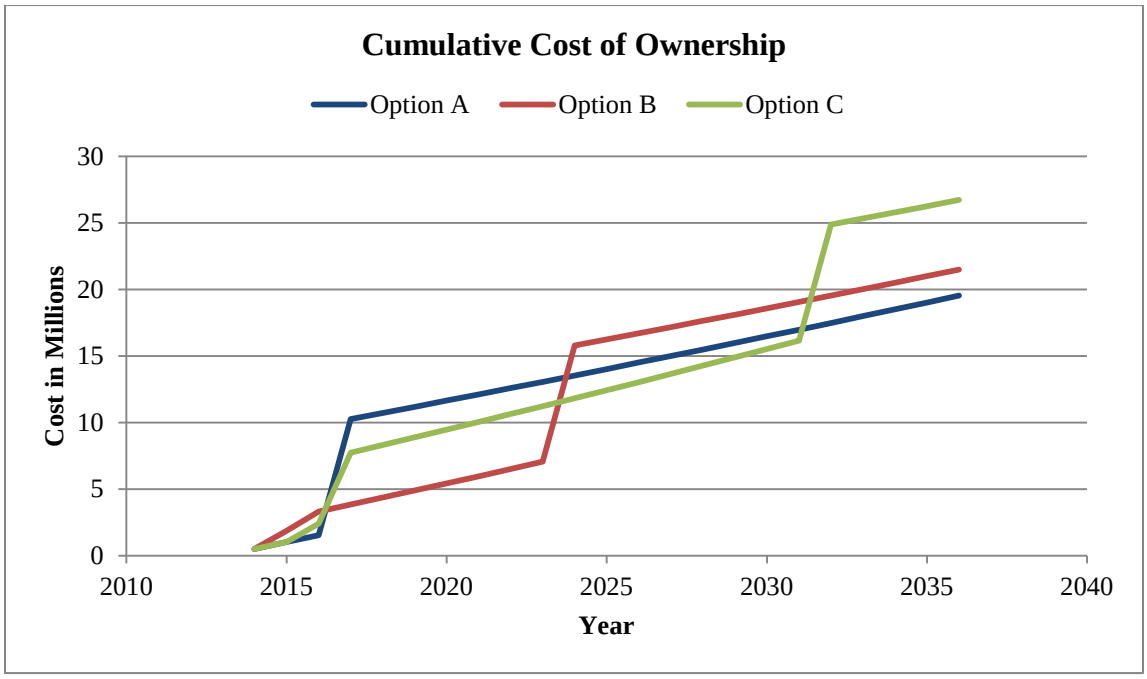

Figure 13: The Cumulative Cost of Ownership for Each Replacement Option

While immediate vessel replacement is recommended, EBDG recognizes that such a vessel replacement timeline may not be possible due to funding constraints and planning time. Therefore, the projected cost of delaying vessel replacement was calculated and is shown in Figure 14. The cost of delay is driven by the difference in maintenance costs between the existing vessel and the replacement vessel. Note that this assumes no overhaul of the existing vessel. If replacement is postponed, care should be taken to adequately maintain the vessel to ensure safe operation.

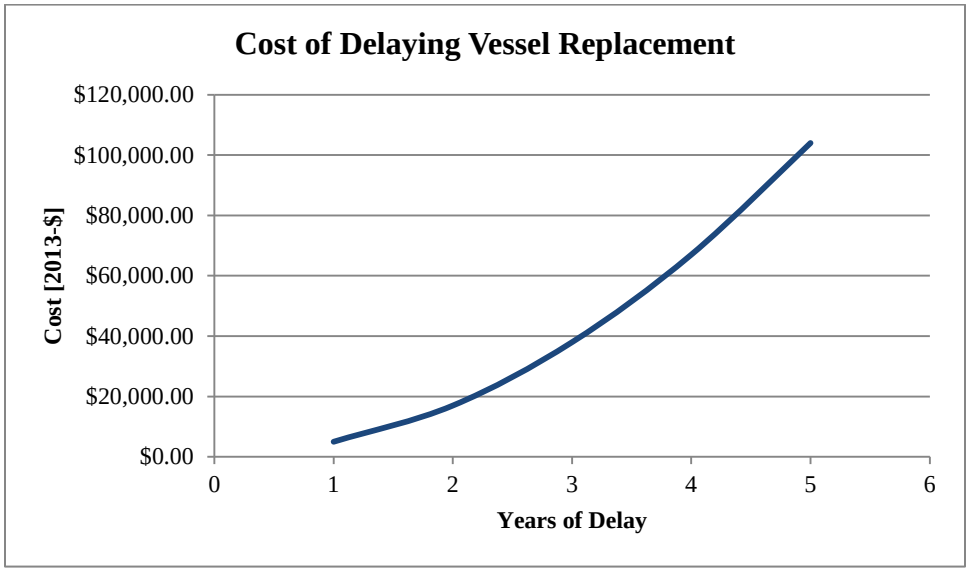

Figure 14: The Cost of Delaying Vessel Replacement

6 FUTURE STUDIES

This report has been focused on the review of the existing vessel condition and the economic analysis of options that would ensure continued operation of the Guemes Island ferry service. While outside of the scope of this effort, funding of the option selected by Skagit County is likely to be of great interest. As a potential follow-on study, research can be done related to many aspects of funding to assist Skagit County in their planning to exercise the selected option. Elements of the study could include procurement methodologies, funding sources and financing alternatives. Additionally, if Option A is adopted, disposal costs or credits associated with removal of the M/V GUEMES from service should be considered.

7 REFERENCES

[1] Nickum & Spaulding Associates, "M/V Guemes Design Package," Seattle, WA, 1977.

[2] "Building Permit Reports," 2013. [Online]. Available: http://www.skagitcounty.net/Common/asp/default.asp?d=PlanningAndPermit&c=General&p=historicalreports.htm. [Accessed 27 June 2013].

[3] Berryman & Henigar, "Skagit County Population & Employment Allocation," Skagit County, 2003.

[4] "U.S. Census Records," 2012. [Online]. Available: http://www.city-data.com/county/Skagit_County-WA.html. [Accessed 28 June 2013].

[5] "Land Use & Population Growth," Growth Management Indicators Program, Skagit County, 2002.

[6] "Guemes Island Sub-Area Plan," Skagit County, 2010.

[7] "2.22.12 Press Release," 23 February 2012. [Online]. Available: http://watourismalliance.com/2012/02/press-release-2-22-12/. [Accessed 27 June 2013].

[8] "State Tourism Summit," 12 March 2013. [Online]. Available: http://watourismalliance.com/2013/03/state-tourism-summit-takes-place-today-in-olympia/. [Accessed 27 June 2013].

[9] "Draft 2012 Operations Status Report," Skagit County Public Works, Skagit County, 2012.

[10] "Guemes Island Ferry Data Reports," 2013. [Online]. Available: http://www.skagitcounty.net/Common/Asp/Default.asp?d=PublicWorksFerry&c=General&p=main.htm. [Accessed June 2013].

[11] "Ferry to Lummi Island," 3 June 2013. [Online]. Available: http://www.co.whatcom.wa.us/publicworks/ferry/. [Accessed 1 July 2013].

[12] M. Bennion, "A Comparison of Operational Performance: Washington State Ferries of Ferry Operators Worldwide," Washington State Department of Transportation, 2010.

[13] "Fourteen-Year Ferry Capital Improvement Plan," Skagit County Public Works, Skagit County, 2013.

