MARAD DTMA1C10061

American Marine Highway Design Project

Final Report

Prepared for:

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October 28, 2011
Rev. -

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ABBREVIATIONS

AMH	America's Marine Highways
ATB	Articulated Tug Barge vessel
BEA	Business Economic Area
CCDoTT	Center for Commercial Deployment of Transportation Technologies
CCF	Capital Construction Fund
DOD	Department of Defense
ECA	Emissions Control Area, area with 200 n.m. of the coast of the US and Canada where ship fuel types and emissions are controlled to reduce air pollution. Becomes effective in 2012.
EEDI	Energy Efficiency Design Index
HEC	Herbert Engineering Corp.
IMO	International Maritime Organization
kt	Knots
kW	Kilowatt
LNG	Liquid Natural Gas
MARAD	US Maritime Administration
MGO	Marine Gas Oil (distillate type diesel fuel)
mt	Metric Ton
NDF	National Defense Feature
nm	Nautical Mile
RFR	Required Freight Rate
Rocon	Combination RoRo ship and container carrier
RoPax	RoRo ship with some passenger carrying capacity
RoRo	Roll-on / Roll-Off Ship
TEU	Twenty-foot Equivalent Unit (cargo volume carried in a 20 ft container)

A Executive Summary

There are many types of vessels that can be used for transportation of cargoes along the American Marine Highways (AMH). The intent of this design project was to focus on the vessel types best suited for transporting trailers and cargoes normally driven over the road so the marine highways can contribute to the national goals of reducing congestion, pollution, and wear and tear from large tractor trailers on the nation's highway system. In this way, the nation would benefit from the positive environmental "externalities" that marine highways offer, compared to highway transport. As part of the project a portfolio of concept level designs was developed, to cover the spectrum of possible ocean-going AMH vessels suitable for the longer range coastal routes that would serve the long haul freight market. It was decided, in consultation with the Maritime Administration (MARAD), that eleven different designs would adequately address the spectrum of vessel types envisioned. The eleven designs range in size, type, and speed, from Articulated Tug Barge (ATB) Roll on / Roll off (RoRo) vessels to conventional RoRo type trailer ships, combination RoRo and container carriers, and special high speed vessels. Besides being useful for taking long haul freight traffic off the highways, it was also intended that the designs meet a secondary goal of being suitable for military use in times of national emergency. This so-called military dual-use goal required the designs of applicable ship types to meet, where feasible, minimum speed, size, and range requirements. Short coastal routes and inland routes can be well served by smaller tug/barge type vessels and those routes and vessels were not the subject of this project.

The project was broken down into six phases plus a final report. Phase1 was an assessment of the AMH market and development of requirements for AMH vessels, Phase 2 was evaluation of existing designs, Phase 3 was development of the military dual-use requirements, Phase 4 was development of environmental requirements for the vessels, Phase 5 was the preparation of the vessel designs, and Phase 6 was the economic analysis, which first estimated the construction and operating costs of each vessel and from that data calculated the required freight rates (RFR) for selected routes. The reports generated for each phase are Appendices to this Final Report

The ship design process always starts with a mission and an intended cargo. To determine the appropriate cargoes and characteristics needed by the AMH vessels, a market assessment was carried out, of what were considered the most viable AMH routes. The primary routes analyzed were along the Atlantic Corridor (designated by MARAD as M-95) and the Pacific Corridor (M-5). Also analyzed were routes between Maine, southern New England, and the port of New York/New Jersey, and routes originating from Gulf of Mexico ports (M-10).

The market assessment was carried out with the assistance of Mercator International, a consultant specialized in cargo freight transportation. They interviewed 25 trucking and intermodal companies, and Herbert Engineering Corp. (HEC) interviewed ship owners, port authorities, and AMH advocacy groups, to obtain their input. A literature search identified available published information that could assist with this project. The interviews and literature provided valuable guidance to the vessel design process on expected cargo volumes, cargo types and weights, and schedule and speed requirements. Besides providing cargo and route data, the market assessment also provided input on what are the market rates that would attract potential shippers to use an AMH service. As a secondary data source for AMH cargo, selected portions of the TRANSEARCH database offered by Global Insights, Inc., were purchased for the most current year (2009) for freight transportation between key regions on the Atlantic and Pacific Corridors. This confirmed the cargo volume estimates developed from the interviews. Existing vessel designs recently proposed by others were discussed during the interviews with those who were proposing them, and this provided valuable input to the vessel design process.

The estimated AMH weekly cargo volumes for the primary routes are summarized in Table 1. An expanded version of this table is presented in Section D of this report (Table 4). The data is based on information contained in the Phase 1 report, Appendix 1. The selected routes were those considered the most viable for AMH trade. The indicated headhaul direction is the one with larger freight traffic (NB= northbound, SB= southbound). The number of calls per week at a given port influences weekly cargo volume, because greater frequency can enhance the attractiveness of an AMH service, encouraging more shippers to use it. The year 2014 was used as the baseline year because that is about the time frame for when AMH services could become fully operational. The 2014 baseline-plus-25% cargo data was used as the basis for vessel design capacity, to ensure vessels would have adequate capacity available for cargo seasonal variations and cargo volume growth over time.

Table 1 - Overview of Cargo Weekly Volumes on Selected AMH Routes

Route #	Route Ports	Port Calls/ Week	Head-haul	2014 Base Loads/Week	2014 +25% Loads/Week
Atlantic Corridor (M-95)					
B1	Maine to NY/NJ to SE New England	1	SB	556	695
B2A	Delaware River to Jacksonville	2	SB	289	361
B2B	Delaware River to Jacksonville	3	SB	347	434
B3A	Delaware River to Florida, 3 ports	2	SB	417	521
B3A	Delaware River to Florida, 3 ports	3	SB	500	626
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2	SB	417	521
B4	NY/NJ to Hampton Roads to Florida, 3 ports	3	SB	500	626
B4	Hampton Roads cargo	2	SB	138	172
Pacific Corridor (M-5)					
C1A	Portland to LA	2	NB	667	834
C1B	Portland to LA	3	NB	796	995
C2	Puget Sound to LA	2	NB	404	505
C3	Portland to Richmond to LA, 3 ports	2	NB	746	932
C3	Portland to Richmond to LA, 3 ports	3	NB	895	1119
C3	Richmond, CA cargo	2	NB	246	308
C4A	Richmond, CA to LA, 16.5 knots	2	NB,SB	258	322
C4C	Richmond, CA to LA, 26 knots	6	NB,SB	672	840
Gulf Corridor (M-10/M-95)					
D1	Tampa Bay to Brownsville	1	EB	345	431
D2	Delaware River to Houston	2	NB	575	719

The eleven vessel designs developed for this project were broken into three categories. Six of the designs were Roll on / Roll off (RoRo) type vessels, where all the cargo is wheeled, and is loaded and unloaded via ramps from ship to shore, and moves deck to deck using internal ramps. Three of the designs were combination RoRo and container carriers (Rocon) type vessels that carry RoRo cargo below deck and stacked containers above deck. The ability to carry stacked containers allows significantly more cargo to be carried on the same size vessel, compared to RoRo only cargo. The third category of vessels included a container feeder ship that carries only stacked containers, both above and below deck, and a combination RoRo and passenger vessel (Ropax), which can carry tractor trailers and their drivers. Table 2 lists the principal characteristics of the eleven vessels.

Table 2 – Principal Particulars of the AMH Vessel Designs

Vessel Design No. & Type	**01 – RoRo Small 18kt**	**02 – RoRo Trimaran 29kt**	**03 – RoRo Medium 24kt**	**04 – RoRo Medium 20kt**	**05 – RoRo Large 21kt**	**06 – RoRo Fastship 30kt**
LOA	167.7 m (550.2 ft)	205.0 m (672.6 ft)	207.9 m (682.1 ft)	183.5 m (602.0 ft)	225.7 m (740.5 ft)	265.0 m (869.4 ft)
LBP	150.2 m (492.8 ft)	186.0 m (610.2 ft)	190.4 m (624.7 ft)	175.0 m (574.1 ft)	208.6 m (684.4 ft)	229.0 m (751.3 ft)
Beam	27.0 m (88.6 ft)	40.6 m (133.2 ft)	28.5 m (93.5 ft)	29.0 m (95.1 ft)	29.5 m (96.8 ft)	40.0 m (131.2 ft)
Depth	17.9 m (22.6 ft)	21.5 m (70.5 ft)	23.6 m (77.4 ft)	20.8 m (68.2 ft)	23.2 m (76.1 ft)	32.7 m (107.3 ft)
Design Draft	6.0 m (19.8 ft)	8.2 m (26.9 ft)	7.0 m (23.0 ft)	7.1 m (23.3 ft)	6.8 m (22.3 ft)	10.0 m (32.8 ft)
Design Speed (15% sea margin)	18.0 knots	28.5 knots	23.7 knots	20.0 knots	21.0 knots	29.4 knots
Deadweight	5,442 mt	7,295 mt	10,178 mt	10,601 mt	10,380 mt	12,864 mt
TEU Capacity	423	708	714	879	960	1387
Max Cap.: 53' Trailers	111 Trailers	184 Trailers	203 Trailers	234 Trailers	273 Trailers	280 Trailers
Typical Full Load Container & Trailer Cap.	80 Containers 71 Trailers	138 Containers 115 Trailers	104 Containers 151 Trailers	160 Containers 154 Trailers	140 Containers 203 Trailers	440 Containers 60 Trailers
RoRo Deck Area	6,934 m^2 (74,636 ft^2)	9,850 m^2 (106,023 ft^2)	12,154 m^2 (130,822 ft^2)	13,425 m^2 (144,503 ft^2)	15,433 m^2 (166,116 ft^2)	17,889 m^2 (192,552 ft^2)
Type of Ramps to Shore	1 x Stern Quarter Ramp	2 x Stern Flap Ramp	1 x Stern Quarter Ramp	3 x Stern Flap Ramp 1 x NDF Side Ramp	1 x Stern Flap Ramp 1 x NDF Side Ramp	1 x Stern Flap Ramp 1 x NDF Side Ramp

Vessel Design No. & Type	**11 – RoCon ATB Medium 14kt**	**12 – RoCon Large 18kt**	**13 – RoCon Large 22kt**	**21 – Container Feeder 18kt**	**22 – RoPax Medium 22kt**
LOA	215.7 m (707.7 ft) Tug & Barge	181.7 m (596.1 ft)	201.3 m (660.4 ft)	151.7 m (497.7 ft)	215.5 m (707.0 ft)
LBP	199.6 m (654.9 ft) Barge	172.0 m (564.3 ft)	187.0 m (613.5 ft)	142.4 m (467.2 ft)	199.0 m (652.9 ft)
Beam	32.2 m (105.6 ft)	32.2 m (105.6 ft)	32.2 m (105.6 ft)	24.8 m (81.4 ft)	29.5 m (96.8 ft)
Depth	13.8 m (45.3 ft)	18.5 m (60.7 ft)	18.6 m (61.0 ft)	11.8 m (38.7 ft)	22.3 m (73.2 ft)
Design Draft	4.3 m (14.1 ft)	6.8 m (22.4 ft)	7.6 m (24.9 ft)	7.6 m (24.9 ft)	6.7 m (22.0 ft)
Design Speed (15% sea margin)	14.0 knots	18.3 knots	21.7 knots	18.0 knots	22.0 knots
Deadweight	9,411 mt	11,034 mt	14,994 mt	11,866 mt	8,775 mt
TEU Capacity (Full Load)	886	1159	1208	826	510
Max Cap.: 53' Trailers	148	180 Trailers	145 Trailers	None	182
Typical Full Load Container & Trailer Cap.	376 Containers 50 Trailers	289 Containers 125 Trailers	363 Containers 101 Trailers	392 Containers	105 Tractor-Trailer 77 Trailers 100 passengers
RoRo Deck Area	8,145 m^2 (87,627 ft^2)	11,934 m^2 (128,454 ft^2)	10,233 m^2 (110,145 ft^2)	None	13,821 m^2 (148,762 ft^2)
Type of Ramps to Shore & Cargo Gear	1 x Side Ramp	1 x Stern Quarter Ramp, 3 x 35 ton Cranes	1 x Stern Quarter Ramp	None	2 x Stern Flap Ramps, 2 x Bow Ramps

In Phase 6 of the project, an economic analysis was carried out for the proposed AMH vessels and routes. The first part of the analysis was the development of build strategies and construction cost estimates for the eleven vessels. The construction cost analysis included estimates for the cost impact of adding National Defense Features (NDF) to the vessels, and illustrated how the cost per vessel decreases with multiple vessel orders, showing the value of series production.

