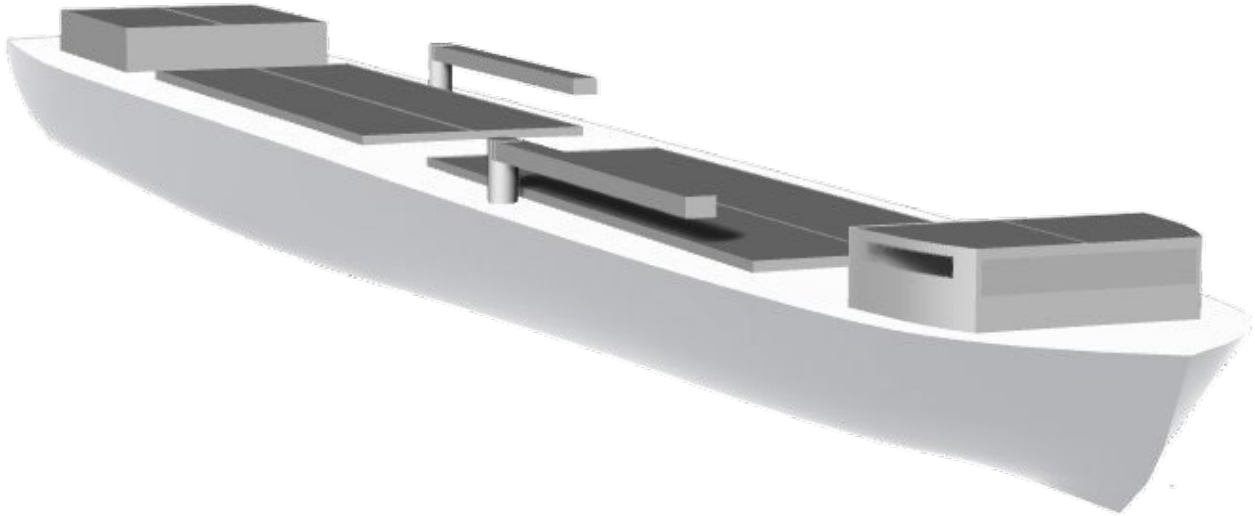
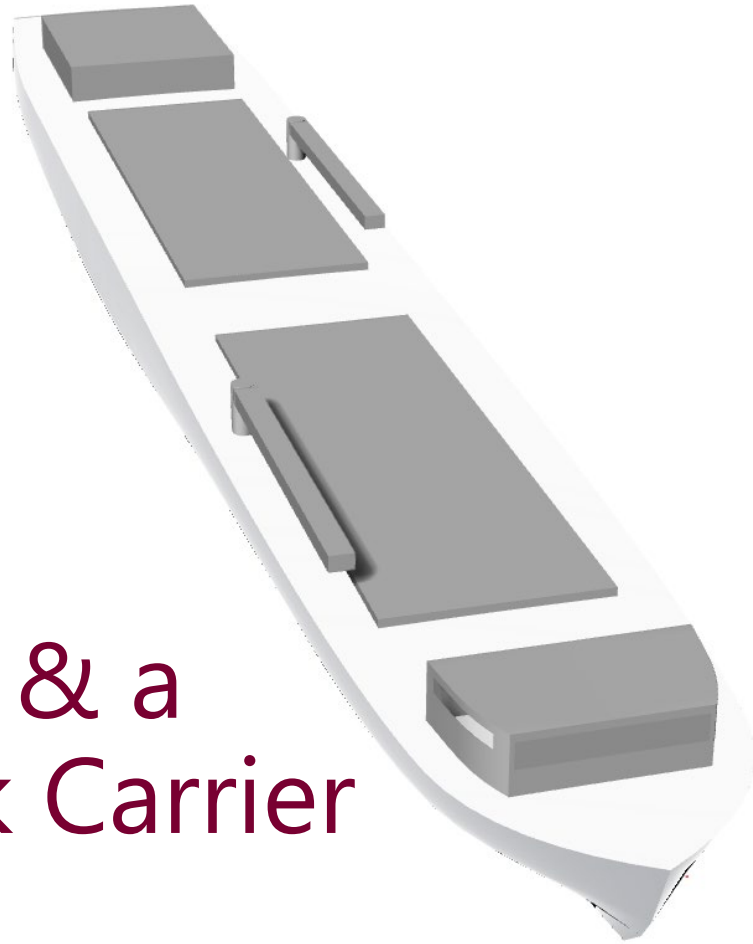




Proposal of Erie Canal Modifications & a Hudson-Erie Class Inland Motor Bulk Carrier

By: Isabelle Gautier, Jaclyn Repanti & Morris Wilson

Advisors: Assistant Professor Hariharan Balasubramanian & Professor Charlie Munch

Inspiration & Previous Researcher: Geoff Uttmark

The Inspiration for this Project was Geoff Uttmark's Report on Green Ship Technologies on the Erie Canal. [1]









RSS-80

Principal Dimensions, Form Coefficients & Hydrostatics

			Notes & Formulas
Principal Dimensions:			
LOA	80.00	Ft.	
LBP	80.00	Ft.	Plumb bow and transom
Beam	20.00	Ft.	
Depth	10.00	Ft.	
Draft	5.25	Ft.	
Draft scantling	7.5	Ft.	
Form Coefficients:			
Block Coefficient	0.695		
Prismatic Coefficient	0.818		
Midship Coefficient	0.850		
Waterplane Area Coefficient	0.825		
Hydrostatics (at DWL full load, no trim or heel)			
Displacement - Salt Water	140.00	LTsw	LWL x BWL x T full load x Cb
Design Displacement	313,600.00	Pounds	
Volume of Displacement	4900.00	Cu. Ft.	
Displacement / Length Ratio	273.44		Displ in LT / ((LWL / 100)^3) This is medium DL ratio. Heavy vessel has D L ratio > 320.
Sail Area	1500	Sq. Ft.	Preliminary … SA/D indicates SA can increase
Sail Area to Displacement Ratio	5.20		SA / (Displ in cu ft)^.6667 Range for heavy displacement vessels is 10 to 15
Waterplane Area (approx.)	1320.00	Sq. Ft.	Cwp x LWL x B
Tons per Inch Immersion	3.81	LT	(LWL x B x 0.08333) / 35 cu ft. per ton SW
Moment to Trim 1 inch (MTi)	30492.00	Foot / Pounds	Approx.: (0.35 x (waterplane area)^2)/B
Wetted Surface (Taylor)	1652	Sq. Ft.	
Wetted Surface (Denny)	1674	Sq. Ft.	

Owners Requirements for the Eco-Friendly Erie Canal Vessel.

Design Goals:

- Maximize cargo capacity
- Canal size restrictions
- Reduce traffic in and around NY

Route:

- From New York Harbor to Buffalo, NY
- Traveling 1100 nautical miles

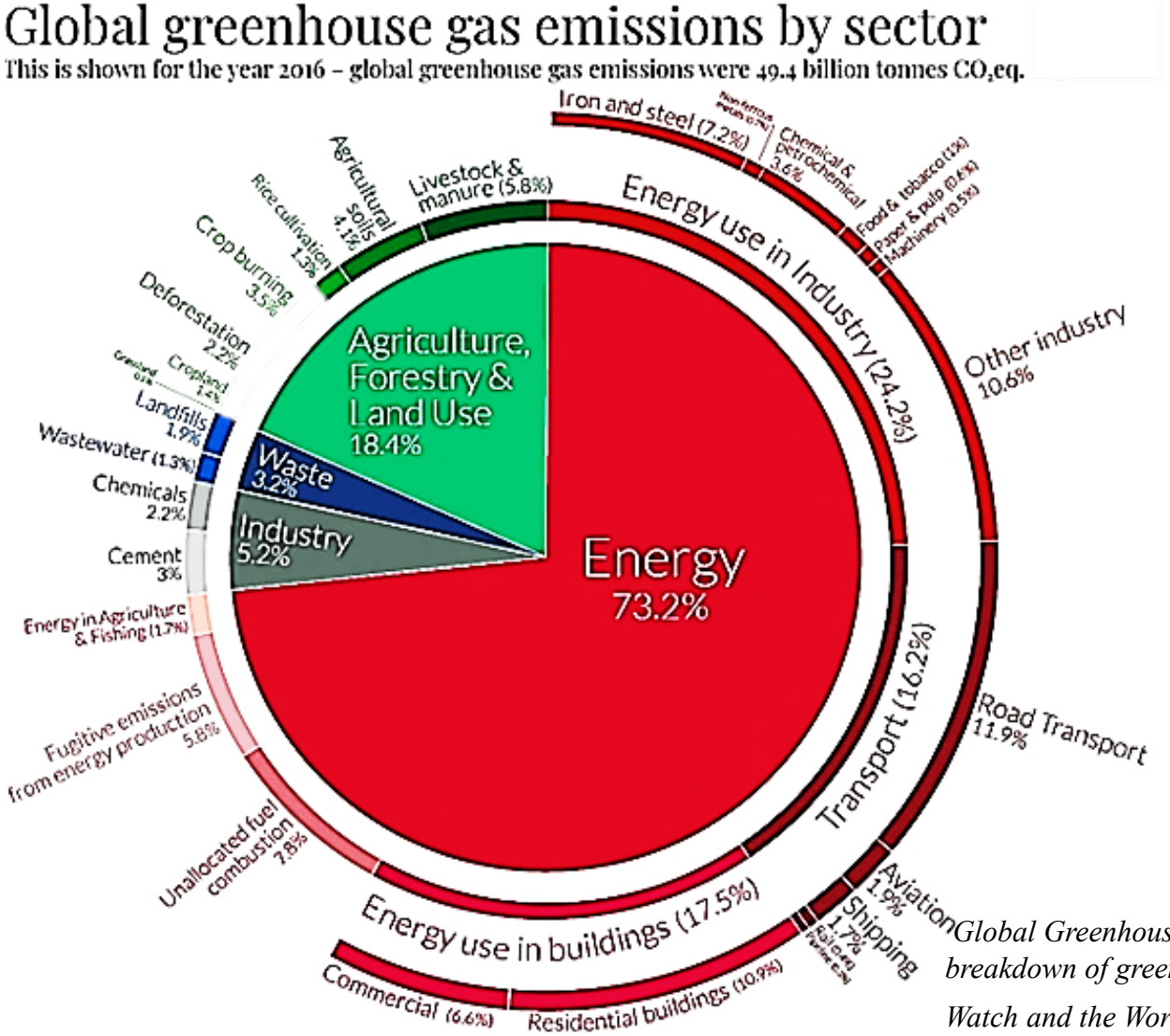
Operational Plan:

- Rebuild the Erie Canal trade route
- Environmentally friendly Vessel

Project Goal:

- Reduce truck and rail pollution
- Eco-friendly bulk carrier

The Maritime Industry has Lower Global Greenhouse Gas Emission than Intermodular Shipping and the Aviation Shipping.

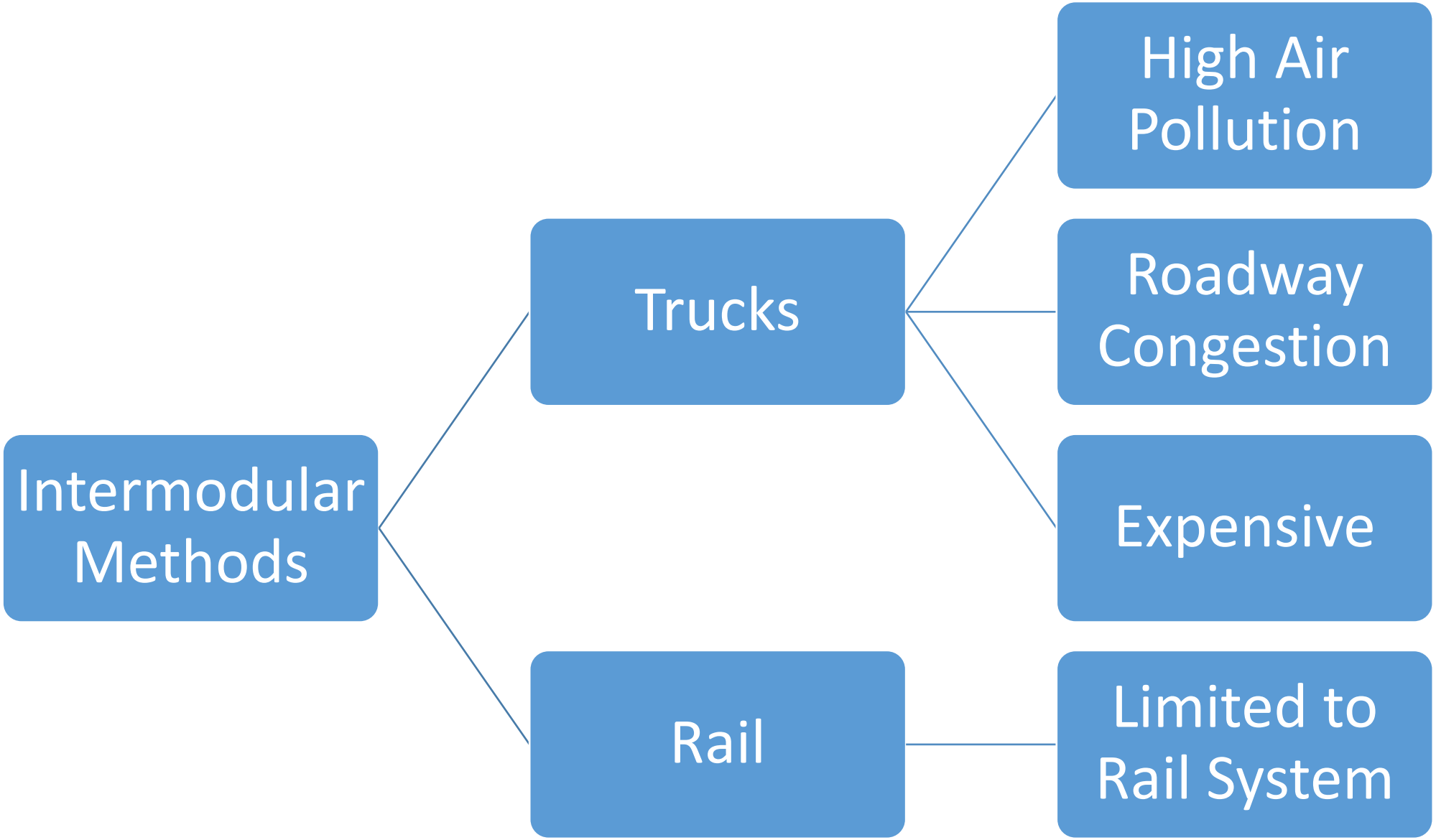


Global Greenhouse Emissions by Sector visually depicts the breakdown of greenhouse gas emissions data published by Climate Watch and the World Resources Institute in a pie chart [12] [13] [14]

International Imports Can Be Presented by Country to Display the Relevance of Sea Freight to Global Trade.