[14] F. Belford, "GUEMES Hull Condition Survey," Seattle, 2010.

[15] J. Waterhouse, "J13039 JWW Meeting Notes (05-02-13)," Seattle, 2013.

[16] "Emissions Evaluation Report," Emissions Technology, Inc., Houston, 2013.

[17] T. Laing, "Condition & Valuation Report," Mt. Vernon, 2012.

[18] E. Snyder, "Technical Memo," Art Anderson Associates, Bremerton, 2006.

[19] Elliott Bay Design Group, "Port Aransas Ferry Design," Seattle, WA, 2007.

[20] "The Maritime Executive," 18 July 2011. [Online]. Available: http://www.maritime-executive.com/article/ebdg-designed-port-aransas-ferries-begin-service/. [Accessed 18 July 2013].

[21] Art Anderson Associates, "Midship Extension Construction Cost Estimate," Bremerton, April 14, 2006.

[22] "Shipyard Bid Compilation.xls," 2013.

[23] J. Mauter, "GUEMES USCG Suspect Plate," Seattle, 2012.

[24] D. Boyes, "Condition & Valuation Survey for MV Guemes," Anacortes, 2010.

[25] J. Waterhouse, *Field Survey Images,* Anacortes, 2013.

[26] "Skagit County, Washington," 6 June 2013. [Online]. Available: http://quickfacts.census.gov/qfd/states/53/53057.html. [Accessed 1 July 2013].

[27] J. Dickinson, "Lummi Island Ferry Comparative Analysis," Lummi Island, 2011.

[28] *Guemes Island Ferry Operations Public Forum Minutes,* Guemes Island, 2012.

[29] *Guemes Island Ferry Operations Public Forum Minutes,* Guemes Island, 2011.

[30] "2013 Guemes Island Ferry Fare Revenue Target Report," Skagit County Public Works, Skagit County, 2013.

[31] "Guemes Island Ferry Customer Satisfaction Survey Results," Skagit County Public Works, Skagit County, 2012.

[32] *Guemes Island Ferry Operations Public Forum Minutes,* Guemes Island, 2011.

[33] *Tidelands Lease Agreement for Lummi Island Ferry Use at Gooseberry Point,* Washington, D.C.: U.S. Department of the Interior, 2012.

Appendix A – New Vessel Construction Cost Estimate

CONSTRUCTION COST ESTIMATE

A parametric estimate of the construction cost associated with building a replacement ferry was completed by EBDG. The cost projection was based on the Port Aransas, TX ferry design [19]. The Port Aransas ferry is an open, double-ended ferry with a 28-car capacity. It is shown in Figure 15 [20] and the principal characteristics are given. Note that this vessel was used only to determine an estimate of construction cost and does not represent a recommendation of a vessel type or capacity. It is important that a new vessel is designed to be well suited to the needs of a specific route to ensure safe and efficient operation.

Figure 15: The Port Aransas Ferry

Length Overall:	159 ft 7 in
Beam:	52 ft 0 in
Draft:	11 ft 8 in
Installed Power:	1200 HP
Passenger Capacity:	150
Vehicle Capacity:	28

The weights and material costs of the vessel were broken down by SWBS number. The estimated material costs from the Port Aransas design were in 2007 dollars and were inflated to present day values assuming an annual inflation rate of 3%. The estimated weights of the new Guemes Island ferry were reduced as it was assumed this vessel would carry fewer vehicles and have a smaller, less complex deck house than the Port Aransas ferry design. This, as well as an overall reduction in principal dimensions to account for the difference in capacity, resulted in an overall light ship weight reduction of 16% compared to the Port Aransas ferry.

Labor rates were based on a typical Pacific Northwest shipyard and assumed to be $78 per hour. A materials markup of 17% was used, except in the case of propulsion machinery where an 8% markup was used. Engineering costs were estimated as 3% of the total labor hours and

construction services were estimated as 14% of the total materials cost. A 12% margin was added to the total cost of labor and materials, as well as a 15% contingency margin.

The total cost of the vessel without added margins or contingency was $6,520,000. The material costs accounted for 48% of this total and labor for 52%. The total estimated cost with margins and contingency was $8,400,000.

Appendix B – Existing Vessel Overhaul Cost Estimates

Option B – Delayed Vessel Replacement

Option C – Mid-body Extension

ASSUMPTIONS

The assumptions used in estimating the costs of existing vessel overhauls, Option B and Option C, as applicable, are:

- Labor rates were estimated assuming the work would be completed at a medium sized Pacific Northwest shipyard. The historical average labor rate was inflated to present day value, resulting in a labor rate of $78 per hour.
- A 17% shipyard markup was assumed on all materials and sub-contractor costs.
- Steel weights for the engine housing repair were estimated from surveys and pictures taken during the field survey.
- The weight of each of the engine foundations was assumed to be 25% of the engine weight.
- The total steel weight was estimated based on the C-number ratio to similar vessel weights.
- Required steel refurbishment was assumed to be 20% of the total estimated steel weight.
- The steel cost was estimated from the average price in North America in March of 2013. A 20% margin was added for scrap.
- Labor hours for steel repairs were estimated at 0.140 hours per pound.
- Labor hours for painting were assumed to be 0.004 hours per square foot and assumed four coats.
- The cost of paint was assumed to be $60 per gallon with coverage of 250 square feet per gallon.
- Grit blasting and cleanup was assumed to cost $0.60 per square foot.
- Labor hours for thruster replacement were based on previous experience.
- The azimuthing thruster cost was based on an estimate for a Global Marine Engineering deck mounted thruster including controls. Other manufacturers of deck mounted azimuthing thrusters include Thrustmaster, SCHOTTEL, and Veth Propulsion.
- The propulsion unit cost was based on an estimate from SCHOTTEL. Other manufacturers of deck mounted propulsion units include Thrustmaster and Veth Propulsion.
- The cost of upgrading the navigation equipment was based on Furuno electronics. This does not indicate a recommendation to use Furuno electronics; it was merely a means to gather relevant cost data.
- Labor hours for electronics installation were based on previous experience.
- The engine housing repair costs were estimated assuming 100% steel shapes for conservatism.
- Paneling replacement was based on estimates made from drawings of the deckhouse.
- Disposal costs for asbestos laden materials were estimated based on typical residential home costs due to the small amount of material needing disposal.
- It was assumed five weatherproof doors needed replacement. The cost of the materials was based on Freeman Marine doors and labor rates were based on previous experience.
- The cost of the mid-body extension was based on an estimate by Art Anderson Associates [21].

- The mid-body extension estimate was inflated to 2013 dollars assuming a 3% annual inflation rate.
- A 15% margin was applied to the cost of the mid-body extension for conservatism.
- Rigging labor was estimated to be 14% of the total production hours.
- Rigging material cost was estimated to be 3% of total material cost.
- It was assumed that the vessel would be in dry dock for three weeks for overhaul and five weeks for mid-body extension.
- Allowances were made for dock trials, sea trails, and delivery. A cost for bonding was also included.
- A 10% contingency was added to the total estimate for Option B to allow time for planning and decision-making.
- A 15% contingency was added to the total estimate for Option C to allow time for planning and decision-making and to account for changes in price with long term scheduling.