The RFR for selected AMH routes, with selection based on potential for viable operation, were then determined by two methods. The main Atlantic and Pacific Corridor routes were analyzed by the Center for Commercial Deployment of Transportation Technologies (CCDoTT) sponsored AMH System Evaluation Model developed by Dr. Matthew Tedesco, and the Maine and Gulf routes were analyzed by SPAR Associates, using the ESTI-MATE model. RFR calculations were made for port to port (loading terminal to discharge terminal) and for door to door (cargo origination point to destination point) service. Port to port rates would apply to truckers who arrange the overall freight transportation and only contract the long haul transport to the AMH vessel, and door to door rates would apply to cargo owners and shippers who are looking for the complete transportation cost. In

Table 3 are summarized the results of the port to port analyses. Shown are the nominal RFR rates, which are based on all costs being fully covered by the freight, and a Discounted RFR - which is what the rate to cover all costs would be if lower cost, LNG fuel, a (strictly hypothetical) construction cost reduction of 50% through government incentives, and elimination of the Harbor Maintenance Tax, were made available. It illustrates the effect on rates if these cost saving measures could be implemented. The estimated market rates are then listed and these are compared to the RFR to determine the route's potential for profitability, either at full cost or with discounted costs. The rates and profit and loss are on a per unit transported basis. The door to door results are similar, and presented in Section F of this report (Table 9) and in Appendix 10. As can be seen, profitable operation for many of the routes and vessel types will be a challenge, based on the predicted market rates. Ways to increase the market rates and provide incentives for shippers to use AMH would greatly help in making the services profitable. Also as indicated, operating the vessels nearly full (90% full is considered a full vessel) significantly improves potential profitability.

Table 3 – Summary of AMH Route Profitability Port to Port

Route #	Route Ports	Loads Basis	Design Number	Nominal RFR Port to Port ($ Per Unit)	RFR w/ all Discounts[1] Port to Port ($ per Unit)	Market Avg Rates w/ 30% Fuel Sur.[2] Port to Port ($ Per Unit)	Profit/(Loss) Nominal Port to Port ($ per Unit)	Profit/(Loss) w/ Discounts[1] Port to Port ($ per Unit)
B1	Maine to NY/NJ to SE New England	97% Full Load	11	$774	$542	$416	($359)	($126)
B1	Maine to NY/NJ to SE New England	2014 Base Load	11	$896	$627	$416	($481)	($212)
B1	Maine to NY/NJ to SE New England	98% Full Load	21	$733	$513	$416	($318)	($98)
B1	Maine to NY/NJ to SE New England	2014 Base Load	21	$792	$554	$416	($377)	($139)
B2A	Delaware River to Jacksonville	2014 Base Load	02	$3,424	$2,359	$1,049	($2,375)	($1,310)
B2A	Delaware River to Jacksonville	90% Full Load	02	$2,099	$1,419	$1,049	($1,050)	($370)
B2A	Delaware River to Jacksonville	2014 Base Load	06	$5,505	$3,783	$1,049	($4,456)	($2,734)
B2A	Delaware River to Jacksonville	90% Full Load	06	$1,800	$1,210	$1,049	($751)	($161)
B2B	Delaware River to Jacksonville	2014 Base Load	03	$2,774	$1,908	$910	($1,864)	($998)
B2B	Delaware River to Jacksonville	90% Full Load	03	$1,369	$907	$910	($459)	$3
B2C	Delaware River to Jacksonville	2014 Base Load	04	$2,516	$1,762	$910	($1,606)	($852)
B2C	Delaware River to Jacksonville	90% Full Load	04	$1,040	$690	$910	($130)	$220
B3A	Delaware River to Florida, 3 ports	2014 Base Load	05	$2,954	$2,104	$1,198	($1,756)	($906)
B3A	Delaware River to Florida, 3 ports	90% Full Load	05	$1,931	$1,354	$1,198	($733)	($156)
B3A	Delaware River to Florida, 3 ports	2014 Base Load	04	$3,242	$2,318	$1,198	($2,044)	($1,120)
B3A	Delaware River to Florida, 3 ports	90% Full Load	04	$1,857	$1,300	$1,198	($659)	($102)
B4	NY/NJ to Hampton Roads to Florida	2014 Base Load	12	$1,839	$1,323	$1,269	($570)	($54)
B4	NY/NJ to Hampton Roads to Florida	90% Full Load	12	$1,252	$882	$1,269	$17	$387
B4	NY/NJ to Hampton Roads to Florida	2014 Base Load	21	$1,719	$1,324	$1,269	($450)	($55)
B4	NY/NJ to Hampton Roads to Florida	90% Full Load	21	$1,087	$815	$1,269	$182	$454
B4	NY/NJ to Hampton Roads to Florida	90% Full Load	01	$2,513	$1,882	$1,269	($1,244)	($613)
C1A	Portland to LA	2014 Base Load (92% Ful Load)	05	$1,116	$731	$1,398	$282	$667
C1A	Portland to LA	2014 Base Load	13	$1,268	$867	$1,398	$130	$531
C1A	Portland to LA	90% Full Load	13	$1,068	$726	$1,398	$330	$672
C1B	Portland to LA	90% Full Load (< Base Load)	02	$2,356	$1,557	$1,607	($749)	$50
C2	Puget Sound to LA	2014 Base Load	03	$2,578	$1,754	$1,398	($1,181)	($357)
C2	Puget Sound to LA	90% Full Load	03	$2,171	$1,467	$1,398	($774)	($70)
C3	Portland to Richmond to LA	90% Full Load	04	$1,552	$1,108	$1,398	($155)	$290
C3	Portland to Richmond to LA	2014 Base Load	12	$1,427	$1,006	$1,398	($30)	$392
C3	Portland to Richmond to LA	90% Full Load	12	$1,354	$950	$1,398	$44	$448
C4A	Richmond to LA	2014 Base Load	01	$1,362	$994	$400	($962)	($594)
C4A	Richmond to LA	90% Full Load	01	$1,228	$891	$400	($828)	($491)
C4C	Richmond to LA	2014 Base Load	02	$2,295	$1,528	$460	($1,835)	($1,068)
C4C	Richmond to LA	90% Full Load	02	$1,145	$738	$460	($685)	($278)
D1	Tampa Bay to Brownsville	90% Full Load	11	$980	$686	$1,250	$270	$564
D1	Tampa Bay to Brownsville	90% Full Load	21	$876	$613	$1,250	$374	$637
D2	Delaware River to Houston	90% Full Load	04	$2,218	$1,553	$1,639	($579)	$86

Overall, the project met its goals to determine potential AMH routes, develop detailed requirements for vessels to service those routes, and design a broad portfolio of vessels suitable for the AMH trade. The economic analysis proved that there is potential for viable, profitable AMH operation on some routes, particularly if ways can be found to keep vessels full, discount costs, and increase market rates. This project is a first step in the development of the AMH concept, and suggestions are offered on how to continue the development process, at the end of the report.

B Overview of the American Marine Highway Design Project

The primary goal of this project was to develop a portfolio of concept level vessel designs that met the requirements of the more promising AMH services. As part of the design effort, estimates were to be developed of likely AMH services, cargo volumes and types, and the rates that could be charged. The construction and operation costs of the vessels were to be estimated and, from these, a required freight rate calculated and evaluated against the market rate prediction. The vessel design portfolio and cost information developed during this project is expected to be useful input to total transportation system cost/benefit models, so that policy makers can make more informed decisions. Operators should be able to use this information to develop their business models and evaluate the economic viability of new services, and government agencies will have information that can be useful, in evaluating what incentives may be needed to promote AMH services.

It was understood that there are many public and private stakeholders with interest in an AMH ship design effort. The research carried out for this project to determine the broad commercial market and operational needs considered input from a wide spectrum of stakeholders, as described in the reports for each phase.

The concept designs prepared for this project are intended to be ocean-going vessels suitable for coastwise trade, rather than for inland or river trade, that can also be useful to the military for sealift transport in times of national emergency (military dual-use). Since the vessels will operate in the US coastwise trade, they are required to be constructed in the US for US citizen owners in accordance with the Jones Act (Merchant Marine Act of 1920). Some of the vessel designs could also be suitable for joint service to both coastwise and non-contiguous Jones Act ports (e.g. Puerto Rico, Hawaii, or Alaska).

The project was divided into six (6) phases and a Final Report, as follows:

- Phase 1: Collect/Summarize AMH Service Descriptions and Vessel Performance Requirements – in this phase, the assessment of potential AMH markets, and determination of anticipated cargo types, cargo volumes, suitable routes and ports, and preparation of AMH vessel performance requirements, were carried out.
- Phase 2: Survey the Current Status of Marine Highway Vessel Designs – in this phase a survey and evaluation of AMH suitable vessels that have been proposed by designers, potential operators, and US shipyards was carried out. It was determined which features of existing designs were useful to include in the portfolio of designs of AMH suitable vessels.
- Phase 3: Collect Military Dual Use Requirements – vessel characteristics and/or features required to make a vessel attractive to DOD for sealift were identified.
- Phase 4: Summarize Environmental Performance Requirements and Recommendations – a list of recommendations for comprehensive environmental enhancement and performance to be included in the designs was prepared.
- Phase 5: Develop Vessel Matrix and Concept Designs – designs for eleven different AMH vessels covering a broad range of designs, suitable for reducing trailer and freight transport

over the road, were prepared. The designs ranged from ATB type tug/barges to high speed specialized vessels. The majority of vessels were in the mid-range, in terms of size and speed. Vessel designs were carried out to the concept level, and a summary matrix of design characteristics for all the designs was prepared, along with two-page data sheets, including a vessel general arrangement and stowage plan, for each design.

- Phase 6: Cost Estimates – appropriate build strategy, construction cost estimate, and required freight rate (RFR) was determined for each of the eleven designs. The RFR calculations covered the most promising routes developed as part of Phase 1. The RFR for each route and vessel design were compared to anticipated market rates for that service, to estimate whether the route and vessel are potentially profitable in the near future, and to determine what level of government support or incentives may be needed to make it profitable.
- Final Report – a report summarizing the project and its findings and conclusions was prepared. It provided an overview of the project, and presented conclusions about the findings and recommendations on how to proceed further with the development of suitable AMH services and vessels. Supplementing the Final Report as Appendices are the individual reports prepared for this project.

The eleven designs prepared for this project were divided into three cargo carrying categories: Roll on/Roll off (RoRo) type, RoRo/Container Carrier (Rocon) type, and Other type (a container feeder ship and a RoRo passenger ship (Ropax)). The designs were given numbers and names for easy identification. The design numbers follow three numeric series to differentiate between vessel categories, and for each category, the design number sequence counts up from the smallest to the largest TEU capacity.

- The six RoRo type vessels are Designs 01 to 06,
- The three Rocon type vessels are Designs 11 to 13,
- The two Other type vessels are a container feeder ship, Design 21, and a Ropax, Design 22.

Each design was given a name, and included in the name is an indication of the vessel type, its size or special characteristics, and its design speed. There are three size categories referenced in the design names for conventional RoRo and Rocon vessels: Small (500 TEU or less), Medium (between 500 TEU and 1000 TEU) and Large (1000 TEU or more).