#	Country	Trade in USD	#	Country	Trade in USD
1	United States	$3.359 trillion	11	Mexico	$625.9 billion
2	Mainland China	$2.587 trillion	12	Italy	$615.6 billion
3	Germany	$1.425 trillion	13	Canada	$554.3 billion
4	United Kingdom	$815.6 billion	14	Belgium	$519.1 billion
5	Japan	$743.3 billion	15	Singapore	$457.6 billion
6	France	$740.8 billion	16	Spain	$451.3 billion
7	India	$702.8 billion	17	Taiwan	$394.1 billion
8	Hong Kong	$698.9 billion	18	Vietnam	$382.5 billion
9	Netherlands	$635.4 billion	19	Poland	$379.5 billion
10	South Korea	$632.1 billion	20	Switzerland	$369.7 billion

The Costs of Intermodular Shipping Methods in NYS are High.



Increasing NYS Waterways' Port Access Offers Opportunity for Goods to be Shipped Domestically and Internationally.



Increasing NYS Waterways' Port Access Offers Opportunity for Goods to be Shipped Domestically and Internationally.



Image: *Port Expansion underway for New York and New Jersey ports - From Scarbrough Global*

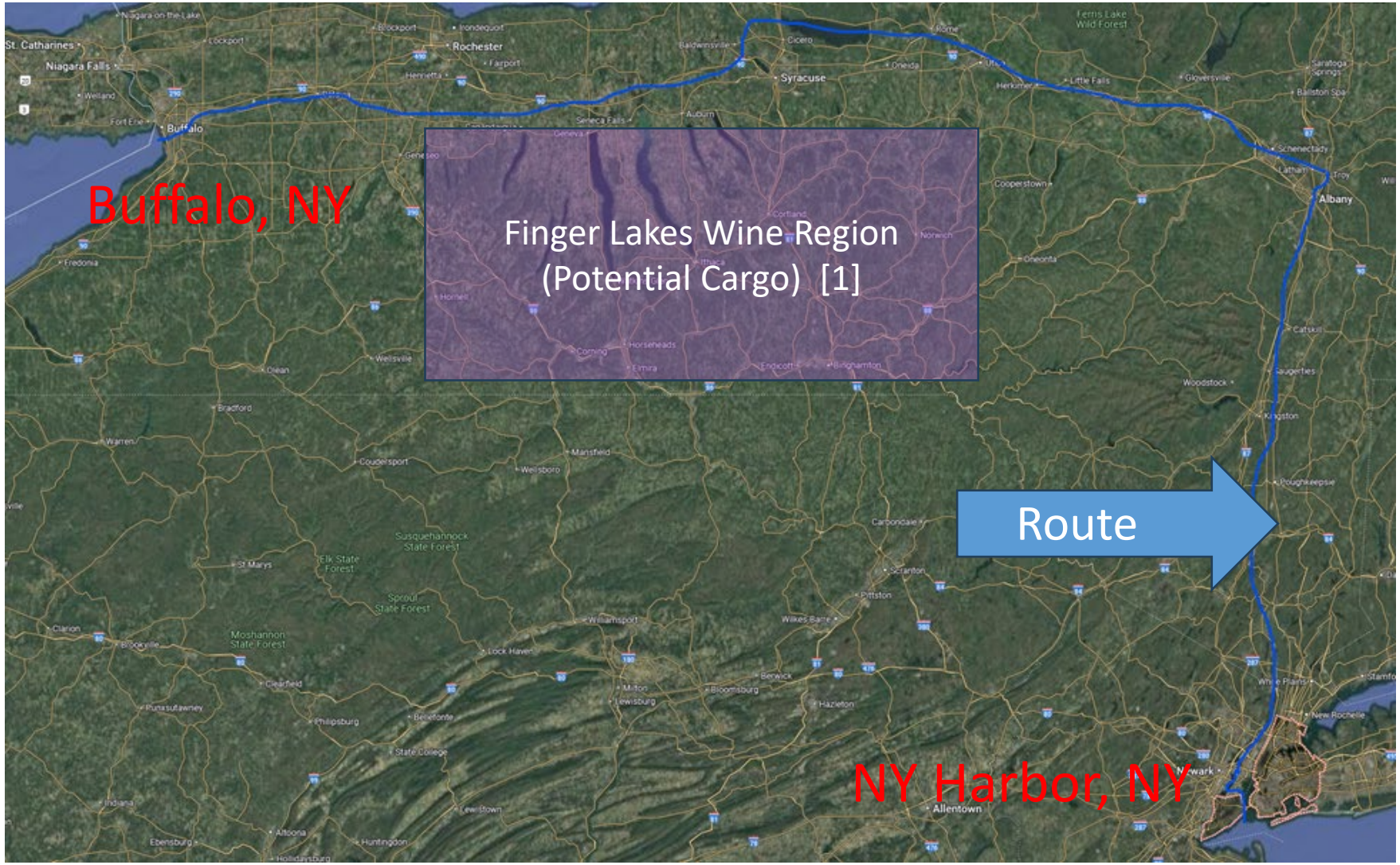
New York Harbor Connects to the Domestic Waterways in NYS.

- Atlantic Ocean and Long Island Sound
- Freshwater Lakes
  - Lake Champlain, Finger Lakes, in central New York, and the Great Lakes
- Rivers
  - Hudson River, Mohawk River, Niagara River, St. Lawrence River, and the Genesee River, the Oswego River
- Man-made canals-524 miles
  - Champlain Canal, Oswego Canal, Cayuga Seneca Canal and the Erie Canal



Image: Rivers in New York, New York Rivers Map, from https://www.mapsofworld.com

Design Route of the Erie Canal/Hudson River Waterway.



Wine Region: G. Uttmark, "Assessment of Green Ship Technologies and Plan for Deployment on the Erie Canal / NYS," TransTech Marine Co., Brooklyn, NY, 2015.

The Vessel Must be Designed to Maximize Cargo Capacity While Adhering to Canal Size Restrictions.

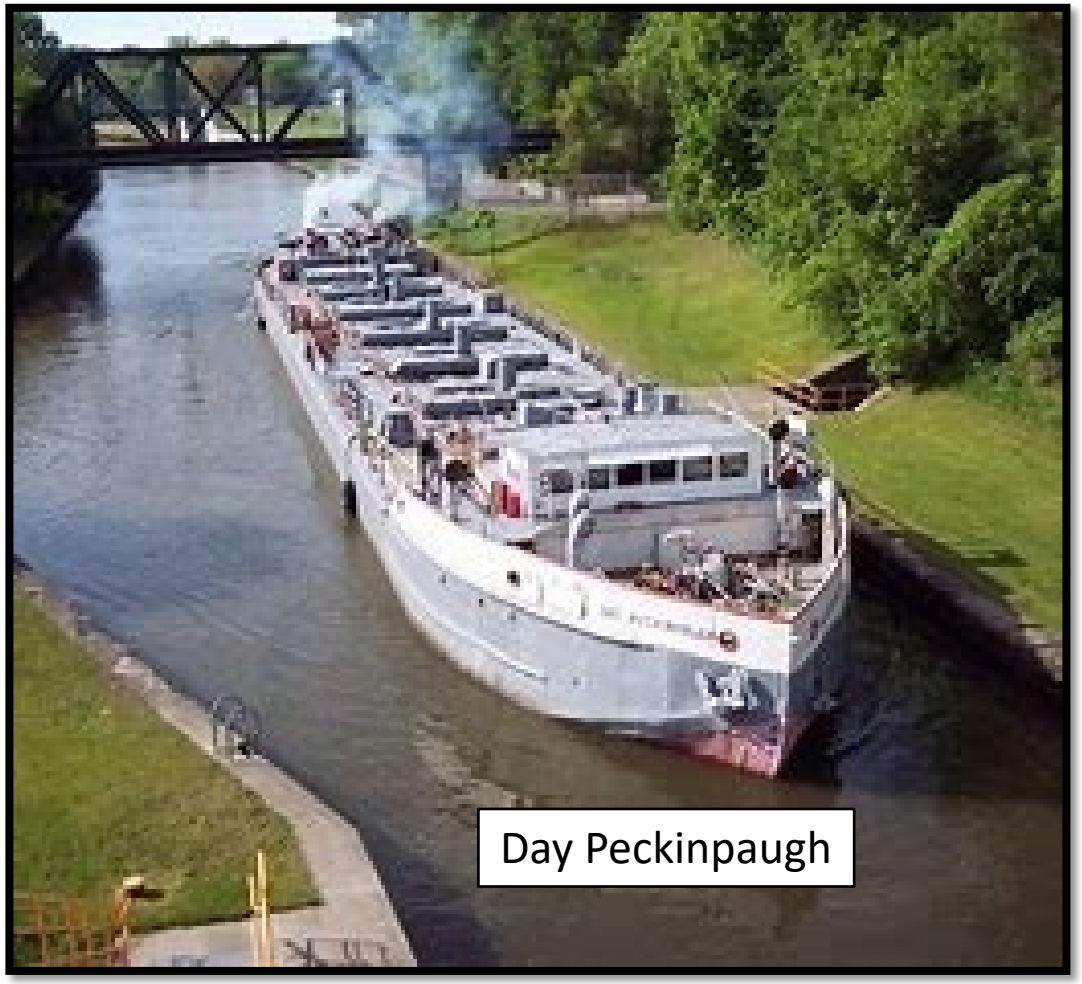
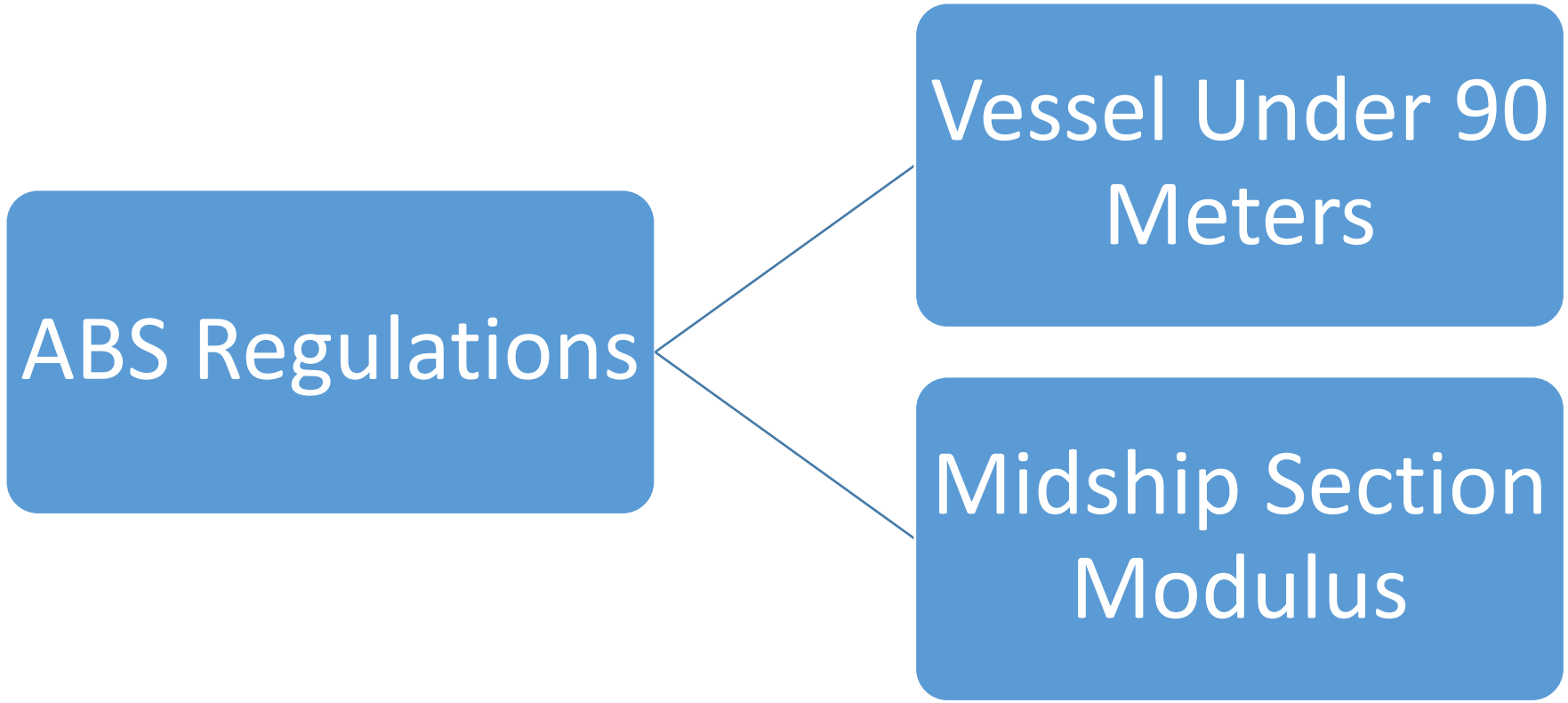


Image Source: (eriecanal.org, 2009)

Canal Dimensions

Max Vessel Length	296 ft
Max Vessel Beam	43.5 ft
Max Vessel Draft (Waterford, NY to Oswego, NY)	11 ft
Max Vessel Draft (Western Canal Systm)	8.5 ft
Max Vessel Air Draft (Waterford, NY to Oswego, NY)	21 ft
Max Vessel Air Draft (Western Canal Systm)	15.5 ft

ABS Regulations Were Used to Develop the Vessel Size and Structural Characteristics.