OPTION B – SUMMARY

COST ESTIMATE SUMMARY									
SWBS No.	**Item Description**	**Labor Hours**	**Material & Services @ Cost, ($)**	**Subcontracts @ Cost, ($)**	**Labor Cost @ $75/Hr**	**Material & Services w/17% Mark-up, ($)**	**Subcontracts w/17% Mark-up, ($)**	**Item Total Costs**	**Percent of Total Cost**
000	PROJECT MANAGEMENT & ADMIN	227	$ 5,775	$ -	$ 17,675	$ 6,757	$ -	$ 24,432	2.63%
100	HULL & HOUSE STRUCTURE	435	$ 43,840	$ -	$ 33,900	$ 51,293	$ -	$ 85,193	9.17%
200	PROPULSION MACHINERY	508	$ 406,188	$ -	$ 39,640	$ 475,240	$ -	$ 514,880	55.42%
300	ELECTRICAL SYSTEM	0	$ -	$ -	$ -	$ -	$ -	$ -	0.00%
400	ELECTRONICS & IC SYSTEMS	0	$ 26,345	$ -	$ 5,045	$ 30,824	$ -	$ 35,868	3.86%
500	AUXILIARY SYSTEMS	0	$ -	$ -	$ -	$ -	$ -	$ -	0.00%
600	OUTFITTING	800	$ 33,486	$ 10,000	$ 62,409	$ 39,179	$ 11,700	$ 113,288	12.19%
700	MISSION SPECIFIC EQUIPMENT	0	$ -	$ -	$ -	$ -	$ -	$ -	0.00%
800	INTEGRATION & ENGINEERING	0	$ -	$ -	$ -	$ -	$ -	$ -	0.00%
900	SHIPYARD SUPPORT SERVICES	407	$ 33,501	$ -	$ 31,780	$ 39,197	$ -	$ 70,977	7.64%
	Contingency @ 10%							**$ 84,464**	**$ 0**
	TOTALS FOR ALL ITEMS	**2377**	**$ 549,136**	**$ 10,000**	**$ 190,448**	**$ 642,489**	**$ 11,700**	**$ 929,101**	**100%**

OPTION B – SWBS 000

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
000	PROJECT MANAGEMENT & ADMIN									
	Dock Trials									
	Preparation and Trials	1		60	60	$ 4,680				
	Sea Trials									
	Preparation	1		10	10	$ 780				
	Underway	1		80	80	$ 6,240				
	Fuel	1					$250	$ 250.00		
	Delivery Allowance	1		40	40	$ 3,120				
	Supervision	1		16	16	$ 1,248				
	Bonding	1						$ 5,000.00		
	MARGINS									
	Labor		**10%**		**21**	**$ 1,607**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 525**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$0	$0	
					0	$ -		$0	$0	
	Totals for Item 000	**7**		**206**	**227**	**$ 17,675**	**$250**	**$5,775**	**$0**	

OPTION B – SWBS 100

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
100	HULL & HOUSE STRUCTURE									
	Engine Foundation									
	Steel Weight	2,285		0.135	308	$ 24,061				
	Labor: Assume NC Lofted, Cut & Marked	2,285	lbs	0.027	62	$ 4,807				
	Material Cost With 20% Scrap Allowance	457	20%							
	Total Hull Steel	2,742					$0.35	$ 959.70		
	100% Bare Shapes		100%							
	Bare Shapes	2,285					$0.65	$ 1,485.25		
	NC Cutting	2,285					$0.02	$ 45.70		
	Wheeled and Primed	2,285					$0.12	$ 274.20		
	Painting	100	sq ft	0	25	$ 1,950	$0.9	$ 90.00		
	Engine Removal and Replacement							$ 37,000.00		
	MARGINS									
	Labor @ 0%		**10%**		**40**	**$ 3,082**		**-**	**$ -**	
	Material @ 0%		**10%**		**0**	**$ -**		**3,985**	**$ -**	
	Sub-Contracts @ 0%		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$ -	$ -	
					0	$ -		$ -	$ -	
Totals for Item 100		**14724**	**$ 2**	**0**	**435**	**$ 33,900**	$2	**$ 43,840**	**$ -**	

OPTION B – SWBS 200

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
200	PROPULSION MACHINERY									
	Azimuthing Thruster Replacement									
	Deck Mounted Thruster	2					$183,227	$ 366,454		
	Staging	2		2	4	$ 312	$100	$ 200		
	Rigging	2		5	10	$ 780				
	Certify Void for Entry	2		2	4	$ 312	$250	$ 500		
	Propeller Removal	2		4	8	$ 624	$50	$ 100		
	Burning	2		24	48	$ 3,744	$144	$ 288		
	Installation	2		24	48	$ 3,744				
	Preliminary Coupling Alignment	2		4	8	$ 624				
	Final Coupling Alignment	2		24	48	$ 3,744	$100	$ 200		
	Supervision	2		8	16	$ 1,248				
	Inspection	2		8	16	$ 1,248				
	Welding	2		72	144	$ 11,232	$360	$ 720		
	Weld Testing	2		8	16	$ 1,248				
	Gasket Installation	2		6	12	$ 936	$100	$ 200		
	Propeller Removal and Installation	2		16	32	$ 2,496	$100	$ 200		
	Painting	2		24	48	$ 3,744	$200	$ 400		
	MARGINS									
	Labor		**10%**		**46**	**$ 3,604**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 36,926**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$ -	$ -	
					0	$ -		$ -	$ -	
Totals for Item 200		**32**	**$ 0**	**231**	**508**	**$ 39,640**	**$184,631**	**$ 406,188**	**$ -**	

OPTION B – SWBS 400

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
400	ELECTRONICS & IC SYSTEMS									
	Navigation Electronics Replacement									
	Plotter - Furuno MFD12	2					$4,895	$ 9,790		
	Radar Array - Furuno DRS6A	2					$5,800	$ 11,600		
	AIS Receiver	1					$1,800	$ 1,800		
	AIS VHF Antenna - Furuno 150M-W2VN	1					$360	$ 360		
	Plotter Installation	2		6	12	$ 936	$25	$ 50		
	Radar Installation	2		12	24	$ 1,872	$50	$ 100		
	AIS Installation	1		2	2	$ 156	$25	$ 25		
	VHF Antenna Installation	1		3	3	$ 234	$25	$ 25		
	Plotter Testing	2		1	2	$ 156				
	Radar Testing	2		2	4	$ 312				
	AIS Testing	1		1	1	$ 78				
	VHF Antenna Testing	1		1	1	$ 78				
	Inspection	6		1	6	$ 468				
	Rigging	2		2	4	$ 312	$100	$ 200		
	MARGINS									
	Labor		**10%**		**6**	**$ 443**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 2,395**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$ -	$ -	
					0	$ -		$ -	$ -	
Totals for Item 400		**26**	**$ 0**	**31**	**65**	**$ 5,045**	**$13,080**	**$ 26,345**	**$ -**	

OPTION B – SWBS 600

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
600	OUTFITTING									
	Engine House Steel Renewal									
	Steel Weight	2,759		0.135	372	$ 29,052				
	Labor: Assume NC Lofted, Cut & Marked	2,759	lbs	0.027	74	$ 5,804				
	Material Cost With 20% Scrap Allowance	552	20%							
	Total Hull Steel	3,311					$0.35	$ 1,159		
	100% Shapes		100%							
	Bare Shapes	552					$1	$ 359		
	NC Cutting	552					$0.02	$ 11		
	Wheeled and Primed	552					$0.12	$ 66		
	Painting	358	sq ft	0.25	90	$ 6,981	$0.9	$ 322		
	Paneling Replacement									
	Paneling	1600	sq ft				$9	$ 14,400		
	Removal	1		10	10	$ 780			$ 10,000	
	Disposal	1						$ 500		
	Installation	1		30	30	$ 2,340		$ 100		
	Inspection	1		1	1	$ 78				
	Door and Lock Replacement									
	Doors - Freeman Marine 1110	5					$2,700	$ 13,500		
	Removal	5		2	10	$ 780				
	Installation	5		24	120	$ 9,360	$5	$ 25		
	Inspection	5		1	5	$ 390				
	Painting	5		3	15	$ 1,170				
	MARGINS									
	Labor		**10%**		**73**	**$ 5,674**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 3,044**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$ -	$ -	
					0	$ -		$ -	$ -	
	Totals for Item 600	**13023**	**$ 2**	**71**	**800**	**$ 62,409**	**$2,716**	**$ 33,486**	**$ 10,000**	