C Assumptions

The key assumptions that formed the basis for carrying out the project are described below.

1) AMH vessels should be suitable to carry freight currently being carried over the road in trucks and trailers.
2) This was primarily a vessel design project and not a comprehensive assessment of the AMH market. The market assessment carried out was for the purpose of developing guidelines for what are suitable routes, schedules, service frequency, cargo traffic volumes, cargo types, and market rates for some of the more likely AMH services. Interviews could only be made with a limited number of shippers, potential operators, and other stakeholders, however, interviews included participants who operate on all the coasts of the US, so it was felt the scope of the interviews was wide enough for the concept level basis for this project. It is acknowledged that more in depth assessment of the AMH market and shipper requirements

can lead to different conclusions, regarding the AMH market. A more in depth analysis of the Pacific and Atlantic corridor AMH markets, the MARAD sponsored “M-5 an M-95 Corridor Studies”, is ongoing, and the results of those assessments may be used to update the conclusions in this report.

3) Vessel designs should be ocean-going vessels suitable for coastwise trade routes along the main coasts of the US (Atlantic, Pacific, and Gulf), and not for inland or short coastwise trades, which can be served well by tugs and barges.
4) As practical, vessel designs should incorporate features that will make them suitable for military dual-use, and incorporate the requirements issued by the US Navy for commercial vessels to be used for sealift transport.
5) Vessels will be constructed in the US, so as to be documented for coastwise service in accordance with the current requirements of US laws and regulations (Jones Act and USCG).
6) The benefits of incorporating technology, design services, equipment, and technical support from overseas can be considered in the design and construction estimates, so as to take advantage of the modern and efficient vessel designs and equipment available overseas, and the resulting reduction in construction costs for US shipyards.
7) Vessel financing cost estimates assume the availability of low interest, long term financing, such as that offered by the Maritime Administration under Title XI.
8) For the purposes of carrying out the economic viability analyses of potential AMH services, it was assumed an AMH service operator will be competing in a relatively free marketplace and have to offer competitive rates and service levels to attract freight traffic from already-established (truck and intermodal rail) modes, without any government mandates, taxes, or fees that would push shippers to use a marine highways mode of freight transport. This was considered a conservative basis for estimating the economic viability of AMH services and reflects current government policy. If, in the future, government policy directly incentivizes shippers to use a marine highway alternative, this could lead to higher cargo traffic volumes and higher rates, which would improve the economic viability of the AMH services that were discussed in this project, and could lead to greater interest in the private sector to enter this market. Similarly, any direct government financial support to AMH operators would also encourage entry into this market.
9) Current and projected future operating and manning requirements will be in effect when AMH services are started, in the next few years. Included in this assumption is the fact that the US ECA will be in effect starting in 2012 for operation within 200 miles of the coast. The ECA requires low sulfur fuel (including 0.1% sulfur fuel starting in 2015) be used so vessel designs are based on use of low sulfur marine gas oil or alternatively LNG fuel only, and do not include capability for low cost heavy fuel oil operation, since AMH vessels will always be operating within the ECA.

D Project Phases

The purpose of each project phase, the work that was accomplished, and the key findings and conclusions of each, are described below. The detailed reports are Appendices to this report.

D.1 Phase 1: Collect / Summarize AMH Service Descriptions and Vessel Performance Requirements

1) Surveys were conducted of prospective marine highway owner/operators, potential shippers, AMH advocacy groups and associations, and potential AMH ports. The interviews were primarily one-on-one discussions. About twenty-five trucking companies and potential AMH users were interviewed, plus eight potential AMH vessel operators, five ports, and several advocacy groups. Market analysis and trucking company interviews were carried out by a consultant who specializes in freight market analysis, Mercator International.
2) Existing published AMH reports and studies were reviewed. The goal of this research was to identify vessel performance characteristics required to meet commercial market and operational needs in the defined AMH services.
3) The surveys and literature search focused on the business models developed for the selected services in order to identify the key factors that define vessel requirements. These included cargo type, cargo volume, port selection, schedule requirements, and required transit speed to be competitive with other modes. Cargo handling and port infrastructure interface requirements or constraints were also collected. Tradeoffs between vessel design features (shipboard ramps or cranes, RoRo traffic patterns) and port facilities (shore-side ramps or loading barges, container cranes, staging areas, etc.) were noted.
4) It was decided to focus the interviews and the market analysis on the principal potential tradelanes for AMH that would require ocean-going commercial vessels. The most favorable tradelanes were found to be along the Pacific coast (MARAD M-5 Corridor) and along the Atlantic coast (MARAD M-95 Corridor). These were the two corridors that were the focus of the Mercator International market research. HEC also carried out market analysis of a Maine to New York/New Jersey service that was being developed by port and shipping interests in Maine, and services across the Gulf of Mexico and from the Gulf coast to the Mid-Atlantic region.
5) In order to have data on existing freight transport between selected regions of the country, with MARAD agreement, a region to region freight transport database, TRANSEARCH, was purchased from Global Insight, Inc. This covered freight transported in 2009. The TRANSEARCH data is broken down by Business Economic Areas (BEA's), as defined by the US Bureau of Economic Analysis. The purchased data covered freight transport between the BEA's for the Pacific Northwest and Southern California, and between the US Northeast and Florida and adjacent parts of Georgia. These were considered the most likely regions for AMH trade. Estimates were developed from the TRANSEARCH data on what cargo traffic between these regions could be suitable for AMH.
6) A second source of freight data was the results of the interviews with trucking and intermodal companies. These potential users of AMH provided estimates of their existing freight transport that would be most suitable for AMH and, based on market share estimates for these companies, the total market size could be extrapolated. The potential AMH market based on interviews was somewhat larger than that based on the TRANSEARCH data. The interview based estimates were taken as the primary basis for the market assessment because

they covered the current time frame, while the TRANSEARCH data covered 2009, a low point in freight transport, coinciding with the recession. The TRANSEARCH data was useful, however, to validate the interview data estimates. From the estimated total AMH suitable cargo traffic estimates, estimates were made, based on the interviews, of what percent of the traffic could be diverted to a marine service. It was found that less than 20% of the traffic and, in some cases, less than 10% would likely divert to AMH, at least in the initial years. There were various reasons given for this, including convenience, transit time, frequency of service, and cost.

7) The cargo volumes derived from current and recent freight transport data were extrapolated to 2014, which was designated as the base year for cargo volume estimates, since it will take several years to acquire vessels and set up and establish an AMH service. The economic and design decisions should be based on the cargo volumes in effect when the service is fully operational and not on current year estimates, to avoid any misleading conclusions. Estimates were also made of future growth in freight traffic volumes, and estimates for AMH volumes in 2020 were also prepared. These estimates are presented in Appendices 1 and 3, and are excerpted below in Table 4, for each of the AMH routes.

8) The results of the interviews and literature search are summarized in Appendix 1, a market assessment report of the principal AMH services for military dual-use suitable vessels. Mercator International provided key input to the preparation of this report. The market assessment report included recommendations on potential routes, schedule requirements, opportunities for diverting cargo to marine highway transportation, cargo traffic volume estimates, expected cargo types, and estimated market rates.

9) The data presented in Table 4 was used as the key input data for the development of the vessel designs, Appendices 7-9, and for the economic analysis, Appendix 10. Besides the estimates of likely AMH cargo traffic in the years 2014 and 2020, volumes for 2014 + 25% were also estimated. These were considered useful guidance for determining vessel design requirements, to ensure the vessels had sufficient capacity for seasonal variations in volumes, and for future volume growth. In Table 4 it is also indicated that the frequency of service can affect the weekly cargo volumes. Higher frequency of service (more calls at a port per week) is expected to increase cargo volumes, because of market perceptions, based on the interviews, that more frequent AMH service better meets shippers' needs.

10) Based on the market assessment and modern vessel design practices, General Vessel Performance Requirements, Appendix 2, and Service Specific Performance Requirements, Appendix 3, were prepared. Appendix 3 provides data on the anticipated cargo volumes, cargo types, routes, schedules, and recommended vessel designs for each of the analyzed AMH services. The basis for the service specific cargo volumes are summarized in Table 4. These two Appendices formed the basis for developing the vessel designs.

Table 4 - Estimated Cargo Volumes for Coastwise AMH Trades

Estimated Cargo Volumes - Headhaul Direction									
Route #	Route Ports	Port Calls/ Week	Head-haul[1]	2011 Est. Loads/Week	2014 Base Loads/Week	2014 +25% Loads/Week	2020 Base Loads/Week	% 53'	% 40'
Atlantic Corridor (M-95)									
B1	Maine to NY/NJ to SE New England	1	SB	500	556	695	626	20%	80%
B2A	Delaware River to Jacksonville	2	SB	260	289	361	325	80%	20%
B2B	Delaware River to Jacksonville	3	SB	312	347	434	390	80%	20%
B3A	Delaware River to Florida, 3 ports	2	SB	375	417	521	469	80%	20%
B3A	Delaware River to Florida, 3 ports	3	SB	450	500	626	563	80%	20%
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2	SB	375	417	521	469	60%	40%
B4	NY/NJ to Hampton Roads to Florida, 3 ports	3	SB	450	500	626	563	60%	40%
B4	Hampton Roads cargo [4]	2	SB	124	138	172	155	60%	40%
Pacific Corridor (M-5)									
C1A	Portland to LA	2	NB	595	667	834	751	80%	20%
C1B	Portland to LA	3	NB	710	796	995	896	80%	20%
C2	Puget Sound to LA	2	NB	360	404	505	454	80%	20%
C3	Portland to Richmond to LA, 3 ports	2	NB	665	746	932	839	80%	20%
C3	Portland to Richmond to LA, 3 ports	3	NB	798	895	1119	1007	80%	20%
C3	Richmond, CA cargo [4]	2	NB	219	246	308	277	80%	20%
C4A	Richmond, CA to LA, 16.5 knots	2	NB,SB	230	258	322	290	80%	20%
C4C	Richmond, CA to LA, 26 knots	6	NB,SB	600	672	840	756	80%	20%
Gulf Corridor (M-10/M-95)									
D1	Tampa Bay to Brownsville	1	EB	300	345	431	405	25%	75%
D2	Delaware River to Houston	2	NB	500	575	719	675	75%	25%

Notes:
1. Headhaul direction is direction with largest cargo volumes, SB = Southbound, NB = Northbound, EB = Eastbound
2. Loads are freight units with cargo. Frequency of service (more port calls per week) can increase perceived level of service and lead to higher market penetration by AMH, per interview comments.
3. Loads per vessel sailing are loads per week divided by the number of port calls per week.
4. Cargo listed for intermediate ports (i.e. Hampton Roads, VA, and Richmond, CA) are headhaul loads discharged and back-loaded in the intermediate port. These loads are in addition to the headhaul loads for the final destination port.
5. Route designations are from the schedules provided in the Service Specific Performance Requirements, Appendix 3.

D.2 Phase 2: Survey the Current Status of Marine Highway Vessel Designs

1) Numerous vessels and design options have been proposed for various AMH services by designers, potential operators, and US shipyards. These were surveyed, evaluated and summarized in a manner consistent with the vessel performance specifications.
2) Where applicable, desirable features from existing designs were incorporated into the AMH vessel designs developed for this project.
3) Vessel designs that were discussed in the Phase 2 Report, Appendix 4, are shown in Table 5.

Table 5 – List of Proposed AMH Suitable Vessels

Vessel Short Name	Type	Sponsor	Designer
Coastal Connect	RoRo	Coastal Connect, LLC	Robert Allan Ltd
HST 140	RoRo	CCDoTT	Herbert Engineering Corp.
HEC RoCon	RoCon	CCDoTT	Herbert Engineering Corp.
IML	RoRo	Intermodal Marine Line, LLC	STX Canada
Pasha-Hawaii	RoCon	Pasha Hawaii Transport Lines	Uljanik Shipyard
Fastship	RoRo	FastShip, Inc.	Thornycroft, Giles & Co., Inc.