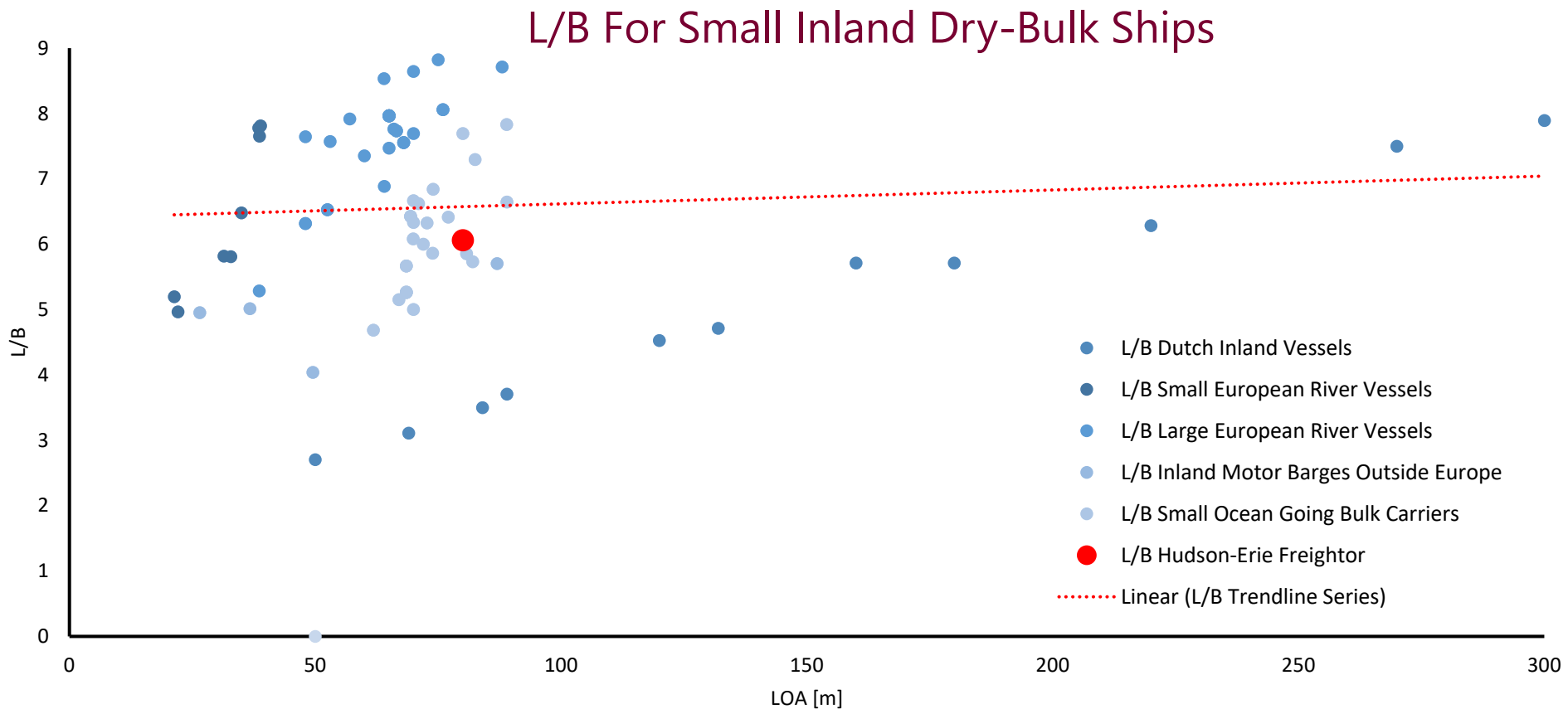


Principle Dimensions are Presented for the Erie Canal Vessel.

Table of Principle Ship Characteristics

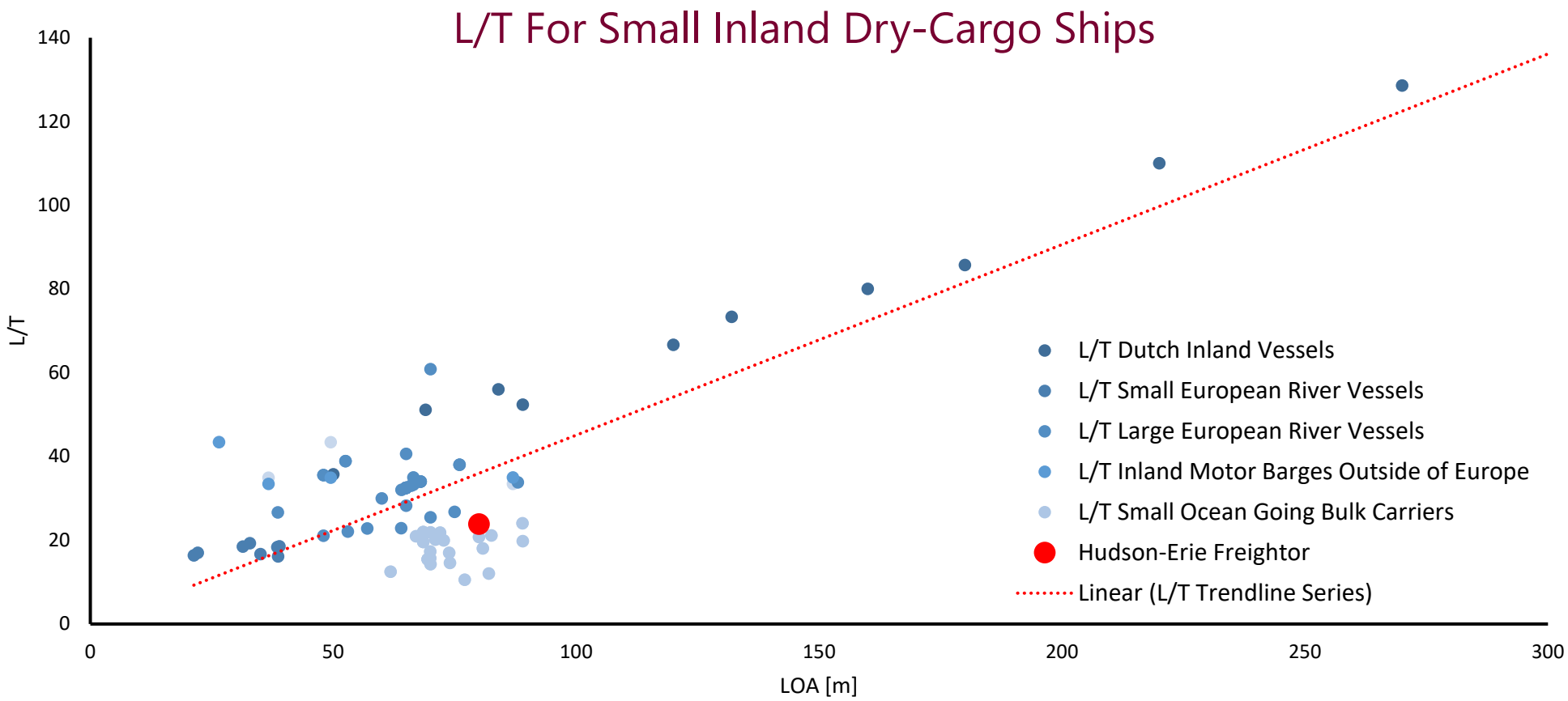
Length, Overall	293.64	Feet	Lightship	930	Lt
Length, B.P.	244.75	Feet	Lightship VCG	8	Feet
Beam, Molded	42.65	Feet	Lightship LCG	127.5	Feet
Depth to Main DK	15	Feet	Crew	4	Crew
Bulkhead	Main Deck		Grain Cubic	36400	ft^3
Machinery	Azipod		Bale Cubic	36400	ft^3
Design Sea Speed	6	Knots	Fuel Oil, Total	380	Lt
Shaft Horsepower, Normal	2635.30	Hp	Fresh water	10	Lt
Shaft Horsepower, Maximum	2729.34	Hp	No. of Holds	2	Holds
Full Load Draft, MLD	11	Feet	Deadweight	1921	Lt
Full Load Displacement	2850	Lt	Net Tonnage	1500	Lt

The Principal Dimensions for the Vessel are Similar to Other River Vessels.



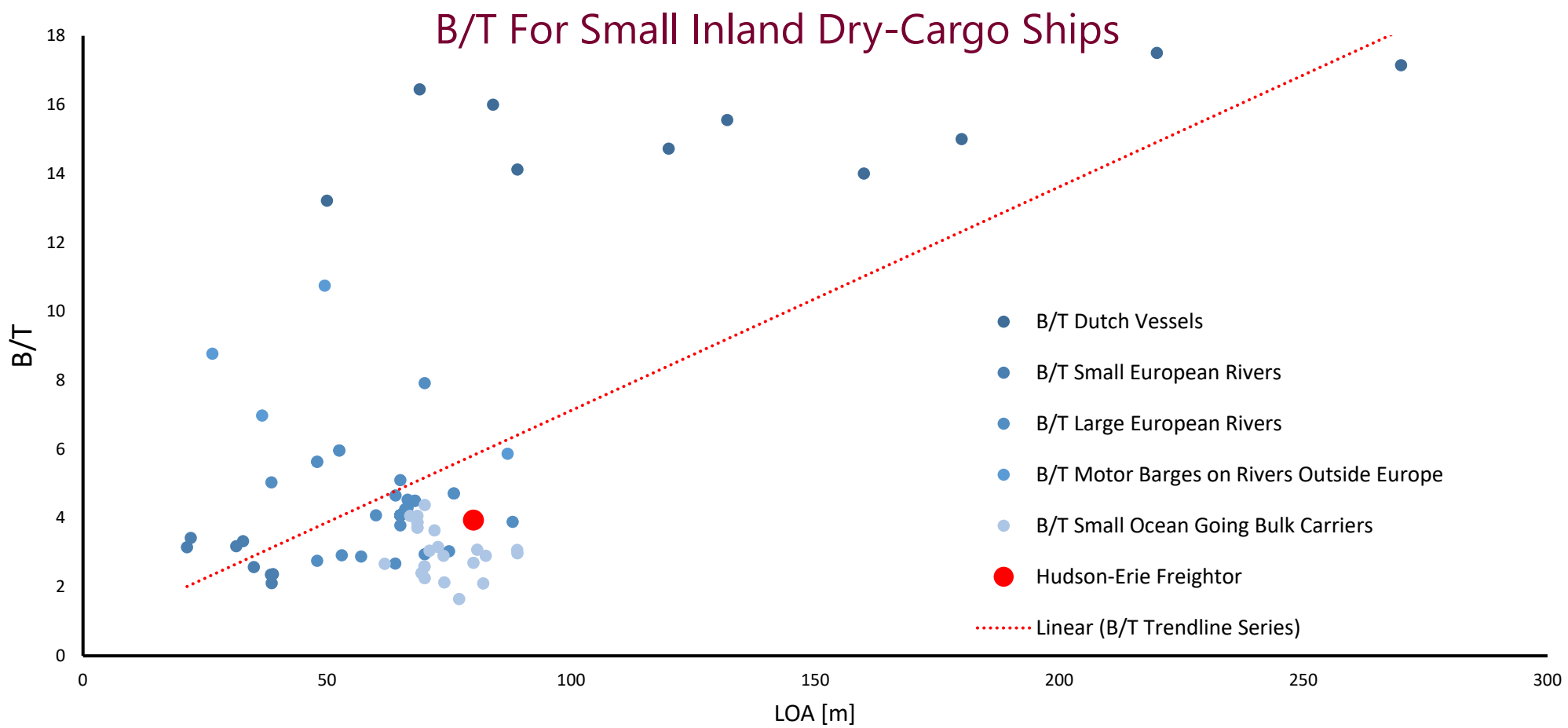
Reference: A. Roorda, Ships and Marine Engines Volume V Small Seagoing Craft and Vessels for Inland Navigation, the University of Michigan, 1985.

The Principal Dimensions for the Vessel are Similar to Other River Vessels.



