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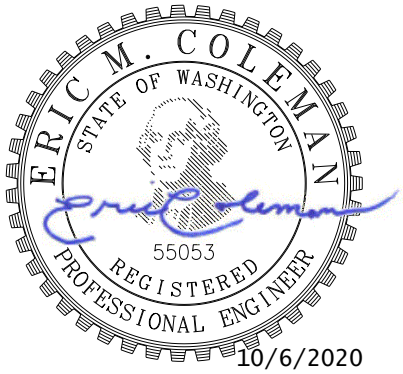
MEMORANDUM

Vessel:	New Lummi Island Ferry
Engineer:	Eric Coleman, PE
Reference:	17098.01-003-043-0-
Date:	10/6/2020
Subject:	Parametric Vessel Construction Cost Estimate



PURPOSE

This memorandum details the construction cost estimate for the New Lummi Island Ferry (LIF). The LIF is a 184 ft x 54 ft x 13.25 ft, 34 car, 150 passenger, double-ended ferry with a maximum loaded draft of 7.50 ft. The new ferry is intended to replace Whatcom County's current ferry (M/V WHATCOM CHIEF) on the same route between the ferry terminals on Lummi Island and the mainland at Gooseberry Point. The vessel will be owned and operated by Whatcom County Public Works (WCPW).

PROCEDURE

The cost estimate is organized based on the Ship Work Breakdown Structure (SWBS). The parametric weight estimate that has been developed as part of the preliminary design process [1] is used to determine the quantity of material in each hull construction SWBS group, 100 through 600. Parametric estimates of dollars per pound and hours per pound are assigned to each hull construction group based on internal EBDG databases [2] [3]. Next, estimates for project management and administration (SWBS group 000), detail and production engineering (SWBS group 800), and construction support (SWBS group 900) are applied as a percentage of the vessel construction costs. Finally, all applicable margins and contingency values are applied to determine the total estimated construction cost.

Parametric Estimate Sources

Construction cost and weight estimate data from similar vessels are used to determine appropriate parametric estimates for each of the various SWBS groups. These referenced vessels are generally double-ended, open-deck, passenger and vehicle ferries of similar dimensions to the LIF. Characteristics of these vessels vary in terms of superstructure material, propulsion, vehicle capacity, passenger capacity, facilities, propulsion systems, and USCG compliance requirements. However, they are representative of the size and complexity of the LIF. See Table 1 for a summary of the reference vessels used.

Table 1 – Reference Vessel Summary

Other Vessels *(Units)*	Year of Build	Dimensions *(ft)*	Propulsion[1]	USCG *Regulatory*	Capacity *Vehicles*	Capacity *Passengers*	Cost *($, 2019)*
Port Aransas Ferry - Amadeo Saenz[2]	2015	159.6 x 52 x 11.7	FPP - DE	T	28	149	$ 9,807,000
Port Aransas Ferry	2010	161 x 52 x 11.66	FPP	T	28	149	$ 8,539,000
Denman Island Ferry	2013	257.6 x 55.8 x 6.90	Cable	*	50	147	$ 13,986,000
Wahkiakum County Ferry[3]	2014	115 x 47.5 x 7.09	FPP	T	23	100	$ 6,203,000
Double-Ended Ferry[2]	2017	152 x 52 x 11.66	CPP	T	30	149	$ 5,775,000
NC Sound Class Ferry[2]	2010	201 x 50 x 12.50	FPP	H	50	300	$ 16,604,000
NCDOT River Class- Avon[2]	2019	183.6 x 46 x10.50	Voith - DE	H	40	300	$ 12,154,000

*Vessel designed to meet Transport Canada Requirements

[1] DE = Diesel Electric

[2] Provided for top line cost comparison purposes only

[3] Single-ended vessel

Inflation Adjustment

Costs for the reference vessels are adjusted to account for inflation and are presented in equivalent, present-day dollars. The inflation values are based on the U.S. Bureau of Labor Statistics Consumer Price Index. All cost values presented in all tables and calculations throughout this memo are in 2020 dollars unless stated otherwise.

Construction Estimate Parametric Inputs

Parametric values for material cost per pound and hours per pound are calculated for each of the reference vessels for each hull construction SWBS group. The average values for each of these properties for all SWBS groups are taken as the baseline parametric estimate value. These values were then adjusted based on an estimate of the vessel's complexity relative to the reference vessels. Note that the parametric estimate is based on a standard diesel mechanical propulsion system. Table 2 presents a summary of the final parametric values for each SWBS group.