D.3 Phase 3: Collect Military Dual Use Requirements

1) Discussions were carried out with appropriate DOD officials. They identified vessel characteristics and/or features that should be provided for a vessel to be attractive to meet DOD sealift needs. The results of the discussions and the military dual-use requirements are provided in Appendix 5.
2) The military dual-use requirements included requirements for ramps, deck strength, range, speed and vessel dimensions that would make a vessel fully suitable for sealift transport. The minimum requirements are summarized in Table 6.

Table 6 – Minimum Military Dual-Use Requirements for AMH Vessels

Minimum Range of 10,000 nautical miles at a speed of no less than 15 knots.
Maximum Length/Beam: The vessel should be capable of transiting the Panama Canal. Vessel’s requiring the widened Canal, which will allow vessel beam up to 160 ft, can be considered.
Maximum draft of 34 feet (10.35 m).
Minimum useable RoRo deck area of 96,000 ft^2 (8,920 m^2). The usable deck area available for vehicle stowage is defined as that internal deck area capable of stowing a standard vehicle having dimensions of 15.4 ft (4.7 m) long x 7.1 ft (2.2 m) wide.
Minimum deck strength of 350 psf (1.7 t/m^2) for 48,000 ft^2 (4,460 m^2), and 150 psf (0.75 t/m^2) elsewhere.
Minimum external ramp capability of 66 mt on stern ramp or side ramp.
External loading ramps must be self-deployed.
Fixed (non-slewing) stern ramp is not acceptable as the only means of access. A stern quarter ramp that permits access to a pier alongside the vessel is acceptable. The intent is for the vessel to have the capability to load and unload while moored alongside a pier.
Internal ramps/elevators for vertical cargo movement are required.
Minimum deck height (clear headroom) of 10 ft (3.05 m).

D.4 Phase 4: Summarize Environmental Performance Requirements and Recommendations

1) To complement the vessel performance specification, a set of requirements and recommendations for comprehensive environmental performance were developed.
2) These can be used for comparing the environmental impacts of the AMH ships and services to displaced land based transportation. The environmental requirements discussed in the Phase 4 Report, Appendix 6, included the following:
   a) Reduced harmful exhaust emissions.
   b) Reduced harmful liquid discharges.
   c) Using shore power while in port (cold ironing).
   d) LNG fuel to reduce emissions.
   e) Ballast water treatment to reduce introduction of alien species into coastal waters
   f) Reduced EEDI (Energy Efficiency Design Index) – IMO sponsored index applicable to new ships to measure the energy efficiency of ships. Goal values will be set for the index with which new ships should comply.
   g) Reduction and tracking of the use of Hazardous Material in the construction and operation of vessels.
   h) Designing vessels for ease of recycling at the end of their life.

D.5 Phase 5: Develop Vessel Matrix and Concept Designs

1) Based on the results of Phases 1 to 4, eleven (11) vessel designs were developed to meet the performance requirements for the selected AMH services.
2) The concept designs included enough detail to ensure technical feasibility and to prepare construction and operating cost data. Deliverables for each concept design included a table of principal characteristics, general arrangement profile and deck plan drawings, power estimate, lightship weight estimate, and loading analysis.
3) The mix of designs illustrated the range of possibilities for vessel loading schemes and ship to shore cargo handling systems that are available for these types of vessels. Most of the proposed vessels, particularly the RoRo vessels, can use any of a number of different ramp options, and the one shown in the vessel design is generally not the only option available.
4) The Phase 5 report, Appendix 7, describes in detail the methods used to develop the vessel designs and provides a description of each vessel including its particulars and capabilities. A summary of the vessel designs developed for this project is provided in Section E of this report.

D.6 Phase 6: Economic Analysis

1) For each vessel design a build strategy was proposed for the most cost effective way to build it. Construction cost estimates were prepared for each vessel, based on the selected build strategy and a cost range determined over which the construction price of each design could be expected to vary. A cost range is necessary, because pricing for commercial vessel construction in the US can vary significantly depending on the specifics of a vessel, where it is built, how many are built, and the competitive environment during the contract negotiation.

2) Construction and detail design costs were estimated using two independent cost models: Herbert Engineering Corp.'s (HEC) Ship Evaluation Program (SEP) and SPAR Associates' ESTI-MATE cost model. These two cost estimating methods are in general agreement.
3) For the majority of the vessels, particularly the conventional hull designs, a build strategy based on the US shipyard partnering with an overseas shipyard was proposed as the most cost effective approach. This strategy has been used in the last decade for most of the successful commercial ship construction projects in the US. The overseas shipyard would provide the vessel design, including the detail and production designs, supply most of the equipment, and provide production support and planning.
4) Costs for features which are not required for commercial operation, but are necessary or desirable for military dual-use (national defense features), were identified.
5) Selection was made of which vessels would operate in which of the proposed AMH services and, based on the vessel and service parameters, annual operating costs were estimated. Operating cost estimates assumed the availability of favorable capital financing, such as that offered by MARAD under Title XI, and US flag operation with union crews of about 18 to 20 persons per vessel, except for the ATB, which had a smaller crew of about 11. Because of the enactment of Emissions Control Areas (ECA), starting in 2012 for vessels operating out to 200 miles from the coast, fuel consumption costs were based on the use of high cost distillate fuels (marine gas oil). Included in the designs, where feasible, was the provision for the vessels to use LNG fuel, which can reduce fuel costs by about 30% and is very clean burning, in compliance with all current and anticipated emission regulations.
6) Using the estimated construction and operating costs, required freight rates were developed for each of the concept designs for the selected AMH routes. Required freight rates were developed under two rate scenarios: the port to port rate, which covers the costs from the loading port's terminal gate to the discharge port's terminal gate; and the door to door rate, which includes the landside drayage costs to/from the cargo destination and origination points to the port terminal. Required freight rates were compared to estimated market rates for each AMH service, and the potential profit or loss was estimated for each analyzed vessel and route combination. It was found that some services were potentially profitable although many were estimated to operate at a loss. The effects of methods to lower AMH costs, such as using LNG fuel, notional 50% construction cost reduction based on government support, and elimination of the Harbor Maintenance Tax, were evaluated for their effects on AMH required freight rates and profitability.
7) The results of the construction cost estimates and required freight rate calculations are included in the Phase 6 report, Appendix 10. Summaries of the construction costs and required freight rates are provided in Section F of this report.

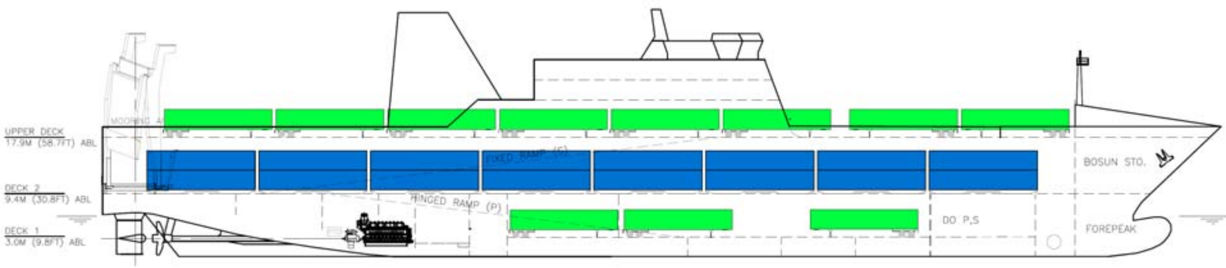
E Vessel Designs

The types of vessels suitable for AMH trade are generally not unique, but can be similar to ships already in service. Desirable features from existing designs, both vessels in service and proposed designs, were incorporated into the portfolio of new designs. The mix of designs was intended to cover the broad range of vessels that would best serve a coastwise freight transportation system intended to reduce truck traffic along the nation's highways. The vessels ranged in type from an ATB vessel to conventional RoRo vessels, to a high speed trimaran and a semi-planning hull Fastship design. They ranged in speed from 14 knots to nearly 30 knots. The designs were also intended to illustrate the range of possibilities for vessel loading schemes and ship to shore cargo handling systems that are available for these types of vessels. Most of the proposed vessels, particularly the RoRo vessels, can use any of a number of different ramp options, and the one shown in the vessel design is generally not the only option available. Ramp designs can be adjusted to suit the facilities and trade envisioned for a specific project. The Rocon type ships have stacked containers on the Upper Deck, and whether shore-based cranes or ship-based cranes are provided depends on the requirements of a project. Both options were shown among the proposed Rocon designs. For the high speed vessels, unique designs developed by others were adopted. This applies to the proposed designs for the High Speed Trimaran (Design 02) and for Fastship (Design 06). These two designs were selected because they are existing high speed designs for which much design effort had already been expended, and they seemed well suited for the requirements of this project. A special purpose Ropax (RoRo vessel with accommodation for 100 truck drivers), Design 22, was also included as one of the designs, to illustrate that a Ropax is a possible consideration for the AMH trade.

The proposed designs are all concept designs, without a high level of detail, and can be considered representative of the capabilities that could be provided in a vessel of the type proposed. Standard size trailers and containers are shown loaded on the vessels in the arrangement drawings, Appendix 9, and below; however, the vessels can accommodate a wide variety of trailer and container sizes, plus special and oversize cargoes.

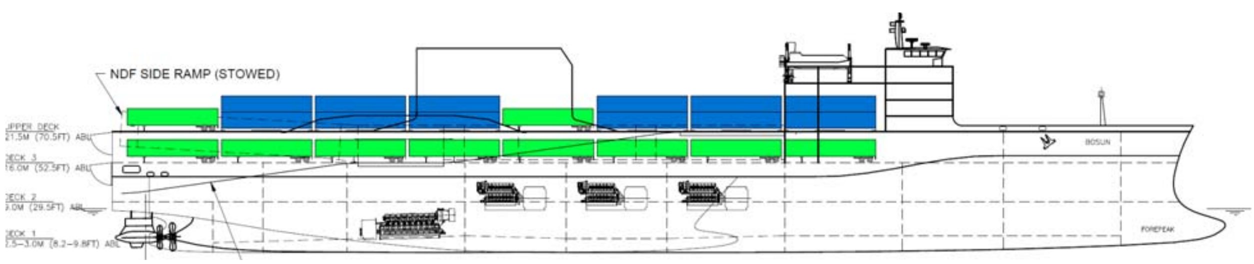
The profile view and main particulars of each of the eleven vessel designs prepared for this project are presented in the following sections. Further details of each design can be found in the Matrix of AMH Vessel Characteristics, Appendix 8, and the design datasheets, American Marine Highways Design Concepts, Appendix 9.