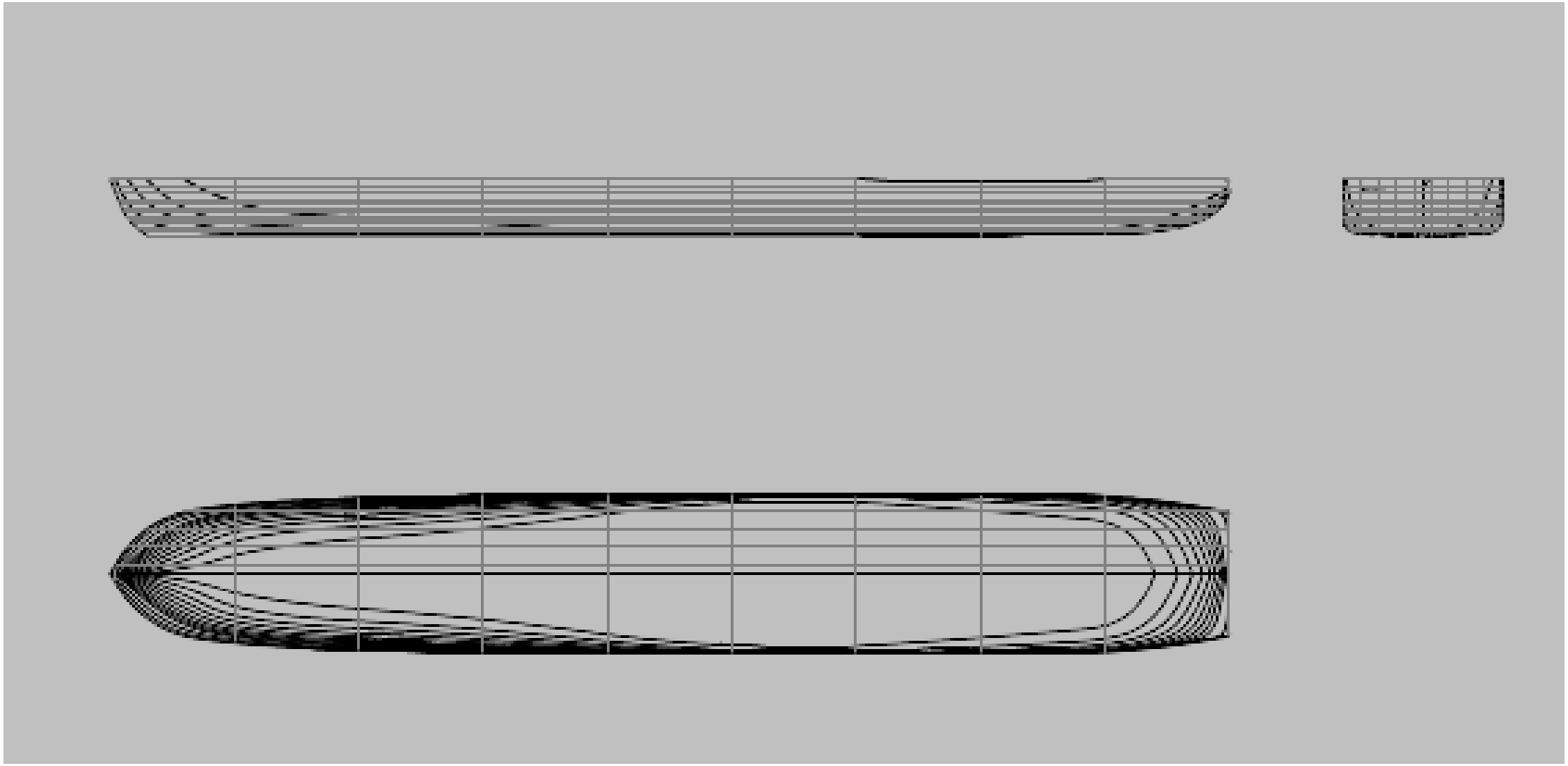
Reference: A. Roorda, Ships and Marine Engines Volume V Small Seagoing Craft and Vessels for Inland Navigation, the University of Michigan, 1985.

The Principal Dimensions for the Vessel are Similar to Other River Vessels.

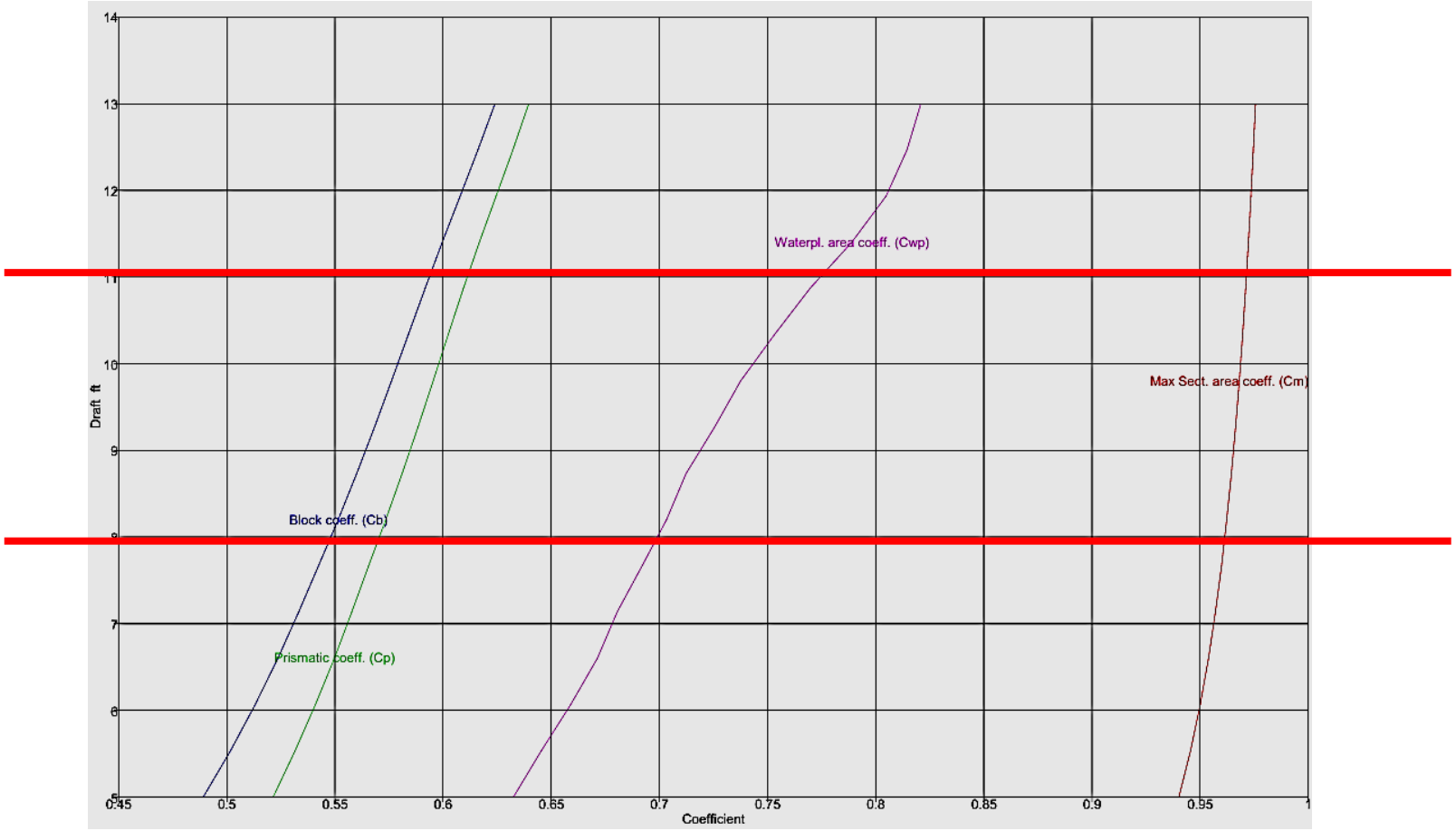


Reference" A. Roorda, Ships and Marine Engines Volume V Small Seagoing Craft and Vessels for Inland Navigation, the University of Michigan, 1985.

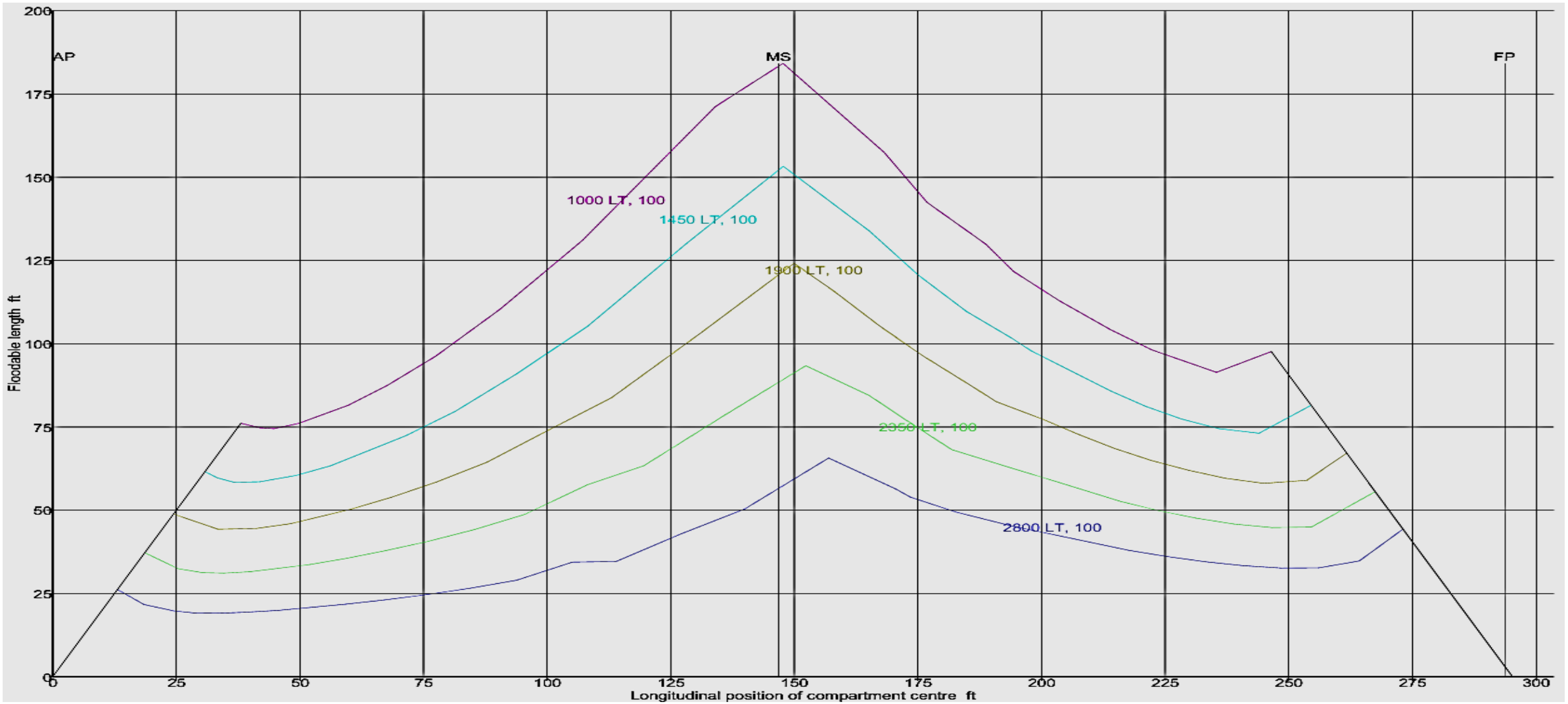
Lines Drawing and Hull Form for the Proposed Vessel.



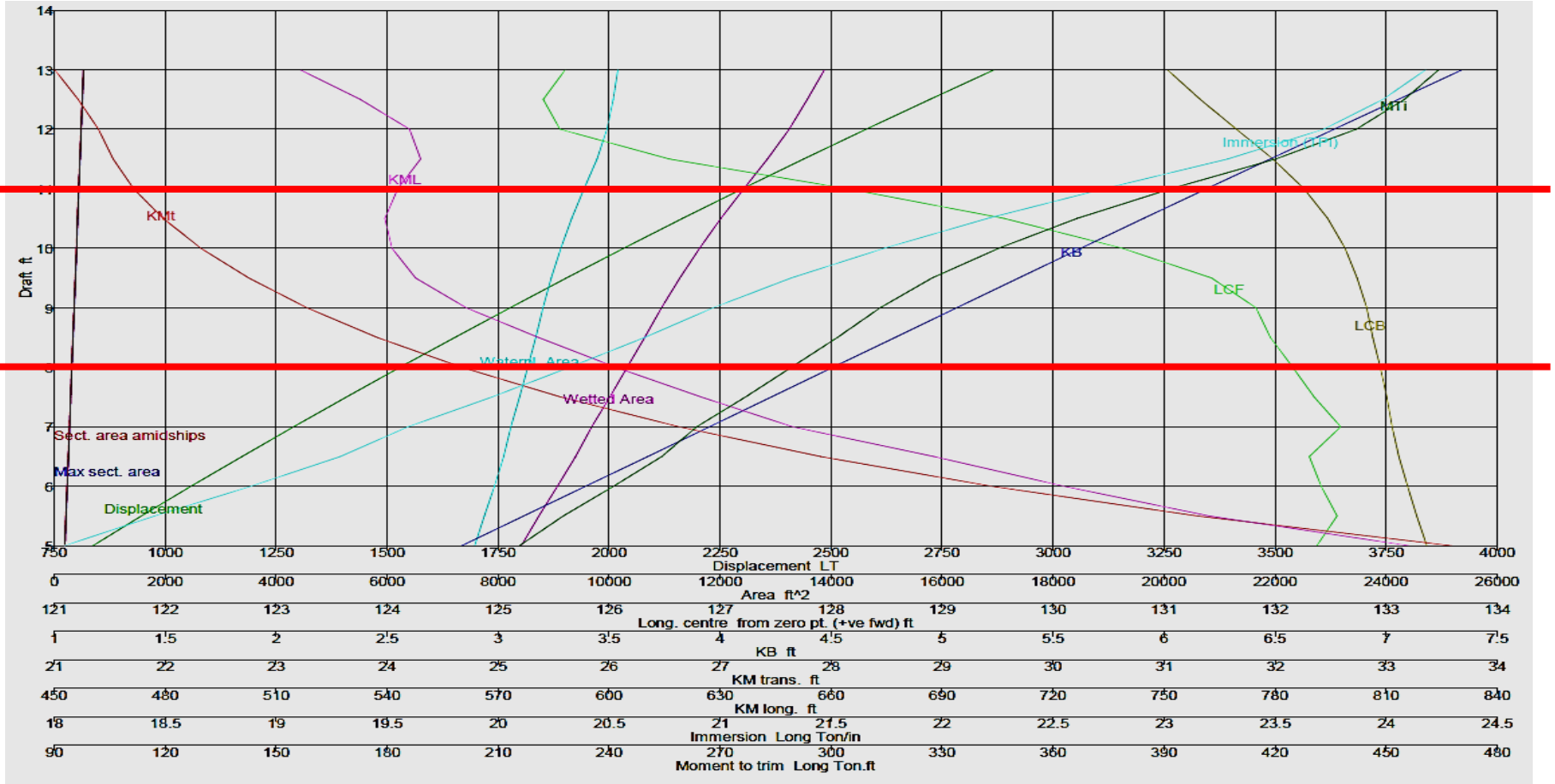
Curves of Form Derived from Hull Geometry at a 8 [ft] Draft and a 11 [ft] Draft.