Table 2 – Parametric Input Values

SWBS Group	Material *($/lb)*	Labor *(hrs/lb)*
100 - Hull Structure	$1.04	0.04
200 - Propulsion	$18.46	0.09
300 - Electrical	$18.67	0.26
400 - Navigation & IC	$125.00	1.12
500 - Aux. Systems	$6.30	0.17
600 - Outfitting	$5.59	0.08

Non-Construction Estimates

Labor costs for vessel construction oversight (SWBS 000) and detail and production engineering (SWBS 800) are estimated as a percentage of the hull construction labor hours. Project management and administration (SWBS 000) labor hours are estimated to be equal to 10% of the labor hours for SWBS 100 – 600. The engineering (SWBS 800) labor hours are estimated to be equal to 8% of all construction labor hours. Construction support services (SWBS 900) are also estimated to be equal to 8% of the construction labor hours. Material costs shown in SWBS 900

are assumed to be 3% of the total material costs to cover materials and resources (e.g., water and electricity) consumed in support of the construction of the vessel.

Labor Rate

An overall labor rate of $68.00 per hour is assumed for the construction work. This is an estimate of the current shipyard burdened labor rate for production labor in the Pacific Northwest of the United States. Labor rates for SWBS 000 and SWBS 800 are assumed to be 120% and 180%, respectively, of the shipyard burdened rate for production labor.

CALCULATIONS

Material Costs

Material costs are calculated based on the product of the parametric estimate of $ / LT and the parametric weight for each applicable SWBS category. An assumed 15% material markup is applied to the total parametric material cost to account for the costs of material acquisition.

Labor Costs

Labor costs are calculated based on the product of the parametric estimate of Hrs / LT, the parametric weight, and the labor rate for each applicable SWBS category. SWBS 000, 800 and 900 labor costs are calculated based on labor hour estimates and labor rates as described above.

Margins and Contingency

An acquisition margin is applied to the total calculated construction cost allocated to each SWBS category. This margin is included to account for the precision limitations that exist at the concept phase of the new vessel design. Table 3 shows the range of acquisition margins appropriate for use through the different phases of vessel design. This table is from NAVSEA instruction 9096.6, Policy for Weight Margins [4] for surface ships and is considered appropriate as the basis for this cost estimate. The acquisition margin used for the estimate is 15%. The level of definition for the vessel is considered conceptual at present.

Table 3 - Acquisition Margins

Rank	Design Phase / Characterization	Uncertainty	Acquisition Margin
1	Developmental design	Very High	15% – 25%
2	New vessel concept design	High	10% – 18%
3	New vessel preliminary design *or* Similar vessel design with major changes	Moderate	6% – 12%
4	New vessel functional/detail design *or* Similar vessel design with minor changes	Low	4% – 8%
5	Follow-on vessel design with minor changes	Almost none	1% – 6%

To account for uncertainty external to the design development throughout the vessel acquisition process, a 10% contingency is included. This contingency is applied to account for factors such as inflation, tariffs and changes in market conditions, and exchange rates. The contingency applied is predicated on a relatively short vessel acquisition process.

Added Cost for Diesel Battery Hybrid (DBH) Propulsion

To determine the added cost of the diesel battery hybrid system, the material cost differential of the two systems [5] is added to the parametric estimate determined herein. To account for the fees associated with the additional integration and shipyard labor associated with the hybrid equipment, a 20% margin is applied to the 300 SWBS labor cost.

The engineering and project management hours are increased by 20% to account for the added project complexity introduced by the hybrid system.

An additional 10% contingency is then applied to the total added cost.

The cost of the DBH vessel is summarized in Table 4.

Table 4 – DBH Vessel Cost.

Description	Cost
Diesel mechanical vessel	$13,900,000
Capital cost increase from DBH equipment [5]	$958,000
Margin for integration and increased shipyard labor (20% of SWBS 300 labor)	$134,000
Added project management/admin, detail engineering fees	$253,000
Added contingency	$135,000
Total	**15,380,000**

CONCLUSIONS

The full calculation of the preliminary construction cost estimate for the baseline diesel mechanical vessel is included at the end of this memorandum. This estimate is based on a concept level of design. The total estimated construction cost in 2020 including all margins and contingency, is $15,380,000. Note that this estimate is intended to capture the shipyard cost of construction. It is not intended to capture the costs associated with contract design, the bid process, construction oversight, spare parts, nor warranty management.