E.1 Vessel Design 01 – RoRo Small 18 kt



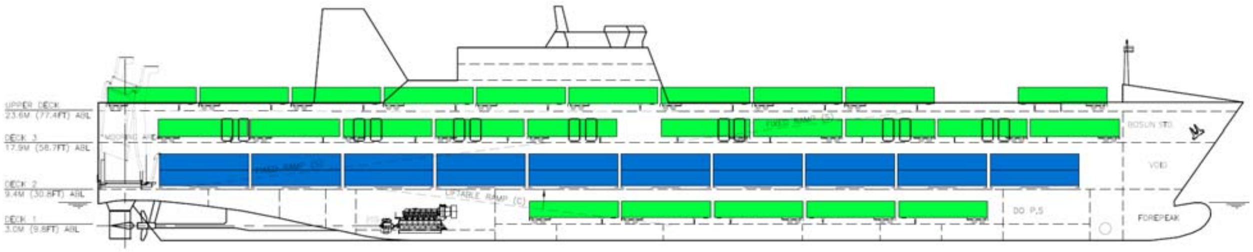
Length Overall	167.7 m (550.2 ft)
Beam	27.0 m (88.6 ft)
Design Draft	6.0 m (19.8 ft)
Design Speed	18.0 knots
TEU Capacity	423
Max 53’ Trailer Capacity	111 Trailers
Typical Full Load Container & Trailer Capacity	80 Containers (53’) 71 Trailers (53’)
RoRo Deck Area	6,934 m^2 (74,636 ft^2)
Type of Ramp	1 x Stern Quarter Ramp

Vessel Design 02 – RoRo Trimaran 29 kt



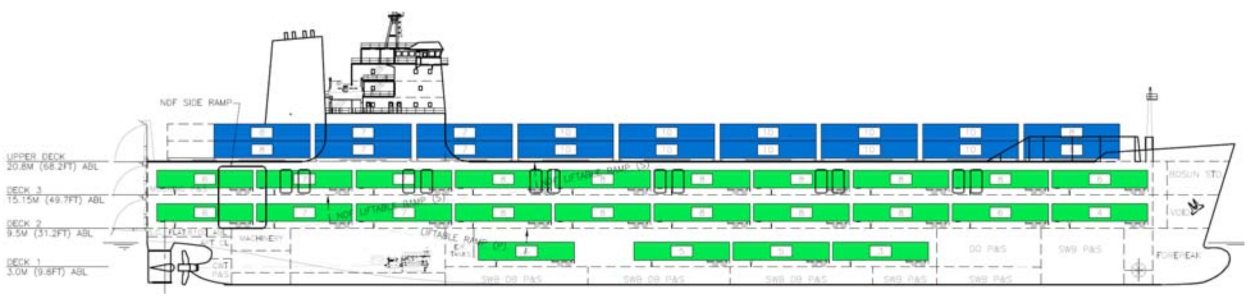
Length Overall	205.0m (672.6 ft)
Beam	40.6 m (133.2 ft)
Design Draft	8.2 m (26.9 ft)
Design Speed	28.5 knots
TEU Capacity	708
Max 53’ Trailer Capacity	184 Trailers
Typical Full Load Container & Trailer Capacity	138 Containers (53’) 115Trailers (53’)
RoRo Deck Area	9,850 m^2 (106,023 ft^2)
Type of Ramp	2 x Stern Flap Ramp 1 x NDF Multi-Level Side Ramp

E.2 Vessel Design 03 – RoRo Medium 24 kt



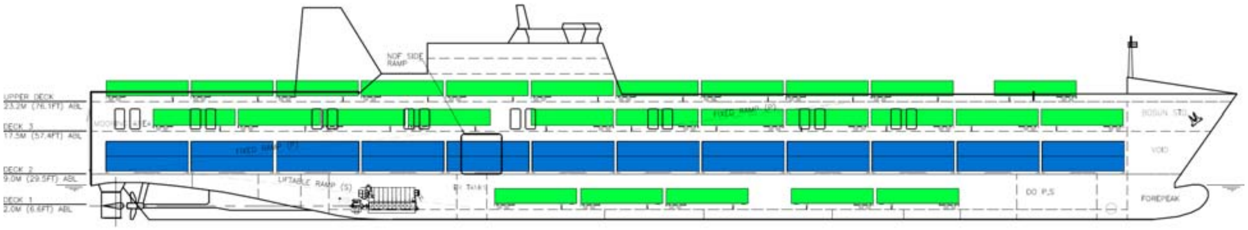
Length Overall	207.9 m (682.1 ft)
Beam	28.5 m (93.5 ft)
Design Draft	7.0 m (23.0 ft)
Design Speed	23.7 knots
TEU Capacity	714
Max 53' Trailer Capacity	203 Trailers
Typical Full Load Container & Trailer Capacity	104 Containers (53') 151 Trailers (53')
RoRo Deck Area	12,154 m^2 (130,822 ft^2)
Type of Ramp	1 x Stern Quarter Ramp

E.3 Vessel Design 04 – RoRo Medium 20 kt



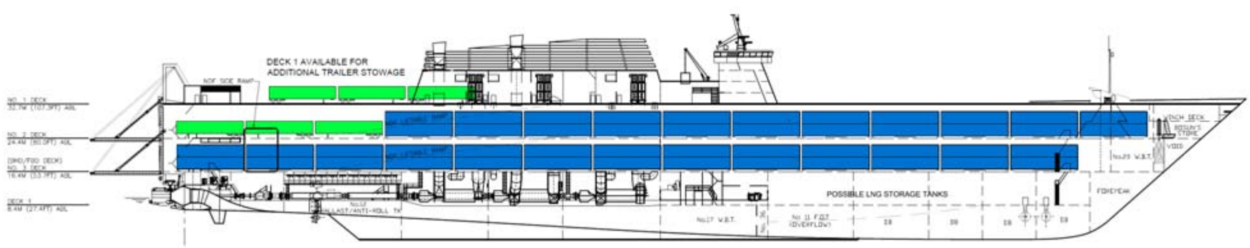
Length Overall	183.5 m (602.0 ft)
Beam	29.0 m (95.1 ft)
Design Draft	7.1 m (23.3 ft)
Design Speed	20.0 knots
TEU Capacity	879
Max 53' Trailer Capacity	234 Trailers
Typical Full Load Container & Trailer Capacity	160 Containers (53') 154 Trailers (53')
RoRo Deck Area	13,425 m^2 (144,503 ft^2)
Type of Ramp	3 x Stern Flap Ramps 1 x NDF Side Ramp

E.4 Vessel Design 05 – RoRo Large 21 kt



Length Overall	225.7 m (740.5 ft)
Beam	29.5 m (96.8 ft)
Design Draft	6.8 m (22.3 ft)
Design Speed	21.0 knots
TEU Capacity	960
Max 53’ Trailer Capacity	273 Trailers
Typical Full Load Container & Trailer Capacity	140 Containers (53’) 203 Trailers (53’)
RoRo Deck Area	15,433 m^2 (166,116 ft^2)
Type of Ramp	1 x Stern Flap Ramp 1 x NDF Side Ramp

E.5 Vessel Design 06 – RoRo Fastship 30 kt



Length Overall	265.0m (869.4 ft)
Beam	40.0 m (131.2 ft)
Design Draft	10.0 m (32.8 ft)
Design Speed	29.4 knots
TEU Capacity	1387
Max 53’ Trailer Capacity	280 Trailers
Typical Full Load Container & Trailer Capacity	440 Containers (53’ & 40’) 60Trailers (53’)
RoRo Deck Area	17,889 m^2 (192,552 ft^2)
Type of Ramp	1 x Stern Flap Ramp 1 x NDF Side Ramp

E.6 Vessel Design 11 – Rocon ATB Medium 14 kt

Length Overall (Tug/Barge)	215.7 m (707.7 ft)
Length Overall (Barge)	199.6 m (654.9 ft)
Beam (Barge)	32.2 m (105.6 ft)
Design Draft (Barge)	4.3 m (14.1 ft)
Design Speed	14.0 knots
TEU Capacity	886
Max 53’ Trailer Capacity	148 Trailers
Typical Full Load Container & Trailer Capacity	376 Containers (40’) 50 Trailers (mix of 53’ & 40’)
RoRo Deck Area	8,145 m^2 (87,627 ft^2)
Type of Ramp	1 x Side Ramp

E.7 Vessel Design 12 – Rocon Large 18 kt

Length Overall	181.7 m (596.1 ft)
Beam	32.2 m (105.6 ft)
Design Draft	6.8 m (22.4 ft)
Design Speed	18.3 knots
TEU Capacity	1159
Max 53’ Trailer Capacity	180 Trailers
Typical Full Load Container & Trailer Capacity	289 Containers (mix of sizes) 125 Trailers (53’)
RoRo Deck Area	11,934 m^2 (128,454 ft^2)
Type of Ramp	1 x Stern Quarter Ramp

E.8 Vessel Design 13 – Rocon Large 22 kt

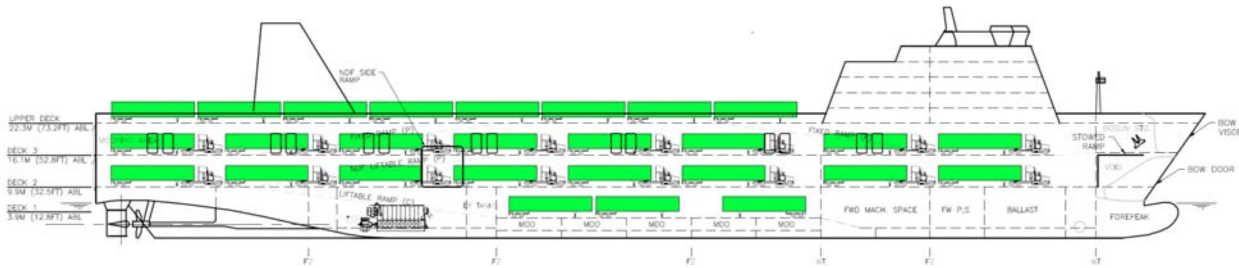
Length Overall	201.3 m (660.4 ft)
Beam	32.2 m (105.6 ft)
Design Draft	7.6 m (24.9 ft)
Design Speed	21.7 knots
TEU Capacity	1208
Max Trailer Capacity	145 Trailers (53’ & 40’)
Typical Full Load Container & Trailer Capacity	363 Containers (mix of sizes) 101 Trailers (53’ & 40’)
RoRo Deck Area	10,233 m^2 (110,145 ft^2)
Type of Ramp	1 x Stern Quarter Ramp

E.9 Vessel Design 21 – Container Feeder 18 kt

Length Overall	151.7 m (497.7 ft)
Beam (Barge0	24.8 m (81.4 ft)
Design Draft (Barge0	7.6 m (24.9 ft)
Design Speed	18.0 knots
TEU Capacity	826
Max Trailer Capacity	None
Typical Full Load Container & Trailer Capacity	392 Containers (mix of sizes)
RoRo Deck Area	None

Type of Ramp	None

E.10 Vessel Design 22 – Ropax Medium 22 kt



Length Overall	215.5 m (707.0 ft)
Beam	29.5 m (96.8 ft)
Design Draft	6.7 m (22.0 ft)
Design Speed	22.0 knots
Crew Size	35 persons
Passengers	100
TEU Capacity	510
Max 53' Trailer Capacity	182 Trailers
Typical Full Load Container & Trailer Capacity	105 Tractor-Trailers (53') 77 Trailers (53')
RoRo Deck Area	13,821 m^2 (148,762 ft^2)
Type of Ramp	2 x Stern Flap Ramp 1x Bow Door and Ramp 1x Bow Visor Door and Ramp 1 x NDF Side Ramp

F Costs and Required Freight Rates

Construction cost estimates and Required Freight Rate (RFR) analyses were carried out for the AMH vessels for the services most suitable for each of the designs. The construction cost estimates are based on construction in US Shipyards to comply with the Jones Act. Since not many vessels of the types proposed for AMH have been built in the US in recent years, the construction cost estimates are approximate costs derived from the costs to build other vessels in the US, and from adjusting the costs and man-hours to build similar vessels in overseas shipyards. As discussed in the report for Phase 6, Appendix 10, it has been found that a cost competitive strategy for building commercial ships in the US today, particularly for larger vessels, is for a US shipyard to have an overseas shipyard partner who provides a complete design package, planning and production assistance, material purchasing and some outfitting prefabrication. It is estimated fully integrating the technical support and purchasing support available from an overseas shipyard can lower the cost of a US built ship by 15% to 25% and provide greater certainty to the building schedule. One of the proposed designs, No. 11-Rocon-ATB, is a type of vessel built frequently in the US, and so a US based build strategy is assumed. Similarly, the specialized high speed vessels, Designs 02-Trimaran and 06-Fastship, are not based on existing vessels built overseas, so there will be less interest and capability by overseas shipyards for involvement in the construction of these vessels and more custom build strategies will likely be used for them. While construction costs in the US are higher than for overseas construction, financing the cost of construction is not the largest cost component in a vessel’s operation (assuming Title XI type financing is available) and, for that reason, may not be the deciding factor on whether a proposed AMH service can be viable.