OPTION B – SWBS 900

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
900	SHIPYARD SUPPORT SERVICES									
	Rigging									
	Labor	2060	hrs	0.14	288	$ 22,495				
	Materials	531593	$				$0.03	$ 15,948		
	Drydocking									
	Lift Day	1	days		50	$ 3,900	$744	$ 744		
	Launch Day	1	days		32	$ 2,496	$744	$ 744		
	Lay Days	21	days				$620	$ 13,020		
	MARGINS									
	Labor		**10%**		**37**	**$ 2,889**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 3,046**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
					0	$ -		$ -	$ -	
					0	$ -		$ -	$ -	
	Totals for Item 900	**533676**	**$ 0**	**0**	**407**	**$ 31,780**	**$2,108**	**$ 33,501**	**$ -**	

OPTION C – SUMMARY

COST ESTIMATE SUMMARY									
SWBS No.	**Item Description**	**Labor Hours**	**Material & Services @ Cost, ($)**	**Subcontracts @ Cost, ($)**	**Labor Cost @ $75/Hr**	**Material & Services w/17% Mark-up, ($)**	**Subcontracts w/17% Mark-up, ($)**	**Item Total Costs**	**Percent of Total Cost**
000	PROJECT MANAGEMENT & ADMIN	244	$ 5,775	$ -	$ 19,048	$ 6,757	$ -	$ 25,804	0.54%
100	HULL & HOUSE STRUCTURE	13018	$ 393,779	$ -	$ 1,443,987	$ 460,721	$ -	$ 1,904,708	39.73%
200	PROPULSION MACHINERY	477	$ 1,037,101	$ -	$ 57,649	$ 1,213,408	$ -	$ 1,271,057	26.51%
300	ELECTRICAL SYSTEM	0	$ 4,201	$ -	$ 6,472	$ 4,915	$ -	$ 11,387	0.24%
400	ELECTRONICS & IC SYSTEMS	0	$ 26,345	$ -	$ 9,916	$ 30,824	$ -	$ 40,740	0.85%
500	AUXILIARY SYSTEMS	858	$ 5,309	$ -	$ 94,026	$ 6,212	$ -	$ 100,238	2.09%
600	OUTFITTING	243	$ 53,548	$ 10,000	$ 91,773	$ 62,651	$ 11,700	$ 166,123	3.47%
800	INTEGRATION & ENGINEERING	347	$ 286,315	$ -	$ 26,012	$ 334,989	$ -	$ 361,001	7.53%
900	SHIPYARD SUPPORT SERVICES	2336	$ 89,998	$ -	$ 182,199	$ 105,298	$ -	$ 287,496	6.00%
	Contingency @ 15%							**$ 625,283**	**$ 0**
	TOTALS FOR ALL ITEMS	**17524**	**$ 1,902,370**	**$ 10,000**	**$ 1,931,082**	**$ 2,225,773**	**$ 11,700**	**$ 4,793,838**	**100%**

OPTION C – SWBS 000

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($75/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
000	PROJECT MANAGEMENT & ADMIN									
	Dock Trials									
	Preparation and Trials	1		60	60	$ 4,680				
	Sea Trials									
	Preparation	1		10	10	$ 780				
	Underway	1		80	80	$ 6,240				
	Fuel	1					$250	$ 250.00		
	Delivery Allowance	1		40	40	$ 3,120				
	Supervision	1		32	32	$ 2,496				
	Bonding	1						$ 5,000.00		
	MARGINS									
	Labor		**10%**		**22**	**$ 1,732**		**$ -**		
	Material		**10%**		**0**	**$ -**		**$ 525**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
	Totals for Item 000				**244**	**$ 19,048**		**$5,775**	**$0**	

OPTION C – SWBS 100

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
100	HULL & HOUSE STRUCTURE									
	Engine Foundation									
	Engine Removal							$ 18,500.00		
	Remove and replace engine foundations									
	Labor	8,819		0.140	1235	$ 96,298				
	Material	10,583	20.00%				$0.65	$ 6,878.82		
	Steel Refurbishment									
	Steel Weight - assumed 20%	74,793								
	Labor: Assume NC Lofted, Cut & Marked	74,793		0.140	10471	$ 816,743				
	20% Scrap Allowance	14,959	20.00%							
	Total Hull Steel Material	89,752					$0.65	$ 58,338.77		
	Preparation and Painting									
	Grit labor and cleanup	21,500	sq ft	0.002	43	$ 3,354	$0.60	$ 12,900.00		
	Paint	21,500	sq ft	0.004	86	$ 6,708	$0.96	$ 20,640.00		
	Mid-Body Extension					$ 389,612		$ 240,723		Estimate from [21]
	MARGINS									
	Labor		**10%**		**1183**	**$ 131,272**		**-**		
	Material		**10%**		**0**	**$ -**		**35,798**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
Totals for Item 100					**13018**	**$ 1,443,987**		**$ 393,779**	**$ -**	

OPTION C – SWBS 200

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
200	PROPULSION MACHINERY									
	Propulsion Unit Replacement									
	Complete Propulsion Unit	2					$434,688	$ 869,375		
	Staging	2		12	24	$ 1,872	$100	$ 200		
	Rigging	2		5	10	$ 780				
	Burning	2		48	96	$ 7,488	$288	$ 576		
	Installation	2		20	40	$ 3,120				
	Engine Hookups	2		24	48	$ 3,744				
	Controls	2		24	48	$ 3,744	$100	$ 200		
	Supervision	2		8	16	$ 1,248				
	Inspection	2		8	16	$ 1,248				
	Welding	2		36	72	$ 5,616	$180	$ 360		
	Weld Testing	2		8	16	$ 1,248				
	Painting	2		24	48	$ 3,744	$200	$ 400		
	Mid-Body Extension					$ 18,556		$ 71,708		Estimate from [21]
	MARGINS									
	Labor		**10%**		**43**	**$ 5,241**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 94,282**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
	Totals for Item 200				**477**	**$ 57,649**		**$ 1,037,101**	**$ -**	

OPTION C – SWBS 300

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
300	ELECTRICAL SYSTEM									
	Mid-Body Extension					$ 5,884		$ 3,819		Estimate from [21]
	MARGINS - EXAMPLES SHOWN									
	Labor		**10%**		**0**	**$ 588**		**$ -**		
	Material		**10%**		**0**	**$ -**		**$ 382**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
	Totals for Item 300				**0**	**$ 6,472**		**$ 4,201**	**$ -**	