Floodable Length For Five Displacements ranging from Lightship to Full Load Departure.



Intact Hydrostatics Generated from Hull Geometry for Drafts of 5 [ft] to 11 [ft].



Eco-Friendly Power Source Options.

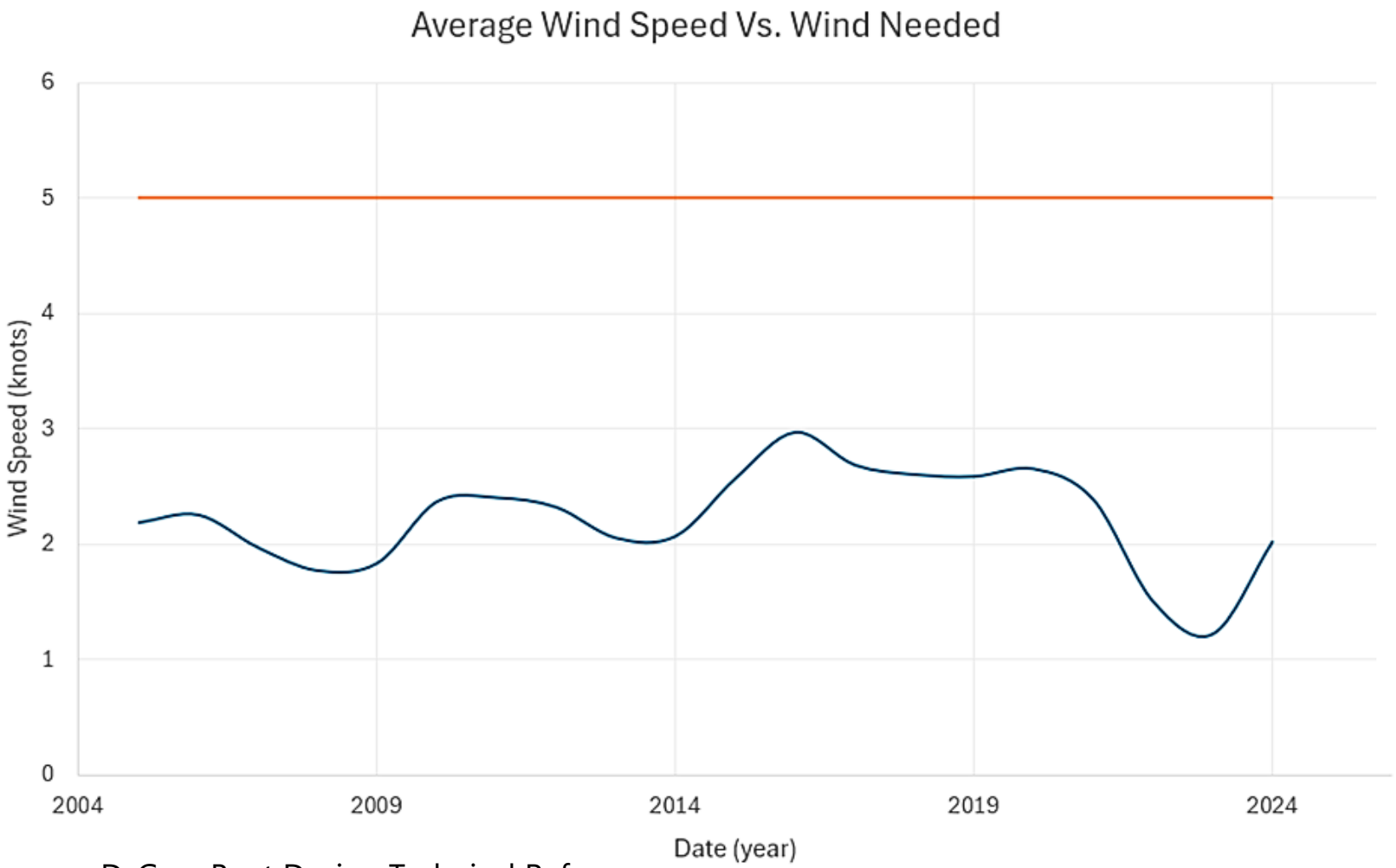




Image Source: (www.maritimeinformed.com)

Reference: D. Gerr, Boat Design Technical Reference Manual, New York, NY, 2016.

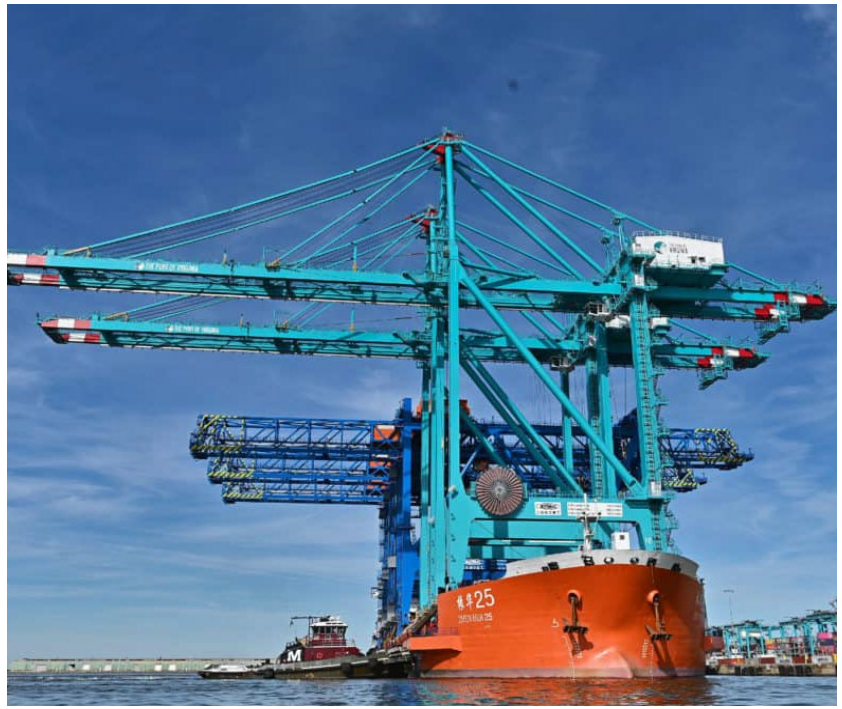
The Fuel Calculations for Voyage from NY Harbor to Buffalo.

Fuel Calculaiton Analysis

Top Speed	8 Knots
Cruising Speed	6 Knots
Round Trip (NY Harbor to Buffalo	1100 NM
Calculated Shaft Power	4500 HP
Calculated Watts	33570 KW
Top Speed Consumption	141.49 Gal/Hr
Cruising Speed Consumption	136.61 Gal/Hr
Top Speed Run Time	137.50 Hr
Cruising Speed Run Time	183.33 Hr
Long Tons of Diesel for Range	87.57 Lt
Two Z-Drive Motors Power	3360 KW

Reference: D. Gerr, Boat Design Technical Reference Manual, New York, NY, 2016.

Mission Systems and Cargo Handling Systems Must Accommodate the Vessel Mission and the Canal's Limitations.

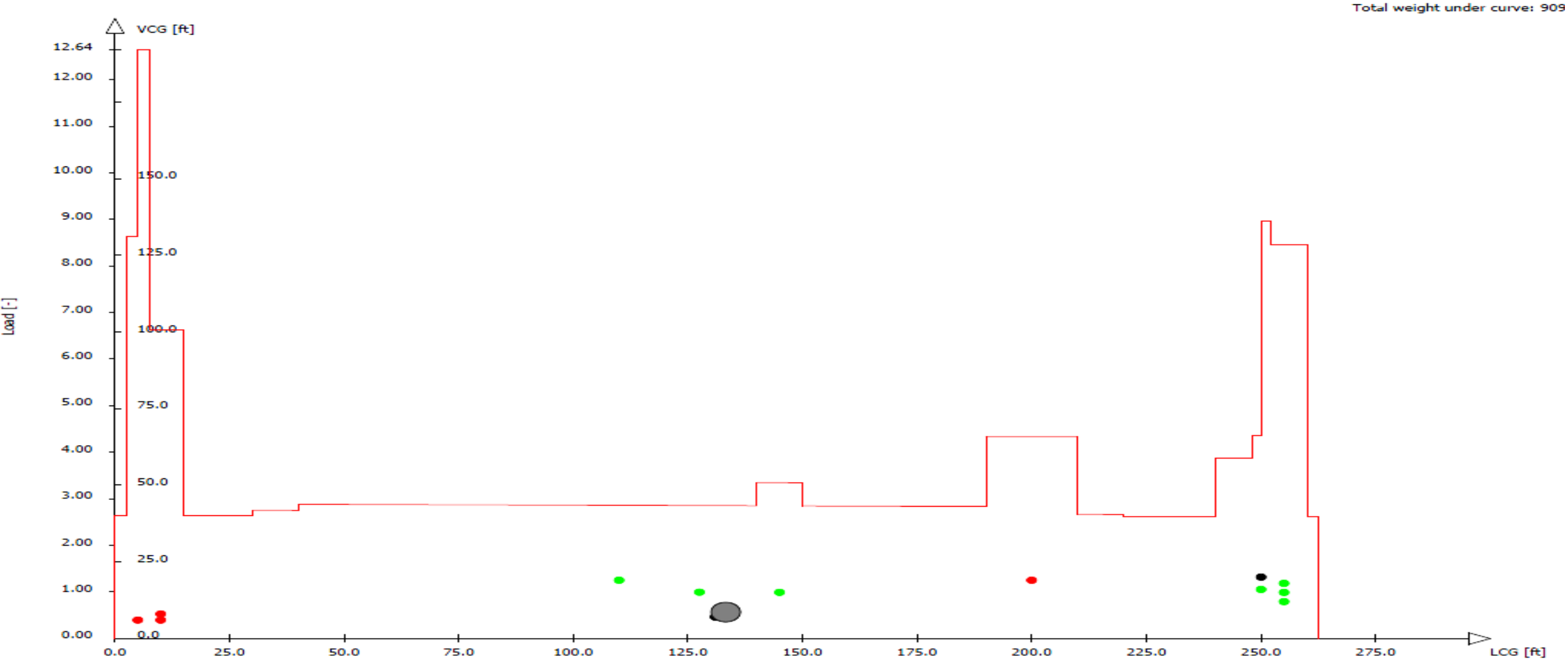




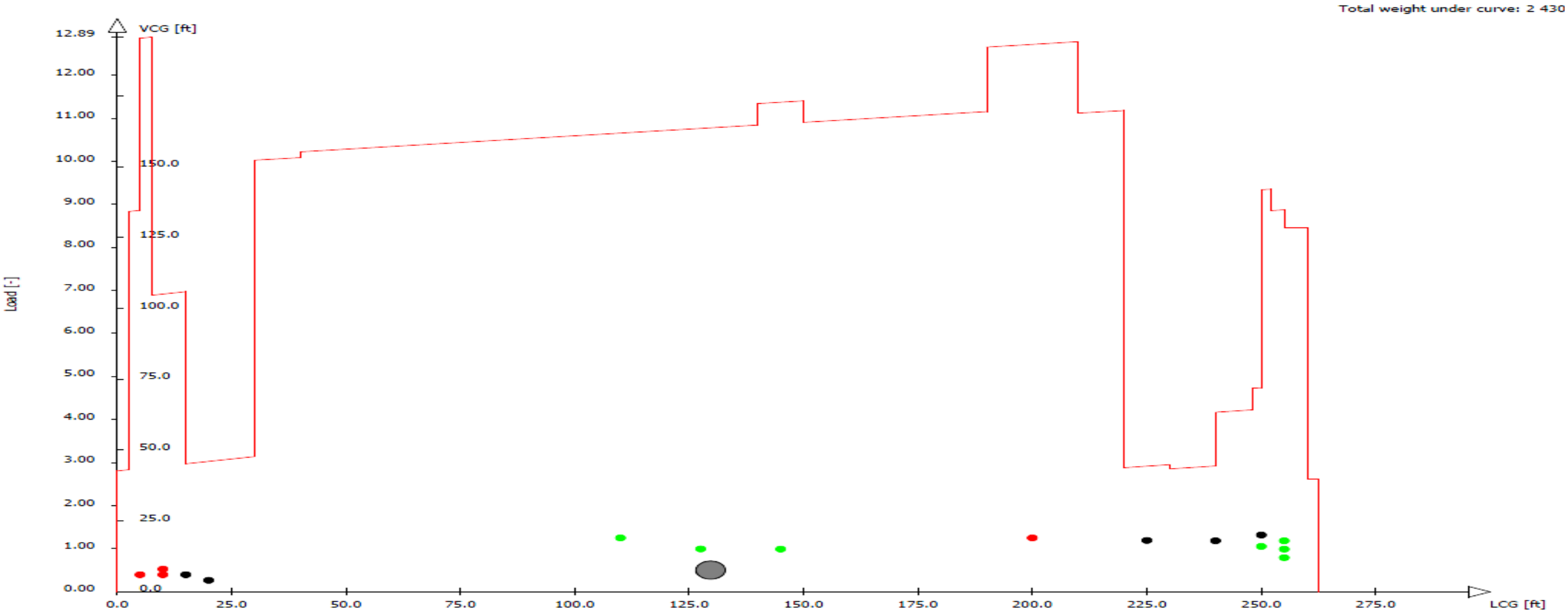
- Bulk cargo such as grain, wine and oil seeds will be carried in bulk holds
- Two cargo holds with hatch covers
- The deck is equipped with four deck wenches for lock transit security
- A crane is necessary for loading
- Accommodations are located below deck