REFERENCES

[1] Elliott Bay Design Group, "Weight Estimate," 17098.01-002-833-0-, Seattle, WA, October, 2020.

[2] Elliott Bay Design Group, "SWBS Group Weight Data," File: SWBSGroupWeights-Costs-Ferries.xls, As of: April 28, 2014.

[3] Elliott Bay Design Group, "SWBS Group Cost Data," File: SWBSGroup Labor & Mat'l-Ferries.xls, As of: June 25, 2014.

[4] NAVSEA, "Instruction 9096.6, Policy for Weight Margins," 2001.

[5] Elliott Bay Design Group, "17098.01-001-062-1 Propulsion System Selection Study," April, 2020.

[6] Elliott Bay Design Group, "17098.01-002-832-0A Outline Specification," September, 2020.

PARAMETRIC CONSTRUCTION COST ESTIMATE

Assumptions

1) This vessel is assumed to be built in the Pacific Northwest.
2) This estimate is intended for budgeting purposes ONLY.
3) Costs are organized in accordance with the EBDG interpretation of the SWBS System.
4) Weights are taken from 17098.01-002-833-0-
5) Other Assumptions as needed.
6) Non-trade labor rates are as follows:
   PM & Admin = 120% of Labor
   Engineering = 180% of Labor

Calculations

SWBS COST GROUPS	Weight in LT	$/LT	HRS/LT	$ MATERIAL + Mark-up	LABOR HRS	LABOR COST	Total Cost
000 - PM & ADMIN					7,069	$ 576,813	$ 576,813
100 - HULL	386.4	2,375	92.20	$ 1,055,244	35,628	$ 2,422,676	$ 3,477,920
200 - PROP MACH'Y	19.9	41,358	195.26	$ 947,274	3,889	$ 264,447	$ 1,211,721
300 - ELECTRICAL	16.7	41,823	589.34	$ 805,581	9,871	$ 671,226	$ 1,476,808
400 - NAVIGATION	0.9	280,000	2,500.00	$ 291,669	2,265	$ 153,987	$ 445,655
500 - AUXILIARY	20.2	14,103	382.81	$ 327,002	7,718	$ 524,851	$ 851,854
600 - OUTFIT	65.3	12,518	173.29	$ 940,128	11,317	$ 769,584	$ 1,709,713
800 - ENGINEERING					5,655	$ 692,175	$ 692,175
900- CONST. SERVICES				$ 131,007	5,655	$ 384,542	$ 515,549
Totals	**509.47**			**$ 4,497,906**	**89,067**	**$ 6,460,301**	**$10,958,207**

Inputs

Current Vessel	**Value**	**Unit**		
Length	184.00	*ft*	Vessel Type	Ferry
Beam	54.00	*ft*		
Depth	13.25	*ft*		
Light Ship Δ	509	*LT*	Does not include SLM	
Structure Weight	386	*LT*		

Shipyard	**Value**	**Units**		
Labor Rate	$68.00	*/hr*		
Material Mark-Up	15.0%		000 - PM & Admin	10.0%
Mat'l & Labor Margin	15.0%		800 - Engineering	8.0%
Contingency	10.0%		900 - Construction Services	8.0%

Other Vessels	**Cube Number**	**Light Ship Δ**	**Structure Wt**	**Labor Hours**	**Cost**
Units	ft^3	*LT*	*LT*	*hrs*	*$*
Port Aransas Ferry - Amadeo Saenz	968.00	395.40	285.85	N/A	$ 9,806,999
Denman Island Ferry	989.68	578.48	481.64	75,312	$ 13,986,000
Double Ended Ferry	921.61	276.80	217.33	40,433	$ 5,774,835
NC Sound Class Ferry	1,256.25	600.72	-	N/A	$ 16,604,000
NCDOT River Class- Avon	886.79	395.00	289.57	N/A	$ 12,154,000

Output

Labor & Material Sub-Total	$10,958,207
Material & Labor Margin @ 15%	$1,643,731
Cost without Contingency =	**$12,601,938**
Contingency	$1,260,194
Total Vessel Construction Cost Estimate with 10% CONTINGENCY	**$13,862,131**
Rounded Up Total	**$13,900,000**