OPTION C – SWBS 400

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($75/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
400	ELECTRONICS & IC SYSTEMS									
	Navigation Electronics Replacement									
	Plotter - Furuno MFD12	2					$4,895	$ 9,790		
	Radar Array - Furuno DRS6A	2					$5,800	$ 11,600		
	AIS Receiver	1					$1,800	$ 1,800		
	AIS VHF Antenna - Furuno 150M-W2VN	1					$360	$ 360		
	Plotter Installation	2		6	12	$ 936	$25	$ 50		
	Radar Installation	2		12	24	$ 1,872	$50	$ 100		
	AIS Installation	1		2	2	$ 156	$25	$ 25		
	VHF Antenna Installation	1		3	3	$ 234	$25	$ 25		
	Plotter Testing	2		1	2	$ 156				
	Radar Testing	2		2	4	$ 312				
	AIS Testing	1		1	1	$ 78				
	VHF Antenna Testing	1		1	1	$ 78				
	Inspection	6		1	6	$ 468				
	Rigging	2		2	4	$ 312	$100	$ 200		
	Mid-Body Extension					$ 4,413				Estimate from [21]
	MARGINS									
	Labor		**10%**		**6**	**$ 901**		**$ -**		
	Material		**10%**		**0**	**$ -**		**$ 2,395**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
	Totals for Item 400				**65**	**$ 9,916**		**$ 26,345**	**$ -**	

OPTION C – SWBS 500

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
500	AUXILIARY SYSTEMS									
	Piping Refurbishment									
	Assume 2" pipe	650	ft	1	780	$ 60,840	$3.40	$ 2,210		
	Mid-Body Extension					$ 24,638		$ 2,617		Estimate from [21]
	MARGINS - EXAMPLES SHOWN									
	Labor		**10%**		**78**	**$ 8,548**		**$ -**		
	Material		**10%**		**0**	**$ -**		**$ 483**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
	Totals for Item 500				**858**	**$ 94,026**		**$ 5,309**	**$ -**	

OPTION C – SWBS 600

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
600	OUTFITTING									
	Paneling Replacement									
	Paneling	1600	sq ft				$9	$ 14,400		
	Removal	1		20	20	$ 1,560			$ 10,000	
	Disposal	1						$ 500		
	Installation	1		50	50	$ 3,900		$ 100		
	Inspection	1		1	1	$ 78				
	Door and Lock Replacement									
	Doors - Freeman Marine 1110	5					$2,700	$ 13,500		
	Removal	5		2	10	$ 780				
	Installation	5		24	120	$ 9,360	$5	$ 25		
	Inspection	5		1	5	$ 390				
	Painting	5		3	15	$ 1,170				
	Mid-Body Extension					$ 66,192		$ 20,155		Estimate from [21]
	MARGINS									
	Labor		**10%**		**22**	**$ 8,343**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 4,868**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
Totals for Item 600					**243**	**$ 91,773**		**$ 53,548**	**$ 10,000**	

OPTION C – SWBS 800

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
800	INTEGRATION & ENGINEERING									
	Detail Engineering									
	5% of Contract Cost	3807553	$				5.00%	$ 190,378		
	Construction Cost									
	1% of Total Labor Hours	17177	Hrs	1.00%	172	$ 12,883				
	1.5% of Total Material Cost	1616055	$				1.50%	$ 24,241		
	Lofting									
	1% of SWBS 100 to 500 Labor Hours	14354		1.00%	144	$ 10,765				
	1.75% of SWBS 100 to 500 Material Cost	1466734					1.75%	$ 25,668		
	Stability Test									
	Testing and Approval							$ 20,000		
	MARGINS - EXAMPLES SHOWN									
	Labor		**10%**		**32**	**$ 2,365**		**$ -**	**$ -**	
	Material		**10%**		**0**	**$ -**		**$ 26,029**	**$ -**	
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**	**$ -**	
	Totals for Item 800				**347**	**$ 26,012**		**$ 286,315**	**$ -**	

OPTION C – SWBS 900

COST ESTIMATE WORKSHEET										
SWBS No.	**Item Description**	**Quant.**	**Unit**	**Labor Factor**	**Labor Hours**	**Labor Cost ($78/hr)**	**Material Factor**	**Material & Services @ Cost, ($)**	**Sub-Contracts @ Cost, ($)**	**Remarks**
900	SHIPYARD SUPPORT SERVICES									
	Rigging									
	Labor at 14% of Production Hours	14597	hrs	14.00%	2044	$ 159,395				
	Materials at 3% of Production Materials	1520282	$				3.00%	$ 45,608		
	Drydocking									
	Lift Day	1	days		48	$ 3,744	$744	$ 744		
	Launch Day	1	days		32	$ 2,496	$744	$ 744		
	Lay Days	56	days				$620	$ 34,720		
	MARGINS									
	Labor		**10%**		**212**	**$ 16,564**		**$ -**		
	Material		**10%**		**0**	**$ -**		**$ 8,182**		
	Sub-Contracts		**10%**		**0**	**$ -**		**$ -**		
	Totals for Item 900				**2336**	**$ 182,199**		**$ 89,998**	**$ -**	

Appendix C – Annual Maintenance Cost Projections

EXISTING VESSEL

An estimate of the maintenance cost associated with extending the service life of the M/V GUEMES was made based on the maintenance records from 1990 to 2012 provided by Skagit County [22]. The cost data were normalized and trends identified in order to attempt to predict the expected increase in maintenance and repair costs as the vessel ages. The results of this analysis, as well as detailed descriptions of the procedures and assumptions made in the cost projection, are given below.

Procedure

The maintenance cost data from 1990 to 2012 provided by Skagit County was first organized by SWBS category. Line items without associated cost data were disregarded. The cost data were then adjusted to normalize all dollar figures to their present day values. This was done assuming a three percent annual inflation rate. Costs with similar item descriptions were then combined, as it was assumed these descriptions varied due only to the work being completed by differing shipyards. This was done to make the data set more manageable, as well as to more easily identify trends in vessel maintenance and repair.

Estimates of equipment maintenance cycles were made through examination of the elapsed time between maintenance items. For most items, the maintenance cycle represents the time that elapsed between maintenance work most frequently over the period from 1990 to 2012. However, priority was given to the maintenance periods between 2007 and 2012, as it was assumed the maintenance items that occurred more frequently during this time were associated with the vessel's increasing age. Maintenance cycles for some items were also based on the records of the meeting with Skagit County Public Works that occurred on 05/02/2013 [15].

Items that had occurred only once during the record period were assumed to have a 20-year maintenance cycle. While these specific items were likely incidental repairs that will likely not require repair again, when taken together they represent an average cost associated with incidental repairs. This effectively creates a miscellaneous maintenance cost that is an important part of the total maintenance cost.

Once the maintenance cycles had been estimated, trends in maintenance cost from 1990 to 2012 were examined. Linear curves were fit to cost data containing three or more data points. These curves were then used to determine the projected cost of the maintenance items from 2013 to 2033. While most items trended upwards, several maintenance items trended downwards. The projected cost of these items was taken to be the average cost so as to maintain conservatism in the projection. For maintenance items that had only two data, the projected cost was taken to be the average. For maintenance items with only one datum, the projected cost was equivalent.

Results

While the procedures outlined above result in specific cost data for each year of the projection, these results should not be considered to indicate the expected fluctuation in maintenance cost from year to year. Instead, the results indicate a range, or area, of expected costs over the future time period. The results of the cost projection are plotted in Figure 16, along with the historical

data for comparison. All dollar figures in the plot are normalized to present day values. The line in Figure 16 is a linear curve indicating the average projected cost.