Images: Left: Port of Virginia Receives East Coast.... Kendall Osborne, Chesapeake Bay Magazine, Right: EBM 1 2 3.2 Ton Mini Offshore Pedestal ...https://www.ebmcrane.com/

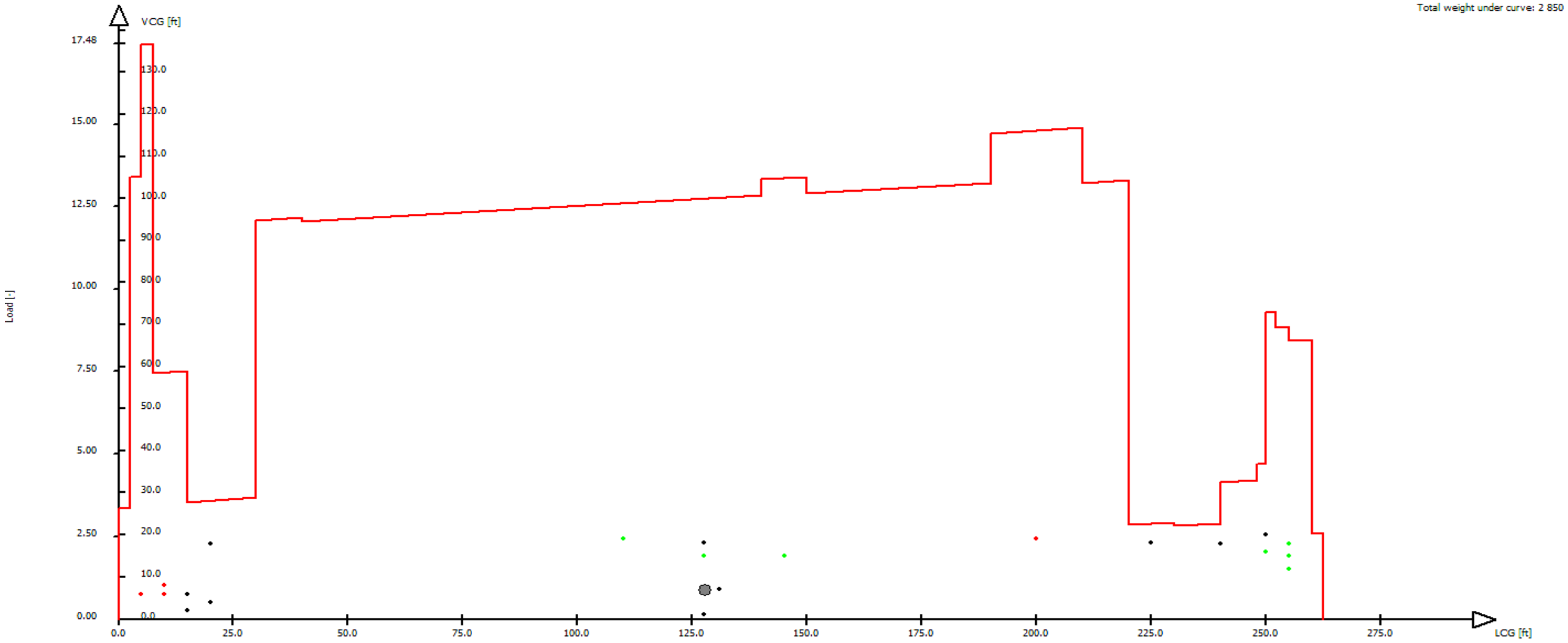
Lightship Weight Estimation Containing No Deadweight Loads.



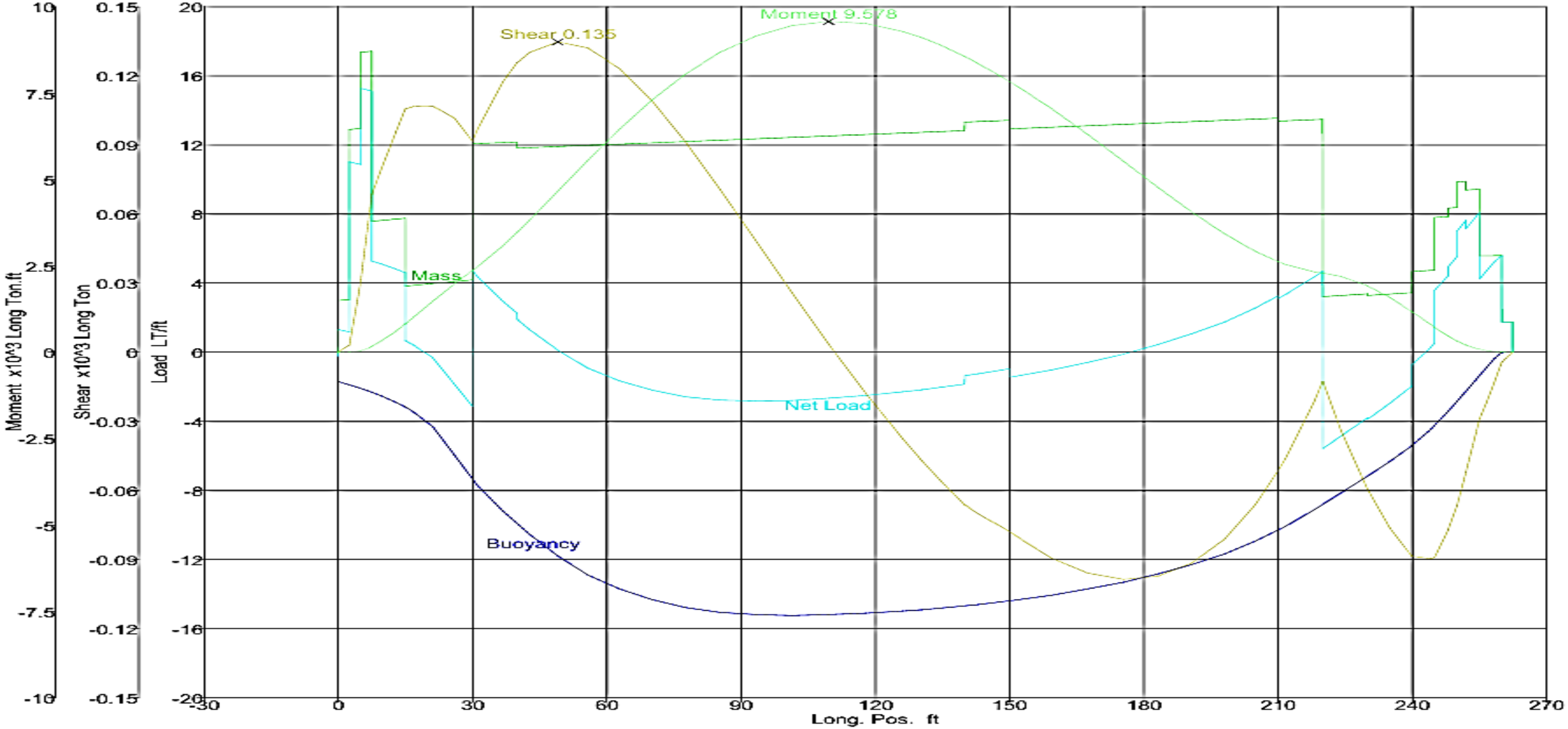
Arrival Condition Weight Estimation Containing 10% Consumables, and Full Cargo Load.



Departure Condition Weight Estimation Containing Full Cargo Load, Full Fuel, Full Stores.

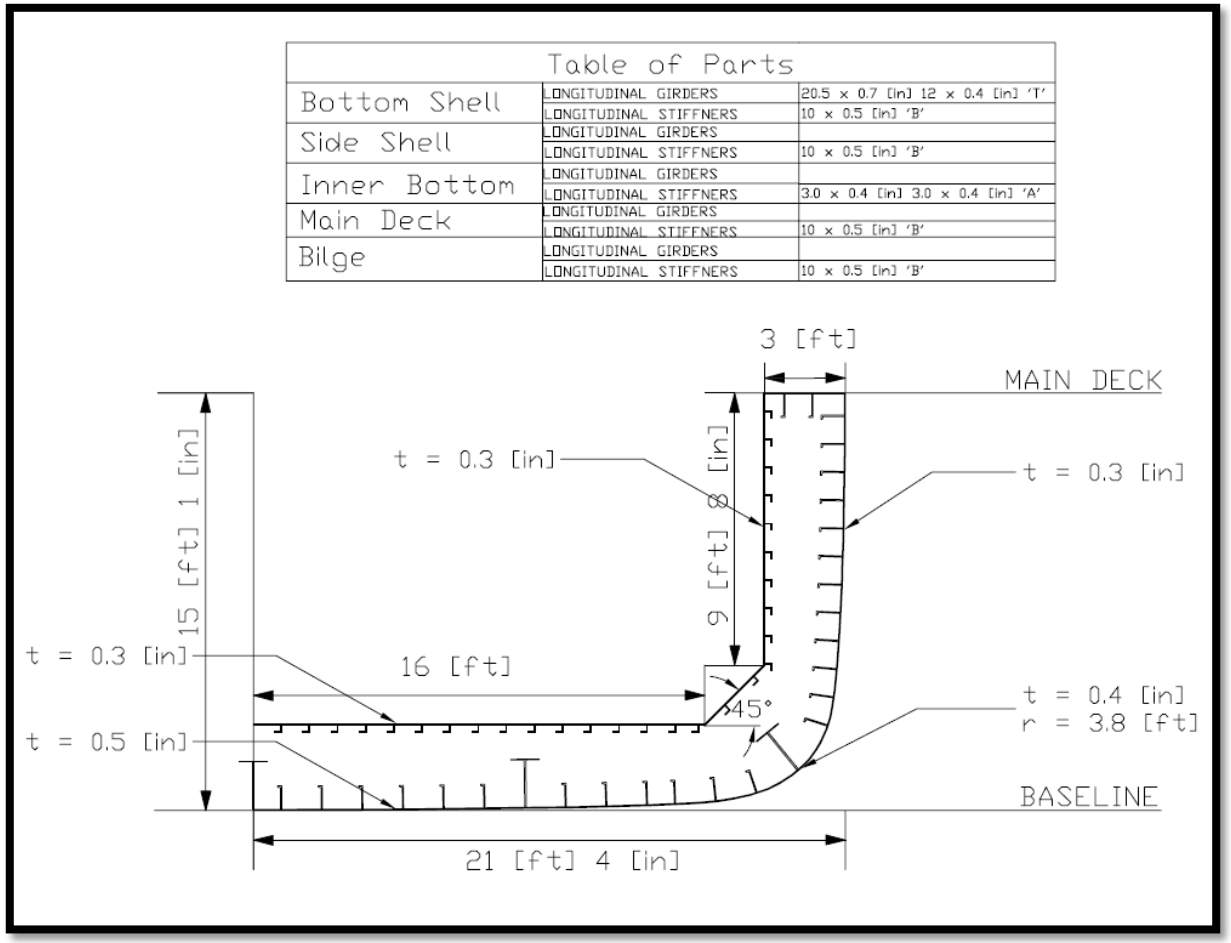


Longitudinal Strength Based Off Departure Full Load Condition.



The Midship Section Design Shown Below is Based off ABS Design Rules And Provides Ample Strength for All loading Conditions.

Table of Parts		
Bottom Shell	LONGITUDINAL GIRDERS	20.5 x 0.7 [in] 12 x 0.4 [in] 'T'
	LONGITUDINAL STIFFNERS	10 x 0.5 [in] 'B'
Side Shell	LONGITUDINAL GIRDERS	
	LONGITUDINAL STIFFNERS	10 x 0.5 [in] 'B'
Inner Bottom	LONGITUDINAL GIRDERS	
	LONGITUDINAL STIFFNERS	3.0 x 0.4 [in] 3.0 x 0.4 [in] 'A'
Main Deck	LONGITUDINAL GIRDERS	
	LONGITUDINAL STIFFNERS	10 x 0.5 [in] 'B'
Bilge	LONGITUDINAL GIRDERS	
	LONGITUDINAL STIFFNERS	10 x 0.5 [in] 'B'