The RFR as used in this project is the average rate that should be charged, on an annual basis, per freight unit transported so as to generate sufficient revenue to cover all the costs of operating a service. Costs include vessel ownership and operating costs, and the administrative and marketing costs to run the freight transportation service. The RFR’s were calculated by dividing total annual costs by annual number of freight units transported. The RFR is a break-even rate that covers all costs, including financing costs, and generates sufficient profit to provide a market return on invested equity.

The RFR calculations were made using two methods. For the Atlantic and Pacific Corridor routes they were based on the Center for the Commercial Deployment of Transportation Technologies (CCDoTT) AMH System Evaluation Model. This is a publically available program using discounted cash flow methodology. It was specifically developed by CCDoTT to evaluate AMH services. This RFR work was done by Dr. Matthew Tedesco, the model developer, under subcontract to HEC and to CDI Marine under a CCDoTT AMH project done in a coordinated effort between CCDoTT and MARAD. RFR’s for the Maine and Gulf routes were calculated using SPAR Associates ESTI-MATE cost model. SPAR also made independent checks on the CCDoTT/Tedesco RFR results to ensure the two models provided comparable results.

While some designs are suitable for several services, only the most favorable services for each type of vessel were analyzed, so as to focus on what are potentially the most viable services. The results of the RFR analyses were compared to the estimated market freight rates (target rates) for the same freight transport, port terminal to port terminal and door to door (cargo origination point to cargo destination point). Port to port rates would be of interest to truckers and intermodal providers who would provide the overall transportation service and were looking for an alternate mode for the long haul portion of the transit, similar to what intermodal rail offers. Door to door rates would be of interest to cargo owners and shippers who wanted to know the overall cost of transporting the cargo.

The RFR results were expressed as cost per freight unit shipped and as cost per statute mile for comparison to typical trucking freight rates for the same freight unit. At least initially, it is expected an AMH service will need to offer discounted pricing compared, to established landside modes of transport, including intermodal rail, in order to attract adequate cargo volumes. This is largely because of shippers' initial skepticism about its service level, and because it is likely it will not offer the same frequency of service as other modes, many of which offer daily or nearly daily service. For door to door rates, nominal drayage charges were added to the terminal to terminal rates. In actual service, drayage charges can vary significantly. This analysis indicated that established landside rates, particularly for intermodal rail, will be a very competitive benchmark for AMH service. To achieve profitable operation, at least initially, it may be necessary for there to be some type of government incentive program that encourages shippers to use AMH, so higher rates can be charged, or some form of financial support provided to lower operator costs. Considering the low rate environment, it was found that one key element to making AMH economically viable was keeping capacity utilization rates high (keeping the vessels full so maximum revenue is generated on each voyage). This can be achieved using vessels sized right for a particular service, and by finding ways to carry more freight units on the same size vessel, such as by carrying stacked containers.

Tables 7, 8 and 9 are taken from Appendix 10. Table 7 lists the estimated construction cost for each AMH design based on series construction of two to three vessels, with a high to low cost range also listed. Tables 8 and 9 show the RFR results of each proposed AMH service for the most likely combinations of route and vessel, plus estimated market rates and the resulting profitability of the service, both on a per freight unit basis and annually (Table 8 only). Table 8 is for port to port RFR and Table 9 is for door to door RFR. These tables lay out the basic cost and profitability findings of this project. These predictions are estimates, and there are many factors that could cause variances in the predicted results, so this should be taken as initial guidance only.

Table 7- Estimated Construction Costs for AMH Vessels – 2011 Pricing

Particulars (Input Data)	01-RoRo Small 18kt	02-RoRo Trimaran 29kt	03-RoRo Med 24kt	04-RoRo Med 20kt	05-RoRo Large 21kt	06-RoRo Fastship 30kt	11-ATB Rocon 14kt	12-Rocon Large 18kt	13-Rocon Large 22kt	21-Container Feeder 18kt	22-Ropax Med 22kt
Type	RoRo	RoRo	RoRo	RoRo	RoRo	RoRo	ATB RoCon	RoCon	RoCon	Containership	Ropax
LBP (m)	150.200	186.00	190.40	175.00	208.60	229.00	199.60	172.00	187.00	142.40	199.00
Beam (m)	27.000	40.60	26.50	29.00	29.50	40.00	32.20	32.20	32.20	24.80	29.50
Depth (m)	17.900	21.50	23.60	20.80	23.20	32.70	13.80	19.10	18.60	11.80	22.30
Design Speed (knots)	18.0	28.5	23.7	20.0	21.0	29.4	14.0	18.3	22.0	18.0	22.0
TEU Capacity (Loaded)	423	708	714	899	960	1,387	886	1,159	1,208	826	510
Propulsion System (2)	MS Diesel	MS Diesel Elect.	MS Diesel	MS Diesel	MS Diesel	Gas Turbine	MS Diesel	MS Diesel	LS Diesel	MS Diesel	MS Diesel
Fuel Type (4)	MGO & LNG	MGO	MGO & LNG	MGO & LNG	MGO & LNG	MGO & LNG	MGO	MGO & LNG	MGO	MGO	MGO & LNG
Rated Power, MCR (kW)	10,080	76,480	24,000	15,680	18,000	118,000	9,000	14,000	18,720	9,600	18,000
No. of Propellers	2	4	2	2	2	3	2	2	1	1	2
SSDG Installed Power (kW)	2,000	Part of Prop. kW	2,640	2,000	2,640	5,280	1,800	2,000	4,620	1,760	3,520
Lightship Weight (mt)	8,710	11,294	14,447	12,729	15,654	17,098	9,025	12,846	13,478	5,530	16,041
No. of Cabins	23	28	23	23	23	28	16	23	23	23	115
Cost Summary Estimates											
in millions of US $	**01-RoRo Small 18kt**	**02-RoRo Trimaran 29kt**	**03-RoRo Med 24kt**	**04-RoRo Med 20kt**	**05-RoRo Large 21kt**	**06-RoRo Fastship 30kt**	**11-ATB Rocon 14kt**	**12-Rocon Large 18kt**	**13-Rocon Large 22kt**	**21-Container Feeder 18kt**	**22-Ropax Med 22kt**
SHIP PRICE (1st of Class)	$142,764,019	$344,823,533	$216,933,327	$186,758,719	$210,372,302	$404,339,486	$131,521,261	$189,655,412	$183,272,674	$99,259,593	$244,668,281
SHIP PRICE (2nd of Class)	$113,749,118	$301,316,123	$175,984,155	$150,923,443	$170,679,763	$356,575,104	$114,499,066	$153,403,509	$148,119,794	$76,999,928	$196,896,057
AVERAGE PRICE PER SHIP	$128,256,568	$323,069,828	$196,458,741	$168,841,081	$190,526,032	$380,467,295	$123,010,164	$171,529,460	$165,696,234	$88,129,760	$220,782,169
SHIP PRICE (1st of Class)	$142,764,019	$344,823,533	$216,933,327	$186,758,719	$210,372,302	$404,339,486	$131,521,261	$189,655,412	$183,272,674	$99,259,593	$244,668,281
SHIP PRICE (2nd of Class)	$113,749,118	$301,316,123	$175,984,155	$150,923,443	$170,679,763	$356,575,104	$114,499,066	$153,403,509	$148,119,794	$76,999,928	$196,896,057
SHIP PRICE (3rd of Class)	$110,233,761	$263,334,120	$170,710,021	$146,235,166	$165,351,519	$312,045,237	$98,233,233	$148,632,632	$143,403,063	$74,629,621	$190,883,238
AVERAGE PRICE PER SHIP	$122,248,966	$303,157,925	$187,875,834	$161,305,776	$182,134,528	$357,653,276	$114,751,187	$163,897,184	$158,265,177	$83,629,714	$210,815,858
Estimated by	HEC SEP	ESTI-MATE	HEC SEP	HEC SEP	HEC SEP	ESTI-MATE	ESTI-MATE	HEC SEP	HEC SEP	HEC SEP	HEC SEP
Cost Range Estimates											
in millions of US $	**01-RoRo Small 18kt**	**02-RoRo Trimaran 29kt**	**03-RoRo Med 24kt**	**04-RoRo Med 20kt**	**05-RoRo Large 21 kt**	**06-RoRo Fastship 30kt**	**11-ATB Rocon 14kt**	**12-Rocon Large 18kt**	**13-Rocon Large 22kt**	**21-Container Feeder 18 kt**	**22-Ropax Med 22kt**
Ship Price (one of 2 ships)	**$128**	**$323**	**$196**	**$169**	**$191**	**$380**	**$123**	**$172**	**$166**	**$88**	**$221**
Lower bound estimate	$115	$291	$177	$152	$171	$342	$111	$154	$149	$81	$199
Upper bound estimate	$141	$372	$216	$186	$210	$438	$135	$192	$186	$95	$254
Ship Price (one of 3 ships)	**$122**	**$301**	**$188**	**$161**	**$182**	**$357**	**$114**	**$164**	**$158**	**$84**	**$211**
Lower bound estimate	$110	$271	$169	$145	$164	$321	$103	$148	$142	$77	$190
Upper bound estimate	$134	$347	$207	$177	$200	$410	$126	$184	$177	$90	$242
Uncertainty (ROM) (5)	-10%/+10%	-10%/+15%	-10%/+10%	-10%/+10%	-10%/+10%	-10%/+15%	-10%/+10%	-10%/+12%	-10%/+12%	-8%/+8%	-10%/+15%

Notes:
1. Construction Cost Estimates assume U.S. Large or Mid-Tier Shipyard Construction with Overseas Shipyard design, purchasing and support package.
2. LS Diesel is Low Speed Diesel with fixed pitch propeller. MS Diesel is Medium Speed Diesel with controllable pitch propeller.
3. Vessel arrangements and capacities per HEC concept arrangements.
4. Vessels indicated with LNG Fuel have LNG suitable engines suitable, but assumed without LNG storage tanks at new construction. LNG suitable engines cost about 30% more on a per kW basis compared to medium speed engines without the LNG option.
5. Containerships have lower cost uncertainty because they are similar to standard designs, RoRo and more so Rocon have increasing uncertainty on high side because they are custom designs with higher structural complexity. High Speed vessels have highest uncertainty on cost.
6. Conventional ships constuction costs were estimated by the HEC Ship Evaluation Program (SEP), while unconventional ships were estimated by the SPAR Associates ESTI-MATE program.