Inspection of Figure 16 indicates a range of costs that are expected over the next 20 years. The minimum and maximum annual maintenance costs are clearly visible below and above the group of data. For example, in 2013 it is projected that maintenance costs will range between approximately $180,000 and $300,000. The range in maintenance costs can be seen to increase with time. In 2033, it is projected that annual maintenance costs will range between approximately $250,000 and $450,000. The average projected annual maintenance cost is perhaps a better indicator of total cost over the next 20 years of vessel service. The average projected annual maintenance cost is approximately $230,000 in 2013 and $320,000 in 2033.

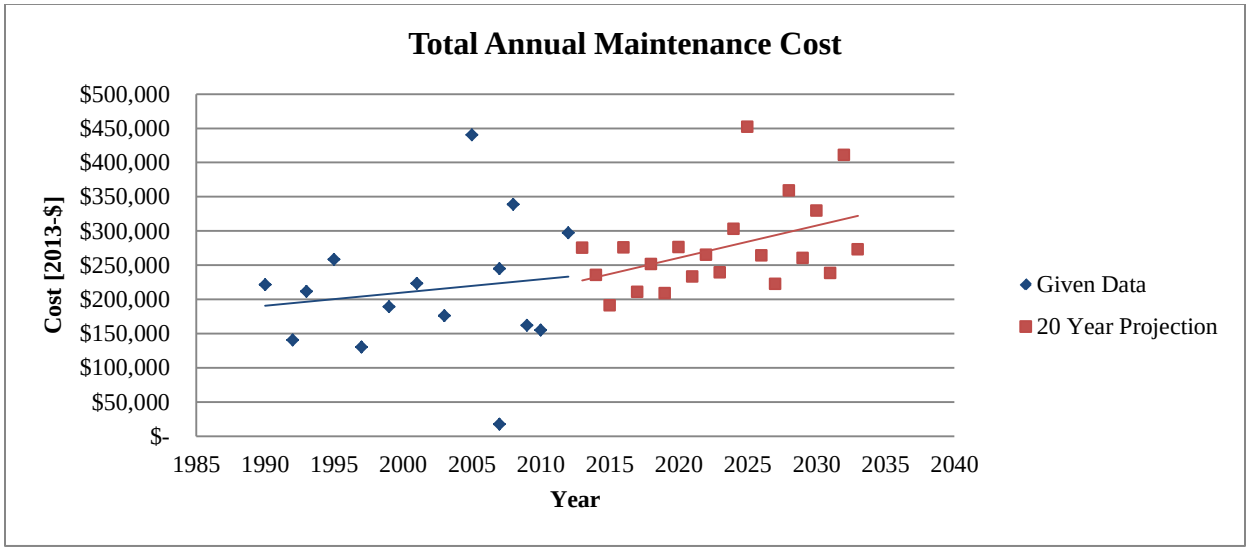

Figure 16: Total Annual Maintenance Cost

The cost projection can also be used to estimate the total maintenance costs expected over the period from 2013 to 2033. The total projected average maintenance cost is approximately $5.77 million. The total projected minimum maintenance cost is approximately $4.52 million, while the total projected maximum maintenance cost is approximately $7.88 million. These totals are shown broken down by SWBS number in Table 13. Additionally, annual costs by SWBS number are given on the following page.

Table 13: Total Maintenance Cost by SWBS Number - 2013 to 2033

SWBS	Minimum Total Cost	Average Total Cost	Maximum Total Cost
100	$178,000	$227,000	$310,000
200	$1,198,000	$1,532,000	$2,090,000
300	$69,000	$88,000	$120,000
400	$47,000	$60,000	$82,000
500	$198,000	$253,000	$345,000
600	$1,865,000	$2,385,000	$3,253,000
800	$961,000	$1,229,000	$1,676,000

SWBS	Item Description	2013	2014	2015	2016	2017	2018	2019	2020	2021
100	Subtotal	$ 2,671	$ 9,163	$ 2,963	$ 9,814	$ 3,255	$ 10,465	$ 3,547	$ 11,116	$ 3,839
200	Subtotal	$ 56,760	$ 32,521	$ 41,074	$ 60,322	$ 58,412	$ 42,115	$ 43,703	$ 61,470	$ 90,411
300	Subtotal	$ 42,918	$ -	$ -	$ 4,205	$ -	$ -	$ 4,205	$ -	$ -
400	Subtotal	$ 19,955	$ 1,500	$ 1,553	$ 1,606	$ 1,658	$ 1,711	$ 1,764	$ 1,817	$ 1,870
500	Subtotal	$ 14,573	$ 6,660	$ 6,073	$ 11,757	$ 5,334	$ 6,533	$ 10,985	$ 8,814	$ 6,994
600	Subtotal	$ 92,383	$ 138,103	$ 90,879	$ 138,103	$ 90,879	$ 138,103	$ 90,879	$ 138,103	$ 90,879
900	Subtotal	$ 45,993	$ 47,243	$ 48,493	$ 49,744	$ 50,994	$ 52,244	$ 53,494	$ 54,744	$ 55,995
	Annual Maintenance Cost	$ 275,000	$ 235,000	$ 191,000	$ 276,000	$ 211,000	$ 251,000	$ 209,000	$ 276,000	$ 250,000

SWBS	Item Description	2022	2023	2024	2025	2026	2027	2028	2029	2030
100	Subtotal	$ 11,767	$ 32,040	$ 12,418	$ 9,594	$ 13,069	$ 4,714	$ 34,405	$ 5,006	$ 14,371
200	Subtotal	$ 52,473	$ 40,248	$ 78,254	$ 260,846	$ 40,278	$ 52,429	$ 98,046	$ 80,927	$ 106,918
300	Subtotal	$ 4,205	$ -	$ -	$ 17,172	$ -	$ 662	$ 4,205	$ -	$ -
400	Subtotal	$ 1,923	$ 1,976	$ 2,028	$ 2,081	$ 2,134	$ 2,187	$ 2,240	$ 2,293	$ 2,346
500	Subtotal	$ 9,659	$ 13,884	$ 12,260	$ 10,120	$ 8,022	$ 7,915	$ 17,013	$ 15,043	$ 17,117
600	Subtotal	$ 138,103	$ 92,383	$ 138,103	$ 90,879	$ 138,103	$ 90,879	$ 138,103	$ 90,879	$ 138,103
900	Subtotal	$ 57,245	$ 58,495	$ 59,745	$ 60,996	$ 62,246	$ 63,496	$ 64,746	$ 65,996	$ 67,247
	Annual Maintenance Cost	$ 275,000	$ 239,000	$ 303,000	$ 452,000	$ 264,000	$ 222,000	$ 359,000	$ 260,000	$ 346,000

SWBS	Item Description	2031	2032	2033
100	Subtotal	$ 8,030	$ 19,400	$ 5,590
200	Subtotal	$ 63,292	$ 131,141	$ 94,052
300	Subtotal	$ 4,205	$ 6,180	$ -
400	Subtotal	$ 2,398	$ 2,451	$ 2,504
500	Subtotal	$ 11,041	$ 43,955	$ 8,836
600	Subtotal	$ 90,879	$ 138,103	$ 90,879
900	Subtotal	$ 68,497	$ 69,747	$ 70,997
	Annual Maintenance Cost	$ 248,000	$ 411,000	$ 273,000

REPLACEMENT VESSEL

An estimate of the maintenance cost of a replacement vessel was made based on the maintenance cost projection for the existing vessel and the new construction cost estimate. The results of this analysis and a description of the procedure are given in the following sections.