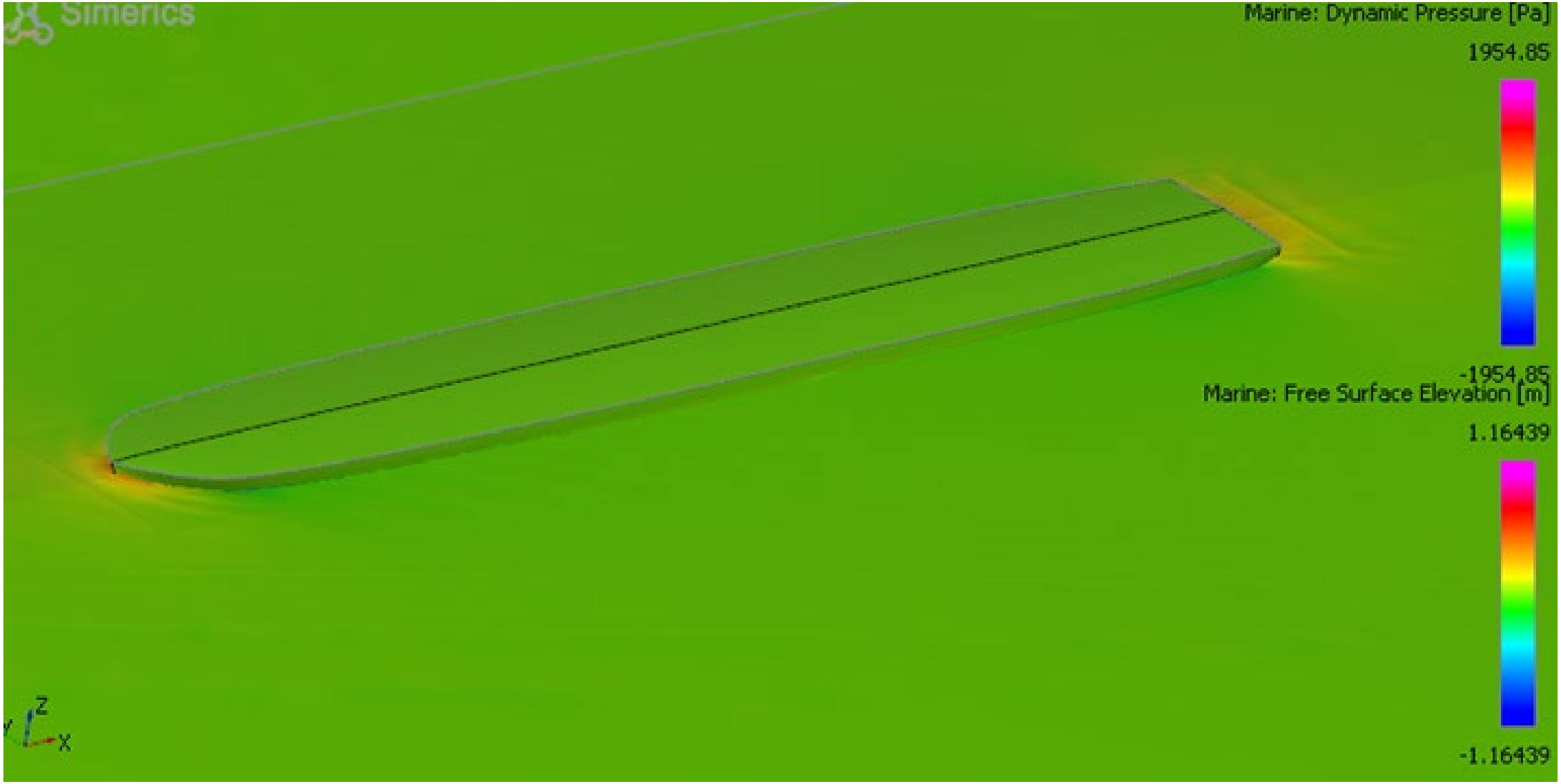


The Preliminary Resistance Calculations for the Vessel are as shown.

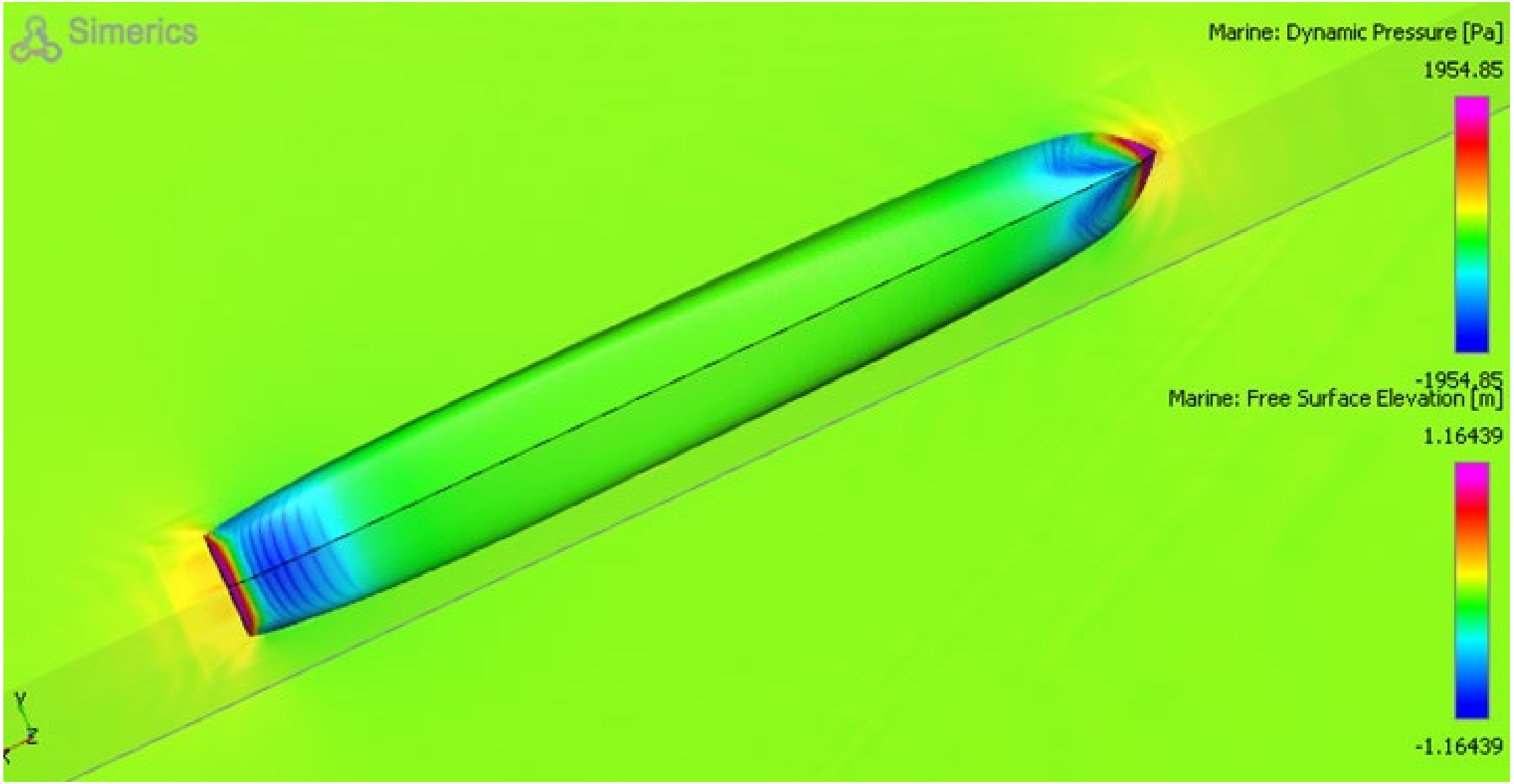
Resistance Calculations	Numerical Value
Reynold's Number	8400
Speed-Length Ratio	0.58
Displacement-Length Ratio	92.5

Reference: A. Papanikolaou, Ship Design: Methodologies of Preliminary Design, Athens, Greece,: SYMEON Publishers, 2014.

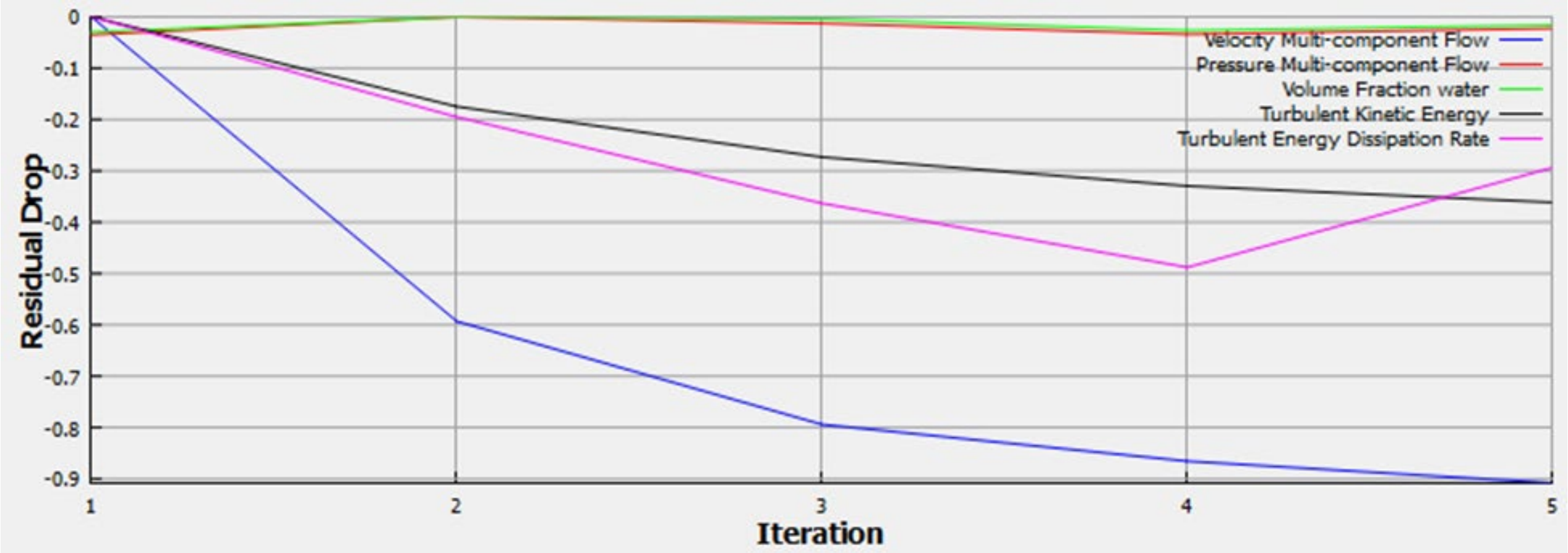
Rhino/Orca CFD Analysis Top View for the Vessel.



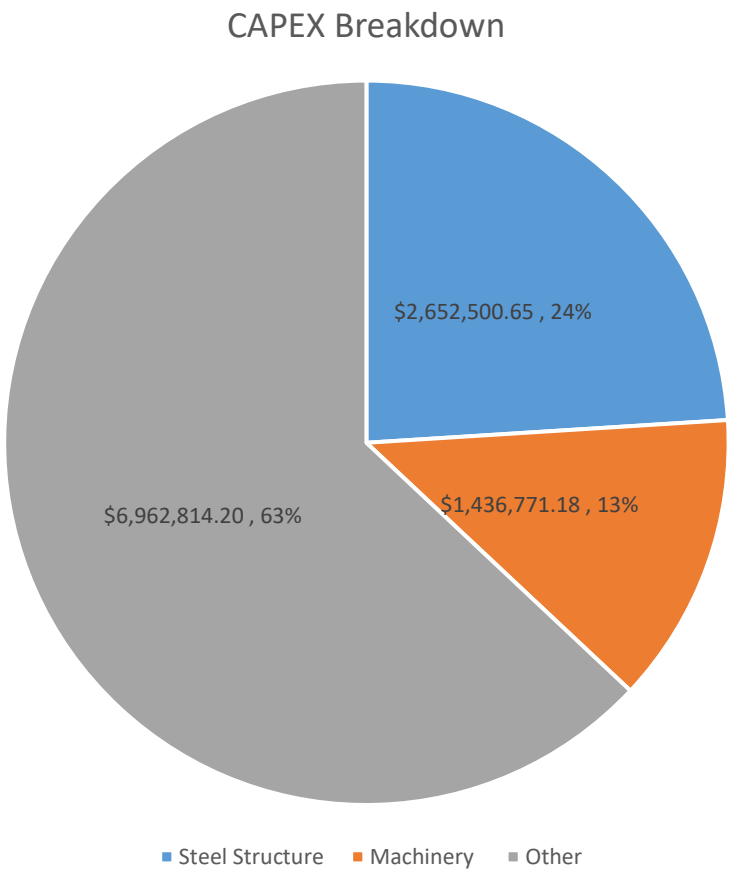
Resistance Analysis View from the Hull Bottom for the Vessel.

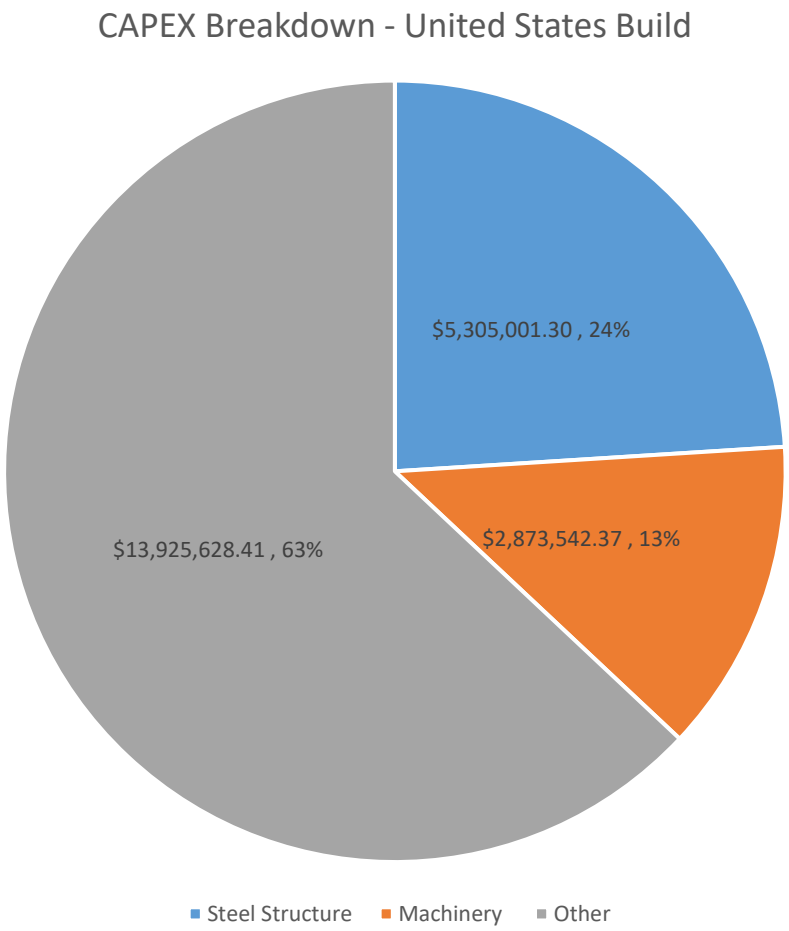


Rhino/Orca Was Used for Vessel CFD Analysis and Graphs Were Completed.



