

**Glosten**

**PROJECT MEMORANDUM**

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**28-Car Options Cost Estimate**

30 March 2018

TO: Skagit County Public Works  
FROM: William L. Moon III, PE  
JOB/FILE NO. 17097.01

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**References**

1. *Guemes Island Ferry Replacement, Concept Design Report*, Glosten Inc., Report No. 17097-053-01.
2. *Guemes Island Ferry Replacement, Engineer's Cost Estimate*, Glosten Inc., Report No. 17097-043-01.

**Summary**

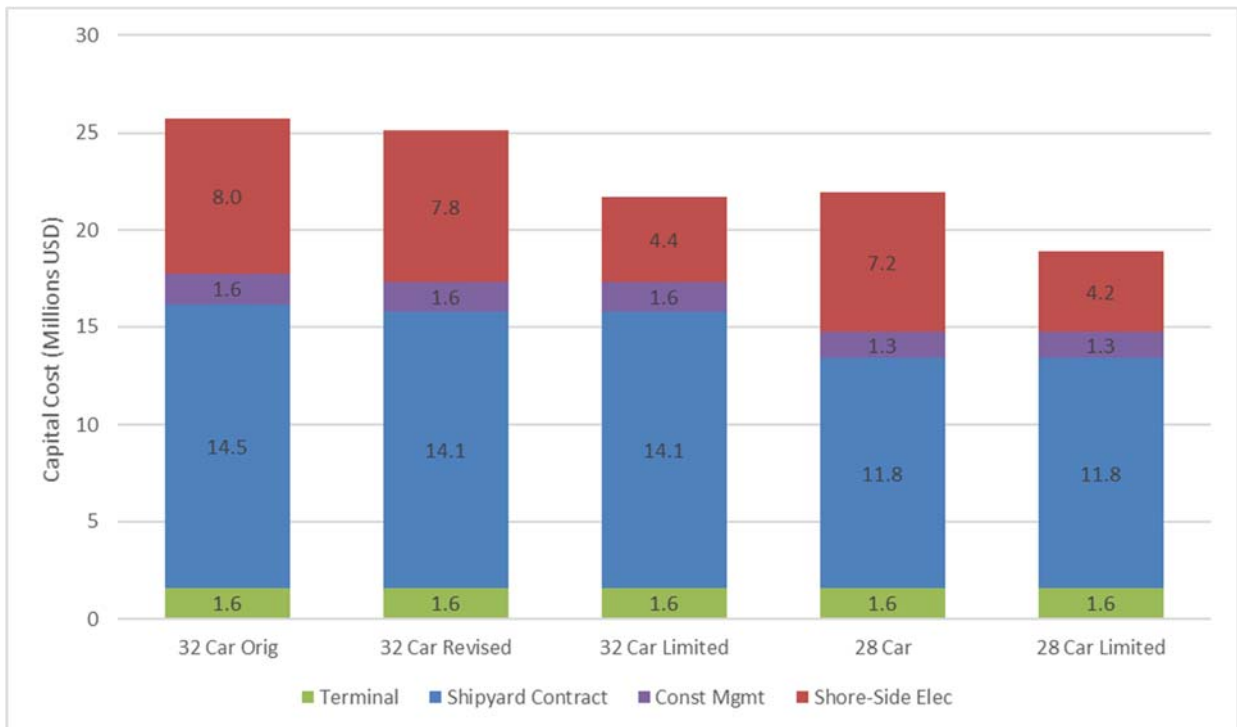
At the request of Skagit County Public Works, a capital cost estimate has been developed for an All-Electric 28-Car variant of the 32-Car ferry previously designed and detailed in Reference 1. Cost metrics used in Reference 2 were applied in this analysis. Only the All-Electric propulsion system option has been evaluated; it is anticipated that the Plug-In Hybrid option will scale similarly.

The 32-Car ferry concept design detailed in Reference 1 was completed in December 2017 to meet the application deadline for County Road Administration Board (CRAB) funding. Given the limited design time, vessel weight refinements (and the impact on installed power) were not able to be completed. The 32-Car Revised option presented below refines the concept design weight and powering predictions. A 2.5% reduction in total cost is realized from this effort.

Reference 1 states that the two round trips per hour schedule requirement has a significant impact on the shore-side electrical cost due to the power required during extreme weather events when combined with full vehicle loads. These are expected to be rare events, but drive the cost of the electrical infrastructure. This report investigates reducing the two round trip per hour requirement to less extreme weather/vehicle load events. Cases have been developed for both the 32-Car and 28-Car vessels and are labeled "Limited" for limited shore charging apparatus ratings. These systems are expected to complete two round trips per hour with full vehicle loads during average weather.

Figure 1 shows the overall cost breakdown of each vessel variant. The 28-Car Limited option represents a 27% reduction in overall capital cost as compared to the 32-Car Original ferry.

While this analysis does not evaluate the impacts on operational costs, a reduction in the overall vessel size from a capacity of 32 cars to 28 cars will generally reduce the operating costs.



**Figure 1 Program capital cost estimate by vessel option**

### Details

Five ferry variants are discussed below.