Procedure

A starting annual maintenance cost was first determined for the replacement vessel. This figure was based on maintenance data from Washington State Ferries' M/V CHETZEMOKA. The percentage of the 2013 fleet maintenance cost was estimated as the portion of the ship's length to the total fleet length. The estimated maintenance cost was then divided by the total ship construction cost. This resulted in a starting maintenance cost estimate of 2.0% of the construction cost. The M/V CHETZEMOKA was selected as it is the newest ferry for which the necessary data could be found.

The existing vessel cost projection was then summed by SWBS number and used to determine the percentage of the total maintenance cost that each SWBS category contributed. These percentages were used to determine starting maintenance costs for the replacement vessel by SWBS category. A projection of maintenance cost growth over 20 years was then made based on the percentage growth projected each year for the existing vessel.

The cost of the first year of replacement vessel maintenance was disregarded as it was assumed this would be covered by vessel warranty.

Results

While the procedures outlined above result in specific cost data for each year of the estimate, these results should not be considered to indicate the expected fluctuation in maintenance cost from year to year. Like the existing vessel maintenance cost projection, the results indicate a range, or area, of expected costs over the future time period. The results of the cost estimate are plotted in Figure 17, along with the historical data for comparison. All dollar figures in the plot are normalized to present day values. The line in Figure 17 is a linear curve indicating the average estimated cost.

Inspection of Figure 17 indicates a range of costs that would occur over the first 20 years of vessel life. The minimum and maximum annual maintenance costs are clearly visible below and above the group of data. For example, it is projected that the first year maintenance costs will range between approximately $110,000 and $170,000. The range in maintenance costs can be seen to increase with time. After 20 years of service, it is projected that annual maintenance costs will range between approximately $150,000 and $300,000. The average projected annual maintenance cost is perhaps a better indicator of total cost over the next 20 years of vessel service. The average projected annual maintenance cost is approximately $136,000 in year one and $200,000 in year twenty.

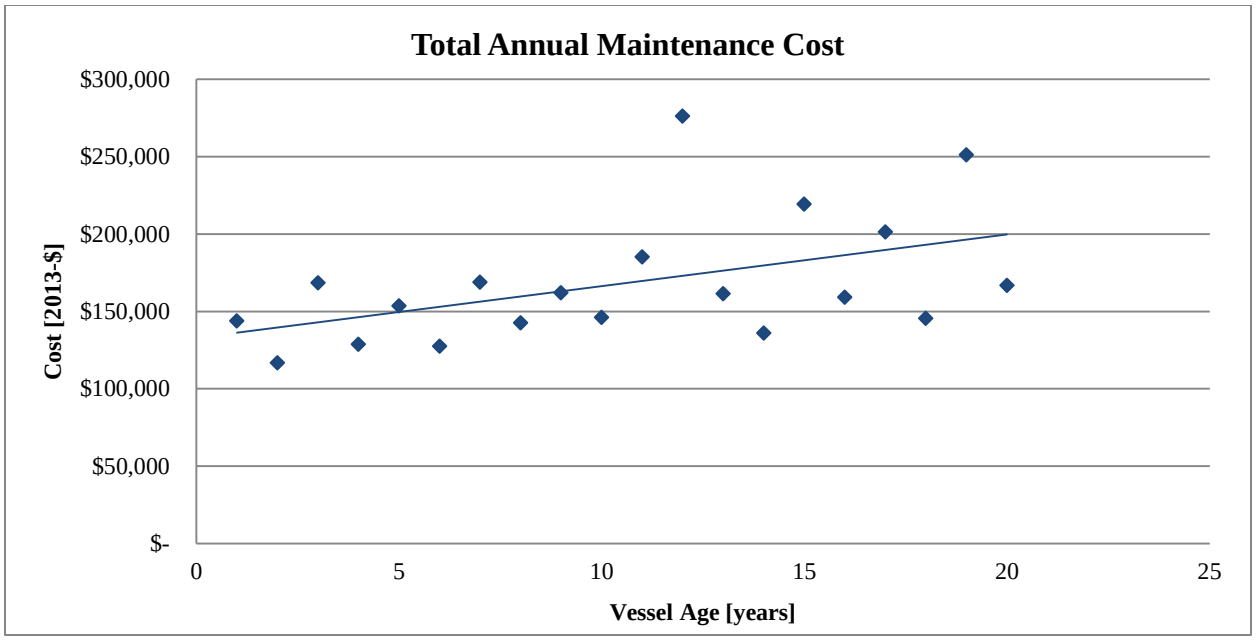

Figure 17: Replacement Vessel Annual Maintenance Cost

The cost projection can also be used to estimate the total maintenance costs over the first 20 years of vessel life. The total projected average maintenance cost is approximately $3.35 million. The total projected minimum maintenance cost is approximately $2.80 million, while the total projected maximum maintenance cost is approximately $4.50 million.

The annual costs by SWBS number are given on the following page.

SWBS	Item Description	1	2	3	4	5	6	7	8	9
100	Subtotal	$ 5,601	$ 1,811	$ 5,999	$ 1,990	$ 6,397	$ 2,168	$ 6,795	$ 2,347	$ 7,193
200	Subtotal	$ 19,880	$ 25,108	$ 36,875	$ 35,707	$ 25,744	$ 26,716	$ 37,576	$ 45,003	$ 25,770
300	Subtotal	$ -	$ -	$ 2,570	$ -	$ -	$ 2,570	$ -	$ -	$ 2,570
400	Subtotal	$ 917	$ 949	$ 981	$ 1,014	$ 1,046	$ 1,078	$ 1,111	$ 1,143	$ 1,175
500	Subtotal	$ 4,071	$ 3,712	$ 7,187	$ 3,261	$ 3,994	$ 6,715	$ 5,388	$ 4,275	$ 5,905
600	Subtotal	$ 84,422	$ 55,554	$ 84,422	$ 55,554	$ 84,422	$ 55,554	$ 84,422	$ 55,554	$ 84,422
900	Subtotal	$ 28,879	$ 29,644	$ 30,408	$ 31,172	$ 31,936	$ 32,701	$ 33,465	$ 34,229	$ 34,993
	Annual Maintenance Cost	$ 143,771	$ 116,778	$ 168,443	$ 128,697	$ 153,540	$ 127,502	$ 168,757	$ 142,551	$ 162,029

SWBS	Item Description	10	11	12	13	14	15	16	17	18
100	Subtotal	$ 19,586	$ 7,591	$ 5,865	$ 7,989	$ 2,882	$ 21,032	$ 3,060	$ 8,785	$ 4,909
200	Subtotal	$ 24,603	$ 47,836	$ 159,454	$ 24,622	$ 32,049	$ 59,935	$ 49,470	$ 55,094	$ 32,384
300	Subtotal	$ -	$ -	$ 10,497	$ -	$ 404	$ 2,570	$ -	$ -	$ 2,570
400	Subtotal	$ 1,208	$ 1,240	$ 1,272	$ 1,305	$ 1,337	$ 1,369	$ 1,401	$ 1,434	$ 1,466
500	Subtotal	$ 8,487	$ 7,495	$ 6,186	$ 4,904	$ 4,838	$ 10,400	$ 9,196	$ 10,464	$ 6,749
600	Subtotal	$ 56,473	$ 84,422	$ 55,554	$ 84,422	$ 55,554	$ 84,422	$ 55,554	$ 84,422	$ 55,554
900	Subtotal	$ 35,758	$ 36,522	$ 37,286	$ 38,050	$ 38,815	$ 39,579	$ 40,343	$ 41,108	$ 41,872
	Annual Maintenance Cost	$ 146,115	$ 185,106	$ 276,114	$ 161,292	$ 135,879	$ 219,307	$ 159,025	$ 201,306	$ 145,504

SWBS	Item Description	19	20
100	Subtotal	$ 11,859	$ 3,417
200	Subtotal	$ 80,166	$ 57,494
300	Subtotal	$ 3,778	$ -
400	Subtotal	$ 1,498	$ 1,531
500	Subtotal	$ 26,869	$ 5,402
600	Subtotal	$ 84,422	$ 55,554
900	Subtotal	$ 42,636	$ 43,400
	Annual Maintenance Cost	$ 251,228	$ 166,797

Appendix D – Annual Fuel Cost Estimate

FUEL AND LUBE OIL COST

The annual cost of fuel and lube oil was estimated for both the existing vessel and a replacement vessel based on the current sailing schedule and engine fuel consumption data. For conservatism and to account for unpredictable changes in fuel price, a price of $3.50 per gallon was assumed. Lube oil was estimated to cost $12 per gallon.