Table 8 - Comparison of Port to Port RFR Results to Estimated Market Rates – All Routes

Route #	Route Ports	Loads Basis	Port Calls/ Week	Design Number	Nominal RFR Port to Port ($ Per Unit)	RFR w/ all Discounts[1] Port to Port ($ per Unit)	Market Avg Rates w/ 30% Fuel Sur.[2] Port to Port ($ Per Unit)	Profit/(Loss) Nominal Port to Port ($ per Unit)	Profit/(Loss) w/ Discounts[1] Port to Port ($ per Unit)	Profit/(Loss) Nominal Port to Port ($ per Year)	Profit/(Loss) w/ Discounts[1] Port to Port ($ per Year)
B1	Maine to NY/NJ to SE New England	97% Full Load	1	11	$774	$542	$416	($359)	($126)	-	-
B1	Maine to NY/NJ to SE New England	2014 Base Load	2	11	$896	$627	$416	($481)	($212)	-	-
B1	Maine to NY/NJ to SE New England	98% Full Load	1	21	$733	$513	$416	($318)	($98)	-	-
B1	Maine to NY/NJ to SE New England	2014 Base Load	2	21	$792	$554	$416	($377)	($139)	-	-
B2A	Delaware River to Jacksonville	2014 Base Load	2	02	$3,424	$2,359	$1,049	($2,375)	($1,310)	($68,875,000)	($37,990,000)
B2A	Delaware River to Jacksonville	90% Full Load	2	02	$2,099	$1,419	$1,049	($1,050)	($370)	($50,610,000)	($17,834,000)
B2A	Delaware River to Jacksonville	2014 Base Load	2	06	$5,505	$3,783	$1,049	($4,456)	($2,734)	($129,224,000)	($79,286,000)
B2A	Delaware River to Jacksonville	90% Full Load	2	06	$1,800	$1,210	$1,049	($751)	($161)	($71,044,600)	($15,230,600)
B2B	Delaware River to Jacksonville	2014 Base Load	3	03	$2,774	$1,908	$910	($1,864)	($998)	($38,055,424)	($20,375,168)
B2B	Delaware River to Jacksonville	90% Full Load	3	03	$1,369	$907	$910	($459)	$3	($19,630,512)	$128,304
B2C	Delaware River to Jacksonville	2014 Base Load	3	04	$2,516	$1,762	$910	($1,606)	($852)	($26,081,440)	($13,836,480)
B2C	Delaware River to Jacksonville	90% Full Load	3	04	$1,040	$690	$910	($130)	$220	($5,460,000)	$9,240,000
B3A	Delaware River to Florida, 3 ports	2014 Base Load	2	05	$2,954	$2,104	$1,198	($1,756)	($906)	($36,700,400)	($18,935,400)
B3A	Delaware River to Florida, 3 ports	90% Full Load	2	05	$1,931	$1,354	$1,198	($733)	($156)	($23,969,100)	($5,101,200)
B3A	Delaware River to Florida, 3 ports	2014 Base Load	3	04	$3,242	$2,318	$1,198	($2,044)	($1,120)	($34,134,800)	($18,704,000)
B3A	Delaware River to Florida, 3 ports	90% Full Load	3	04	$1,857	$1,300	$1,198	($659)	($102)	($19,770,000)	($3,060,000)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2014 Base Load	2	12	$1,839	$1,323	$1,269	($570)	($54)	($15,844,290)	($1,501,038)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	2	12	$1,252	$882	$1,269	$17	$387	$893,095	$20,331,045
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2014 Base Load	2	21	$1,719	$1,324	$1,269	($450)	($55)	($12,508,650)	($1,528,835)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	2	21	$1,087	$815	$1,269	$182	$454	$8,544,718	$21,314,846
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	3	01	$2,513	$1,882	$1,269	($1,244)	($613)	($23,825,088)	($11,740,176)
C1A	Portland to LA	2014 Base Load (92% Ful Load)	2	05	$1,116	$731	$1,398	$282	$667	$9,418,800	$22,277,800
C1A	Portland to LA	2014 Base Load	2	13	$1,268	$867	$1,398	$130	$531	$4,342,000	$17,735,400
C1A	Portland to LA	90% Full Load	2	13	$1,068	$726	$1,398	$330	$672	$13,596,000	$27,686,400
C1B	Portland to LA	90% Full Load (< Base Load)	3	02	$2,356	$1,557	$1,607	($749)	$50	($25,271,260)	$1,687,000
C2	Puget Sound to LA	2014 Base Load	2	03	$2,578	$1,754	$1,398	($1,181)	($357)	($23,836,000)	($7,191,200)
C2	Puget Sound to LA	90% Full Load	2	03	$2,171	$1,467	$1,398	($774)	($70)	($18,783,900)	($1,676,700)
C3	Portland to Richmond to LA, 3 ports	90% Full Load	3	04	$1,552	$1,108	$1,398	($155)	$290	($6,144,600)	$11,571,000
C3	Portland to Richmond to LA, 3 ports	2014 Base Load	2	12	$1,427	$1,006	$1,398	($30)	$392	($1,438,661)	$19,446,728
C3	Portland to Richmond to LA, 3 ports	90% Full Load	2	12	$1,354	$950	$1,398	$44	$448	$2,311,540	$23,535,680
C4A	Richmond to LA	2014 Base Load	2	01	$1,362	$994	$400	($962)	($594)	($29,582,280)	($18,473,832)
C4A	Richmond to LA	90% Full Load	2	01	$1,228	$891	$400	($828)	($491)	($28,439,424)	($16,982,784)
C4C	Richmond to LA	2014 Base Load	6	02	$2,295	$1,528	$460	($1,835)	($1,068)	($71,791,104)	($41,631,744)
C4C	Richmond to LA	90% Full Load	6	02	$1,145	$738	$460	($685)	($278)	($60,061,056)	($25,788,928)
D1	Tampa Bay to Brownsville	90% Full Load	1	11	$980	$686	$1,250	$270	$564	$10,485,774	$21,903,617
D1	Tampa Bay to Brownsville	90% Full Load	1	21	$876	$613	$1,250	$374	$637	$13,349,107	$22,729,175
D2	Delaware River to Houston	90% Full Load	2	04	$2,218	$1,553	$1,639	($579)	$86	($16,886,586)	$2,511,488

Notes:

1. Discounted RFR include cost reductions from LNG fuel, 50% construction cost reduction, and elimination of Harbor Maintenance Tax.
2. Average Market Rate is average of estimated rates for headhaul and backhaul direction and includes adjustment of backhaul rates for empties (particularly D1).

Table 9 - Comparison of Door to Door RFR Results to Estimated Market Rates – All Routes

Route #	Route Ports	Loads Basis	Port Calls/ Week	Design Number	Nominal RFR Door to Door[2] ($ Per Unit)	Statute Miles Port to Port	RFR Nominal Door to Door[2] ($ Per Mile)	Market Avg Rates w/30% Fuel Sur.[1] Door to Door ($ Per Unit)	Market Avg Rates w/ 30% Fuel Sur.[1] Door to Door ($ Per Mile)	Profit/(Loss) Nominal Door to Door ($ per Unit)
B1	Maine to NY/NJ to SE New England	97% Full Load	1	11	$1,074	318	$3.38	$716	$2.25	($359)
B1	Maine to NY/NJ to SE New England	2014 Base Load	2	11	$1,196	318	$3.76	$716	$2.25	($481)
B1	Maine to NY/NJ to SE New England	98% Full Load	1	21	$1,033	318	$3.25	$716	$2.25	($318)
B1	Maine to NY/NJ to SE New England	2014 Base Load	2	21	$1,092	318	$3.43	$716	$2.25	($377)
B2A	Delaware River to Jacksonville	2014 Base Load	2	02	$3,730	847	$4.40	$1,349	$1.59	($2,381)
B2A	Delaware River to Jacksonville	90% Full Load	2	02	$2,386	847	$2.82	$1,349	$1.59	($1,037)
B2A	Delaware River to Jacksonville	2014 Base Load	2	06	$5,805	847	$6.85	$1,349	$1.59	($4,456)
B2A	Delaware River to Jacksonville	90% Full Load	2	06	$2,140	847	$2.53	$1,349	$1.59	($791)
B2B	Delaware River to Jacksonville	2014 Base Load	3	03	$3,087	847	$3.64	$1,210	$1.43	($1,877)
B2B	Delaware River to Jacksonville	90% Full Load	3	03	$1,639	847	$1.94	$1,210	$1.43	($429)
B2C	Delaware River to Jacksonville	2014 Base Load	3	04	$2,930	847	$3.46	$1,210	$1.43	($1,720)
B2C	Delaware River to Jacksonville	90% Full Load	3	04	$1,299	847	$1.53	$1,210	$1.43	($89)
B3A	Delaware River to Florida, 3 ports	2014 Base Load	2	05	$3,256	1179	$2.76	$1,498	$1.27	($1,758)
B3A	Delaware River to Florida, 3 ports	90% Full Load	2	05	$2,208	1179	$1.87	$1,498	$1.27	($710)
B3A	Delaware River to Florida, 3 ports	2014 Base Load	3	04	$3,552	1179	$3.01	$1,498	$1.27	($2,054)
B3A	Delaware River to Florida, 3 ports	90% Full Load	3	04	$2,228	1179	$1.89	$1,498	$1.27	($730)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2014 Base Load	2	12	$2,007	1261	$1.59	$1,569	$1.24	($438)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	2	12	$1,412	1261	$1.12	$1,569	$1.24	$157
B4	NY/NJ to Hampton Roads to Florida, 3 ports	2014 Base Load	2	21	$1,895	1261	$1.50	$1,569	$1.24	($326)
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	2	21	$1,249	1261	$0.99	$1,569	$1.24	$320
B4	NY/NJ to Hampton Roads to Florida, 3 ports	90% Full Load	3	01	$2,703	1261	$2.14	$1,569	$1.24	($1,134)
C1A	Portland to LA	2014 Base Load (92% Ful Load)	2	05	$1,375	998	$1.38	$1,698	$1.70	$323
C1A	Portland to LA	2014 Base Load	2	13	$1,535	998	$1.54	$1,698	$1.70	$163
C1A	Portland to LA	90% Full Load	2	13	$1,322	998	$1.32	$1,698	$1.70	$376
C1B	Portland to LA	90% Full Load (< Base Load)	3	02	$2,634	998	$2.64	$1,907	$1.91	($727)
C2	Puget Sound to LA	2014 Base Load	2	03	$2,857	1159	$2.47	$1,698	$1.46	($1,160)
C2	Puget Sound to LA	90% Full Load	2	03	$2,438	1159	$2.10	$1,698	$1.46	($741)
C3	Portland to Richmond to LA, 3 ports	90% Full Load	3	04	$1,717	998	$1.72	$1,698	$1.70	($20)
C3	Portland to Richmond to LA, 3 ports	2014 Base Load	2	12	$1,589	998	$1.59	$1,698	$1.70	$109
C3	Portland to Richmond to LA, 3 ports	90% Full Load	2	12	$1,514	998	$1.52	$1,698	$1.70	$184
C4A	Richmond to LA	2014 Base Load	2	01	$1,630	407	$4.00	$700	$1.72	($930)
C4A	Richmond to LA	90% Full Load	2	01	$1,494	407	$3.67	$700	$1.72	($794)
C4C	Richmond to LA	2014 Base Load	6	02	$2,569	407	$6.31	$760	$1.87	($1,809)
C4C	Richmond to LA	90% Full Load	6	02	$1,456	407	$3.58	$760	$1.87	($696)
D1	Tampa Bay to Brownsville	90% Full Load	1	11	$1,280	1336	$0.96	$1,550	$1.16	$270
D1	Tampa Bay to Brownsville	90% Full Load	1	21	$1,176	1336	$0.88	$1,550	$1.16	$374
D2	Delaware River to Houston	90% Full Load	2	04	$2,518	1551	$1.62	$1,939	$1.25	($579)

Notes:

1. Average Market Rate is average of estimated rates for headhaul and backhaul direction and includes adjustment of backhaul rates for empties (particularly D1).
2. Door to Door rates include a nominal charge for drayage. In actual service, drayage charges will vary depending on the actual distances traveled

G Discussion of Issues

There are many issues that affect the findings, estimations, predictions, and conclusions of a wide ranging analysis of an entire market segment, such as were done for this project. In particular, the market and economic analyses attempted to predict the performance of a new mode of transport in the US, the coastwise marine transportation of freight cargo normally transported by truck and rail. Since there is no existing experience and market history to go by, this leads to a degree of uncertainty with regard to any findings or conclusions that are made about the market for AMH services. The proposed vessel designs, in general, follow general trends for similar designs already in service or proposed, so there is more certainty with regard to data presented for them. Some of the key issues and difficulties that arose with this project are discussed below.