1. 32-Car Original: this is the same vessel and costs as presented in Reference 1, shown for comparison.
2. 32-Car Revised: this vessel has seen additional design iteration on the vessel weight and powering. It represents a more mature concept design cost estimate.
3. 32-Car Limited: this represents the same ferry as in number 2, but where the shore side electrical equipment is limited in capacity. During days of above normal currents or high wind and wave events, combined with full loads of vehicles, the charging system will restrict the vessel's schedule to less than 2 round trips per hour.
4. 28-Car: this represents a smaller ferry capable of holding approximately 28 vehicles. The length and depth of the vessel as well as the size of the deckhouse have been reduced. Vessel displacement and installed power have been reduced accordingly.
5. 28-Car Limited: this represents the same ferry as in number 4, but where the shore side electrical equipment is limited in capacity. During days of above normal currents or high wind and wave events, combined with full loads of vehicles, the charging system will restrict the vessel's schedule to less than 2 round trips per hour.

Table 1 represents the anticipated capital cost breakdown of several vessel variants. Table 2 shows the resulting battery and shore side electrical connection capacity for each vessel variant.

**Table 1 Principal characteristics of vessel variants**

	<b>32-Car Original</b>	<b>32-Car Revised</b>	<b>28-Car</b>
Full Load Displacement (LT)	699.0	614.2	504.3
LS WT (LT)	566.60	481.6	405.5
LWL (ft)	170.10	169.60	151.76
BWL (ft)	40.27	39.70	39.76
Draft (ft)	7.635	7.025	7.1
Displacement (LT)	697.8	614.4	506.4
Midship Section (ft <sup>2</sup> )	251.5	227.1	230.2
Cb	0.467	0.455	0.414
Depth at Side (ft)	13.5	13.0	13.0
Wetted Surf (ft <sup>2</sup> )	6337	6002	5229
P <sub>e</sub> @ 0.263 FN (kW)	337 (11.5 kts)	325 (11.5 kts)	226 (11.0 kts)
P <sub>d</sub> @ 0.263 FN (kW)	701	675	474
F <sub>side</sub> @ 4.5 kts (kips)	39.1	32.3	28.2
P <sub>d</sub> @ 4.5 kts (kW)	1251 total	976 total	820 total

**Table 2 Vessel and shore side electrical characteristics**

	<b>32-Car Original</b>	<b>32-Car Revised</b>	<b>32-Car Limited</b>	<b>28-Car</b>	<b>28-Car Limited</b>
Vessel Batteries (kWh)	1050	1000	1000	800	800
Shore-Side Batt (kWh)	1400	1400	800	1200	700
Shore Connection (MW)	4.0	3.9	1.4	3.2	1.2
Utility Connection (kW)	1050	1030	370	830	310

Table 3 represents the anticipated capital cost breakdown of the five variants. The terminal upgrades are kept constant throughout all options. While it may be possible to reduce the scope of the dolphin upgrades, specifically for the lighter 28-Car ferry, it is prudent to keep some funding for upgrades should it be necessary.

The utility connection cost has been reduced from the 32-Car Original cost estimate (Reference 2) based on discussions with Puget Sound Energy (PSE). The cost estimates now represent a 50/50 cost share between Skagit County and PSE for the cost to upgrade the utility connection to the ferry terminal.

The emergency services costs primarily consist of the shore-side backup generator for the All-Electric vessel. Savings for this component can only be realized if the generator size can be reduced. Unfortunately the costs are a step function and can only be reduced for the 32-Car and 28-Car Limited variants.

**Table 3 Updated cost estimate for the 32 and 28 car ferry options, cost x \$1,000**

<b>Description</b>	<b>32-Car Original</b>	<b>32-Car Revised</b>	<b>32-Car Limited</b>	<b>28-Car</b>	<b>28-Car Limited</b>
<b>Total Replacement Cost</b>	<b>25,723</b>	<b>25,071</b>	<b>21,704</b>	<b>21,920</b>	<b>18,884</b>
<b>Vessel Total</b>	<b>16,111</b>	<b>15,685</b>	<b>15,685</b>	<b>13,092</b>	<b>13,092</b>
County Oversight	290	283	283	236	236
Vessel Design	726	707	707	590	590
Construction Management	581	565	565	472	472
Shipyards Contract	14,514	14,131	14,131	11,794	11,794
Bonding and Risk Insurance	285	279	279	231	231
Material Markup	684	668	668	552	552
Estimating Allowance	2,258	2,214	2,214	1,835	1,835
Shipyards Engineering & Services	1,886	1,869	1,869	1,583	1,583
Structure	2,799	2,725	2,725	2,311	2,311
Propulsion	1,298	1,259	1,259	934	934
Electric Plant	2,223	2,035	2,035	1,673	1,673
Command and Surveillance	772	772	772	662	662
Auxiliary Systems	806	806	806	730	730
Outfit & Furnishings	1,503	1,503	1,503	1,284	1,284
<b>Shore-Side Electrical Total</b>	<b>7,991</b>	<b>7,765</b>	<b>4,398</b>	<b>7,208</b>	<b>4,172</b>
Utility Connection	260	130	98	117	98
County Oversight	140	139	78	130	73
Permitting	70	69	39	65	37
Shore-Side Design	500	500	300	400	300
Shore-Side Electrical Subtotal	7,020	6,927	3,884	6,495	3,664
Infrastructure	3,099	3,099	2,602	2,933	2,519
Charging Apparatus	3,592	3,498	1,051	3,233	915
Emergency Services Generator	329	329	231	329	231
<b>Terminal Improvements Total</b>	<b>1,621</b>	<b>1,621</b>	<b>1,621</b>	<b>1,621</b>	<b>1,621</b>
County Oversight	29	29	29	29	29
Terminal Design	145	145	145	145	145
Terminal Improvements Subtotal	1,447	1,447	1,447	1,447	1,447
Apron Modifications	345	345	345	345	345
Dolphin Upgrades	1,102	1,102	1,102	1,102	1,102