The annual number of one-way trips was determined from the 2014 calendar and the current schedule. It was found to be 8,564 round trip per year without a margin for additional trips.

The factored engine hours were calculated assuming a five-minute crossing time at 85% of maximum continuous rating (MCR) and 25 minutes spent at the dock at 5% MCR per one-way trip. The factored hours are shown in Table 14.

Table 14: Factored Engine Time

Period	Time [hrs]	MCR	Factored Time [hrs]
Time at Speed	0.17	85%	0.142
Time at Dock	0.33	5%	0.017
Total	**0.5**		**0.159**

Existing Vessel

The fuel consumption rate for the existing vessel was taken from the engine manufacturer's specifications and the lube oil consumption rate was based on similar engine types. A 10% margin was added for conservatism and to account for unscheduled passages. The total cost of fuel and lube oil for the existing vessel was estimated to be $274,000 per year. The calculation is shown below.

$$\frac{COST}{YEAR} = n * S * \left(SFC * P_{fuel} * T_f + SOC * P_{oil} * T_t\right) * margin$$

$$\frac{COST}{YEAR} = 2 * 8564(25.8 * 3.50 * 0.1586 + 0.038 * 12.00 * 0.5) * 1.1 = 274{,}126$$

where:

- n is the number of engines
- SFC is the specific fuel consumption of one engine in gallons per hour
- P_{fuel} is the price of fuel in dollars per gallon
- SOC is the oil consumption rate of one engine in gallons per hour
- P_{oil} is the cost of oil in dollars per gallon
- T_f is the factored hours per trip
- T_t is the total hours per trip
- S is the number of trips per year

Replacement Vessel

The fuel and lube oil consumption rate of a new vessel was based on manufacturer specifications of the engines installed in the Port Aransas ferry; two MTU Series 60 engines delivering a total of 1,200 HP. A 10% margin was added for conservatism and to account for unscheduled passages. The total cost of fuel and lube oil for the existing vessel was estimated to be $322,000 per year. The calculation is shown below:

$$\frac{COST}{YEAR} = n * S * \left(SFC * P_{fuel} * T_f + SOC * P_{oil} * T_t\right) * margin$$

$$\frac{COST}{YEAR} = 2 * 8564(29.9 * 3.50 * 0.1586 + 0.08 * 12.00 * 0.5) * 1.1 = 321{,}754$$

Appendix E – Annual Cost Breakdowns for each Vessel Replacement Option

OPTION A

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
New Vessel	New Vessel Planning & Design		Construction									
Construction Cost				$8,400,000								
Maintenance Cost					$136,000	$139,000	$143,000	$146,000	$150,000	$153,000	$156,000	$160,000
Fuel Oil Cost				$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000
Total Cost Per Year				$764,105	$900,105	$903,105	$907,105	$910,105	$914,105	$917,105	$920,105	$924,105
Existing Vessel												
Maintenance Cost	$234,000	$239,000	$244,000									
Fuel Oil Cost	$274,000	$274,000	$274,000									
Total Cost Per Year	$508,000	$513,000	$518,000									

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
New Vessel											
Construction Cost											
Maintenance Cost	$163,000	$166,000	$169,000	$173,000	$176,000	$179,000	$183,000	$186,000	$189,000	$193,000	$196,000
Fuel Oil Cost	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000
Total Cost Per Year	$927,105	$930,105	$933,105	$937,105	$940,105	$943,105	$947,105	$950,105	$953,105	$957,105	$960,105
Existing Vessel											
Maintenance Cost											
Fuel Oil Cost											
Total Cost Per Year											

OPTION B

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
New Vessel												
Construction Cost								Planning & Design		Construction	$8,400,000	
Maintenance Cost												$136,000
Fuel Oil Cost											$322,000	$322,000
Total Cost Per Year											$1,022,000	$1,158,000
Existing Vessel												
Overhaul Cost	Design	Construction	$929,000									
Maintenance Cost	$234,000		$241,000	$245,000	$250,000	$255,000	$260,000	$265,000	$270,000	$275,000		
Fuel Oil Cost	$274,000	$274,000	$274,000	$274,000	$274,000	$274,000	$274,000	$274,000	$274,000	$274,000		
Vessel Lease		$1,095,000										
Total Cost Per Year	$611,222	$1,472,222	$618,222	$622,222	$627,222	$632,222	$637,222	$642,222	$647,222	$652,222		

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
New Vessel											
Construction Cost											
Maintenance Cost	$139,000	$143,000	$146,000	$150,000	$153,000	$156,000	$160,000	$163,000	$166,000	$169,000	$173,000
Fuel Oil Cost	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000
Total Cost Per Year	$1,161,000	$1,165,000	$1,168,000	$1,172,000	$1,175,000	$1,178,000	$1,182,000	$1,185,000	$1,188,000	$1,191,000	$1,195,000
Existing Vessel											
Overhaul Cost											
Maintenance Cost											
Fuel Oil Cost											
Vessel Lease											
Total Cost Per Year											

OPTION C

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
New Vessel												
Construction Cost												
Maintenance Cost												
Fuel Oil Cost												
Total Cost Per Year												
Existing Vessel												
Overhaul Cost	Planning & Design		Construction	$4,794,000								
Maintenance Cost	$234,000	$239,000		$243,000	$248,000	$253,000	$258,000	$262,000	$267,000	$272,000	$277,000	$281,000
Fuel Oil Cost	$274,000	$274,000	$274,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000
Vessel Lease			$1,095,000									
Total Cost Per Year	$790,000	$795,000	$1,651,000	$847,000	$852,000	$857,000	$862,000	$866,000	$871,000	$876,000	$881,000	$885,000

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
New Vessel											
Construction Cost				Planning & Design		Construction	$8,400,000				
Maintenance Cost								$136,000	$139,000	$143,000	$146,000
Fuel Oil Cost							$322,000	$322,000	$322,000	$322,000	$322,000
Total Cost Per Year							$2,422,000	$2,558,000	$2,561,000	$2,565,000	$2,568,000
Existing Vessel											
Overhaul Cost											
Maintenance Cost	$286,000	$291,000	$296,000	$300,000	$305,000	$310,000					
Fuel Oil Cost	$322,000	$322,000	$322,000	$322,000	$322,000	$322,000					
Vessel Lease											
Total Cost Per Year	$890,000	$895,000	$900,000	$904,000	$909,000	$914,000					