Uncertainty of Freight Availability and Market Rates

In the last 50 years or longer, there has not been a long distance coastwise freight transportation service (for freight that normally goes by truck or rail) in use along the coasts of the US, except for some barge services and a few smaller efforts or start up efforts that did not operate for a long period of time. This means the domestic freight transportation industry has been truck and rail oriented, with little or no experience with domestic marine transportation (except for the petroleum and bulk cargo trades), and has not considered it for its business plans. It also means there is no current or recent historical data from which usages and trends can be estimated. As a result, the discussions with potential users for such a service have been based on “what if” scenarios, typically based on the proposition that if a service were made available with certain designated characteristics, what is one’s interest in using it and what rates, schedule, and features would make it more attractive. Since the shippers have no experience to judge this new service, as would be expected, their answers during interviews tend to be speculative and without commitment. It is unlikely any would sign multi-year contracts to use an AMH service, which an AMH operator would like to see before making the large investment needed to start a service. As a result of this lack of commitment by shippers, estimates of potential AMH market penetrations can vary significantly, depending on the point of view of the person making the estimate and his perception of how receptive the freight market will be to this new mode of transport. For the purposes of this analysis, relatively conservative estimates were made of the potential AMH market volumes, but even these have no certainty that they are minimum volumes, particularly during AMH’s initial years. Also, certain segments of the market, based on interview comments, have been considered unlikely to use a marine service. This particularly applies to refrigerated cargo (fresh fruits and vegetables, plus frozen meats and seafood). This type of cargo tends to be high value, time sensitive, and is a large export cargo from the US Southeast to other parts of the country. During interviews with trucking companies and a few shipper interviews, it was generally the opinion that little of this freight would go by AMH, because of the need for fast and certain transit times, the multi-point routes taken, and the desire to retain control over the trailers. For this reason, the AMH cargo volume estimates used in this analysis included only small amounts of refrigerated cargo, however, if a fast and reliable AMH service with sailings three or more days per week were in operation, with cost competitive rates, it may turn out that the refrigerated freight transport market does find this an attractive option and ends up diverting a significant market share to AMH. It is, therefore, hard to predict at this time what will be the market reactions to real services, once they have become established.

Thus, it can be concluded that the AMH cargo volumes are very sensitive to the perceived reliability of the service, rates, frequency of service, and the difficulties and costs of landside alternative transport. Rising costs, congestion, and difficulty in finding drivers could raise the costs to shippers of landside transportation and make AMH transport more attractive. How much the costs and inconveniences of landside transport will increase over the years is also hard to predict at this time.

The rates that could be charged are also uncertain, and in particular, the potential reaction by intermodal rail to a marine alternative that uses a similar business model, could have a major impact on AMH rates. Ideally, an AMH business strategy that complements existing, challenged transport modes, where possible, would be the most advantageous. Since rail lines have the ability to control how costs are allocated, they can undercut rates on any service where they perceive AMH is a competitive threat. A similar issue is the drayage costs for the cargo to and from the ports. This can vary significantly, and will directly affect the overall cost of using an AMH service. In summation, the lack of reliable and predictable estimates of freight availability and market rates means the economic analyses made for this project have a significant degree of uncertainty to them.

Impacts of Government Policy

Government policy can have a major impact on the viability of AMH services. A few of the government policy issues that could affect AMH are discussed below.

- Availability of government financial support for the construction costs of AMH ships. If such support were to be made available, it is likely it would focus on the costs of National Defense Feature (NDF) enhancements to meet minimum military dual-use capabilities. If financial support is provided by the government, there may be a requirement to enroll the vessel in programs that make it available for call-up in times of national emergency. Another potentially available means of government financial support is low cost, long term financing, such as the Title XI finance underwriting program and the ability to use Capital Construction Funds (CCF). Other forms of government guarantees or incentives for investment in AMH vessels could also be made available.
- Availability of government incentives that would promote the use of a marine transportation as an alternative to landside transport. Incentives, conceivably, could consist of tax credits to shippers who use AMH, higher road use taxes and fees that are not charged to users of AMH, carbon taxes or incentives (with the assumption being that AMH would use less carbon per freight unit transported than trucks), and others.
- Government investment in port facilities to create marine terminals well-laid out for AMH type vessels and cargoes and for rapid loading and unloading of these vessels. Since most AMH vessels handle some or all of their cargo by RoRo means having piers set up for rapid handling of RoRo cargo, including the installation of custom designed shore ramps that line up with ramps on the vessels, is of great advantage. Also advantageous would be space for storing RoRo cargo at the terminals and for expedited transit in and out of the terminal area with good connections to road and rail service.
- Government policies that affect cost, congestion and ease of use of over the road truck and intermodal rail. As the costs and difficulties of using landside freight transportation increase, the greater the attractiveness of AMH, and potentially the higher the rates that can be charged.

- Continuation of Jones Act domestic construction and ownership requirements. If there is any easing of the Jones Act domestic requirements, such as by Congressional action, this could affect the estimated costs for AMH startup and operation, particularly if foreign built vessels are allowed, even if for limited periods of time.
- Government funding and support of studies, advocacy groups and workshops for the promotion of AMH. This would include government funded market assessment studies, vessel design studies, and economic analyses. Such efforts can help inform shippers about AMH and provide valuable information and expertise to potential AMH operators.

Trailers versus Containers

As discussed in this project, one of the primary reasons for setting up a marine highways freight transportation system is to remove freight from congested highways and to reduce the environmental impact of long haul freight transport by shifting that freight to modes of transport that produce less emissions. The most direct way to do that is to transport by ship the same over the road trailers as used on the highway. However, transporting trailers on a ship is not an efficient use of the ship's cargo volume, since trailers cannot be stacked and there is lost volume under the trailers, because of the height of the wheels. A much more efficient way to transport the same cargo volume is to remove the cargo container from the wheels and stack it aboard the ship, in the way that international freight containers are carried. Significantly more revenue-generating freight units can be stowed on the same size and cost vessel if the cargo is stacked containers versus RoRo trailers. Handling containers by LoLo can add to the costs compared to cargo handling by RoRo only, but the added revenue from the extra cargo can likely more than make up the difference. The transport of containers stacked two high on cassettes that are driven onboard using special trailers, and landed on RoRo decks with adequate clear deck height (about 7.3 m or 23.5'), is an alternate way to carry some containers on RoRo vessels. The cassettes provide a method to increase the number of revenue generating freight units on a RoRo vessel without requiring the use of cranes for LoLo container handling. For this reason, the use of cassettes is indicated on most of the proposed RoRo designs developed for this project. However, cassettes are normally stowed only on the deck with the shore ramp, since it is difficult to install internal ramps with the required clear height, and low inclination angle, needed for the cassettes.

Either way, by stacking containers and using cranes, or carrying containers on cassettes, there is advantage in transporting containers over transporting only trailers in terms of the number of freight units that can be carried on the same vessel. To increase container transport on a wide scale basis will require converting the US domestic freight transportation system from one based on standard trailers to one based on domestic and international containers. This is happening to some extent over time, since the intermodal transport of domestic containers by rail has been found to be cost effective for long haul transport (such as transcontinental), and the trucking and freight transportation industry is slowly making this change on its own. The rate of change to containers has a major impact on AMH vessel design. A rapid change would allow near term investment in cost effective Rocon type vessels and allow lower RFR rates to be achieved, making AMH potentially more cost competitive.

H Conclusions and Recommendations

Several key conclusions can be drawn from the work done for this project. As was identified in the reports, there is still a significant degree of uncertainty about how to best initiate American Marine

Highways services so as to achieve the goal of transporting more of the nation's freight by the more environmentally friendly marine transportation system, and reduce the congestion and wear and tear on the nation's highway systems. This project did meet its goal to provide a broad range of vessel designs to demonstrate the variety of vessel types and arrangements that could serve an AMH system, and provides information on the potential markets, and economic analyses of the viability of the proposed vessels.

H.1 Conclusions

The following are some of the key conclusions that can be drawn from the work done on this project.

1) A potential market for AMH services does exist. The size of this market depends on the level of service offered. Any AMH service should offer its users schedules, frequency of service, and rates competitive with that available on land, to attract cargo. It is believed that opportunities exist for AMH services to offer the required competitive level of service.

2) No one size and type of vessel is most suitable for AMH. As shown in this analysis, a wide range of vessel sizes and types can meet the varied requirements for individual AMH services. The right vessel should be developed for each specific service, as the profitability of a service can vary greatly, depending on whether the proposed vessel is the right size, type, and speed for the intended service.

3) The eleven different designs developed for this project, ranging from ATB type vessels to standard RoRo vessels, to high speed specialized vessels, are all technically feasible to build and operate. All are based on off-the-shelf technology, so they can be constructed and operated in a cost competitive way. Cost competitiveness of the designs can be enhanced by using existing designs to form the baseline for a new AMH vessel design, and consideration should be made to incorporate the cost reductions available via technical support from overseas shipyards.

4) Generally, there is significant competition in the domestic freight transportation market for trailer type cargoes, between the trucking companies, and between trucking and intermodal rail. This competitive market place means the market based rates that an AMH service can charge will need to be competitive, as well, to attract cargo. This makes profitability difficult to achieve on some potential AMH services unless full utilization of the vessels is realized and costs are kept under control.

5) As expected, the greatest opportunities for AMH service are routes where trucking costs are high, and where intermodal competition is not strong. One of the best routes for this is the one between the Pacific Northwest and Southern California. Other routes with potential for profitable operation are between the major metropolitan centers in the Mid-Atlantic area (Delaware River or New York/New Jersey) and Florida, and across the Gulf of Mexico from Texas to the west coast of Florida (where the sea route is shorter than the land route). Routes with only two ports are more cost competitive than routes with multiple ports, because any supplemental cargo that the added ports can contribute may not be sufficient to compensate for the higher costs incurred in the extra port calls, and the slower transit times, between the two terminus ports.

6) Government policies and support can have a major impact on the viability of AMH services, since any measures that encourage the setting up the services, offer incentives to users of the services, and provide financial support to the operators will make AMH more attractive to potential operators and investors. It is also beneficial to remove government mandated costs that negatively affect AMH, such as the Harbor Maintenance Tax.

H.2 Recommendations

There are several steps that can be pursued to further the goal of developing vessel designs most suitable for establishing AMH services along the coasts of the US in the near future. Combined with the development of vessels for AMH has to be considered the national need for vessels that can offer sealift transport in times of national emergency, by incorporating into their design the needed features to make them militarily useful.

The following are some recommendations on what should be done next in the advancement of the AMH design process. Some of these recommended steps are currently being carried out in projects sponsored by CCDoTT based on ONR funding, but there is the possibility for further development beyond the CCDoTT projects.

1) Further develop the market assessments for potential AMH markets to better estimate what are the market volumes, types of cargoes, desired ports, schedules, and required market rates. MARAD has several corridor studies underway which are doing that. The information from these studies should be reviewed and extracted into a form where it can be made useful for updating the vessel designs and the economic analyses prepared for this project.
2) Comprehensive interviews were held with many owners/operators while the concept designs were being developed, and afterwards, the eleven concepts were prepared and distributed to key Jones Act carriers for review. Specific comments were received from one owner/operator, which led to the development of a variant of Design 12. It is considered useful to have more in depth review with other owner/operators, as this will be beneficial to the further development of AMH efforts.
3) From these meetings and the updated market assessments, the most likely two or three designs, would be selected, depending on the variance in routes.
4) In discussions with owner/operators, solicit comments on which features to include in each design, such as the type of ramps, types of cargoes, speed, and type of propulsion machinery to enhance their utility for a potential service. Confirm with ports regarding the facilities that are available, to make sure they can handle the proposed vessels.
5) For the selected designs, incorporate the changes and improvements, as deemed worthwhile, considering the overall mission of the vessels, and the intent to promote series production by making the vessels suitable for a variety of uses.
6) Prepare more detailed designs of each of the selected vessels to the stage that shipyards could prepare bids on the designs. Besides the key design drawings, an outline specification should be prepared.

7) Provide support to MARAD, in preparing a comprehensive plan for implementing an AMH ship acquisition plan, including soliciting and evaluating proposals from ship owner/operators and shipyards for AMH services and accompanying ship construction contracts. This could conceivably include investigation of any required DOT offsets to enable a worthwhile shipbuilding program, while creating quality jobs.

This further design effort can be a mix of privately funded efforts by owners intending to invest in an AMH service and government funded projects that are part of the ongoing process of providing information, and encouragement to private industry to invest in the national need for AMH services. It is believed the possibilities for a viable AMH trade are realistic, and that further development of the design process will provide needed encouragement and guidance in getting AMH started in earnest.