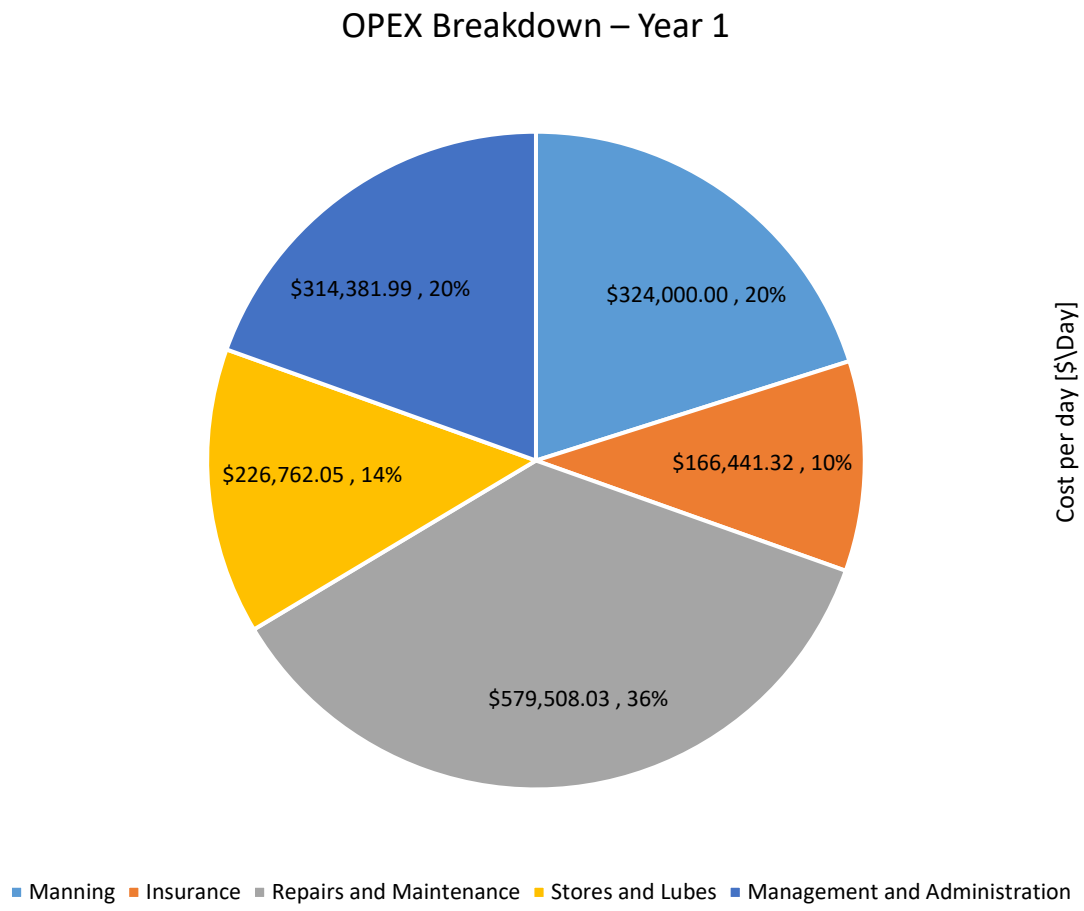
The Hudson-Erie Class Motor Bulk Carrier Construction Expenses Were Calculated for General and U.S. Based Builds.

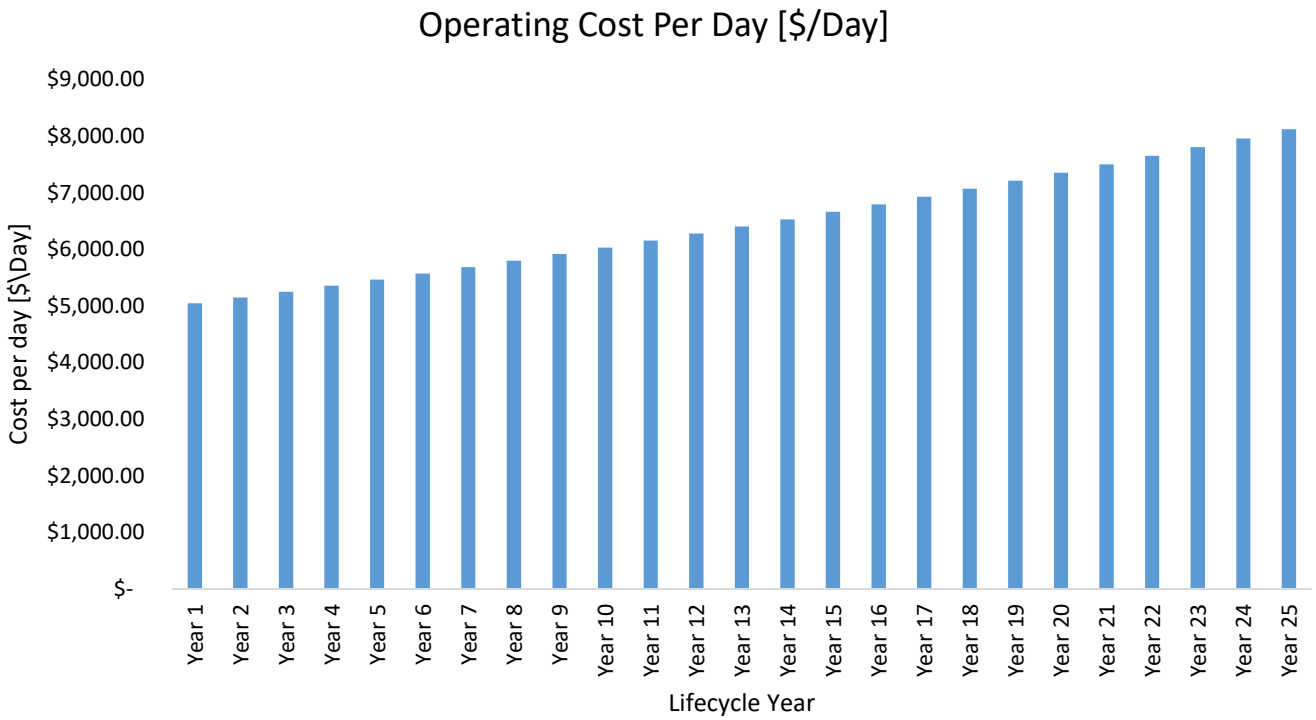




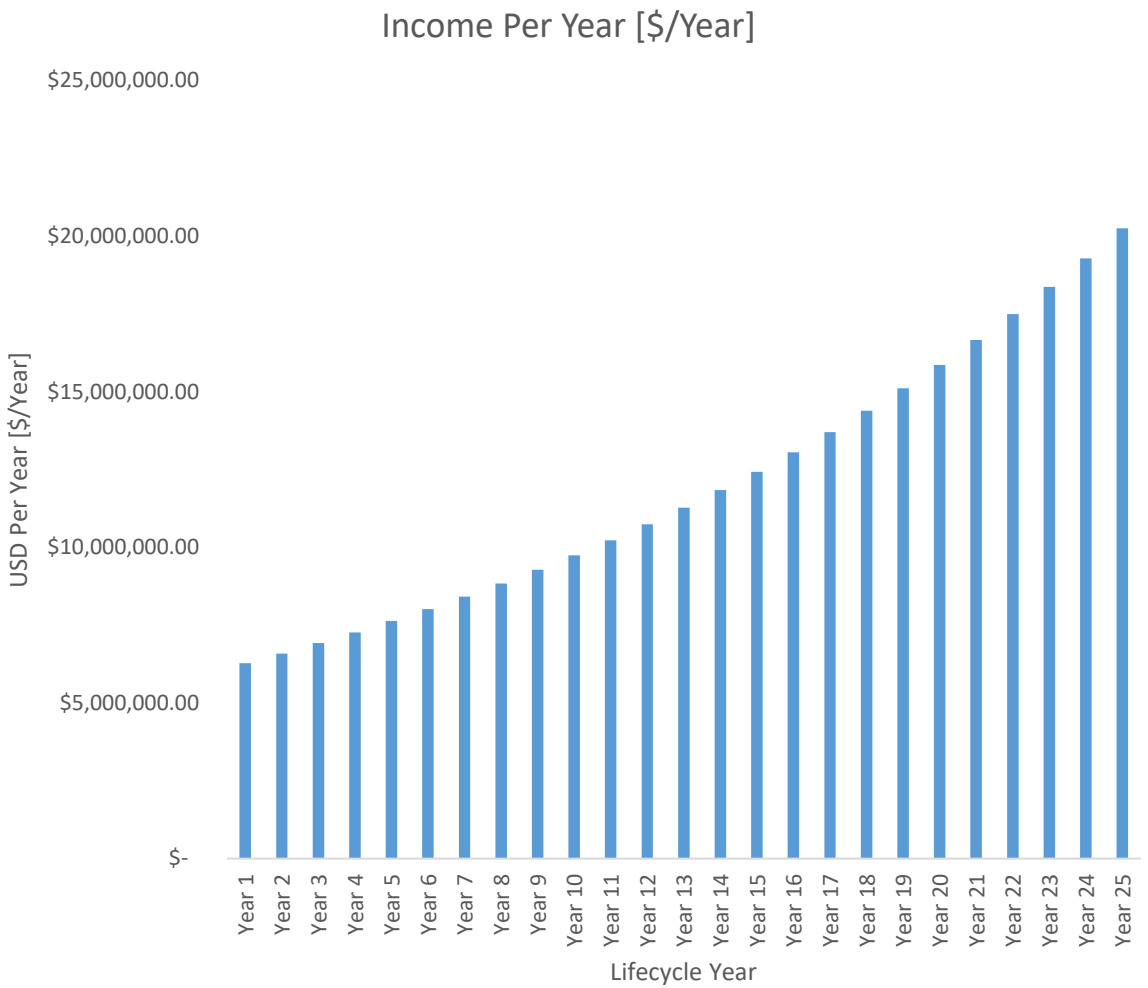
Total CAPEX for construction : $22.2 Million USD

The Operational Expenditure were analyzed by Five Key Categories.





The Hudson-Erie Class Motor Bulk Carier's Income Is Predicted Annually.



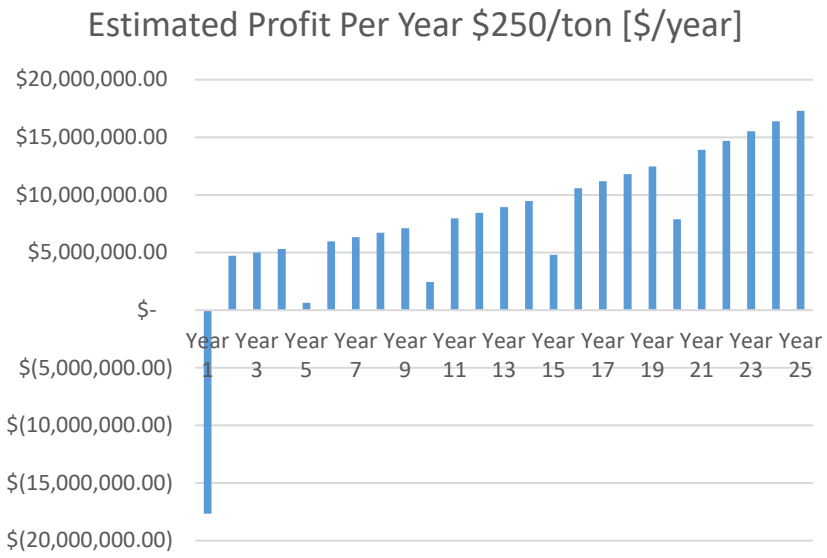
Canal Operates ~160 Days/Year

80% = ~125 Days/Year

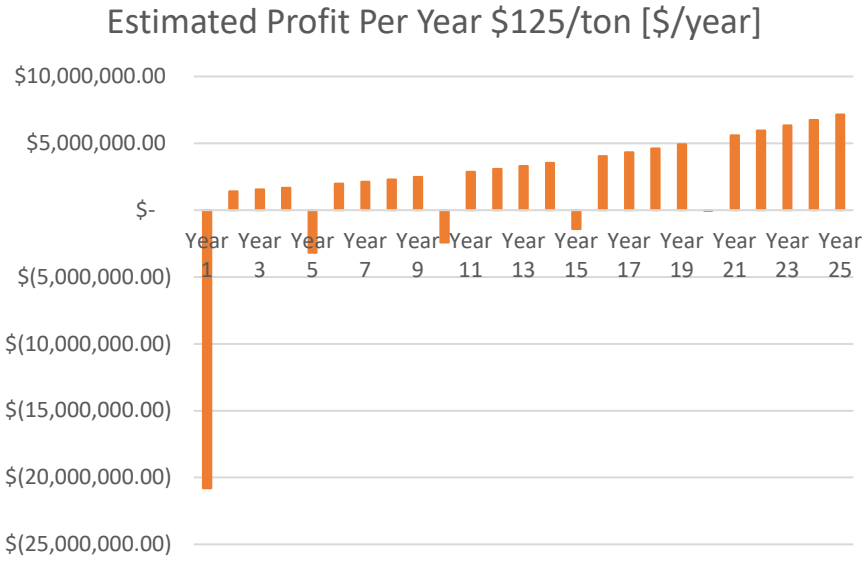
~5 days per trip = ~25 Trips/Year

$250 per ton per trip

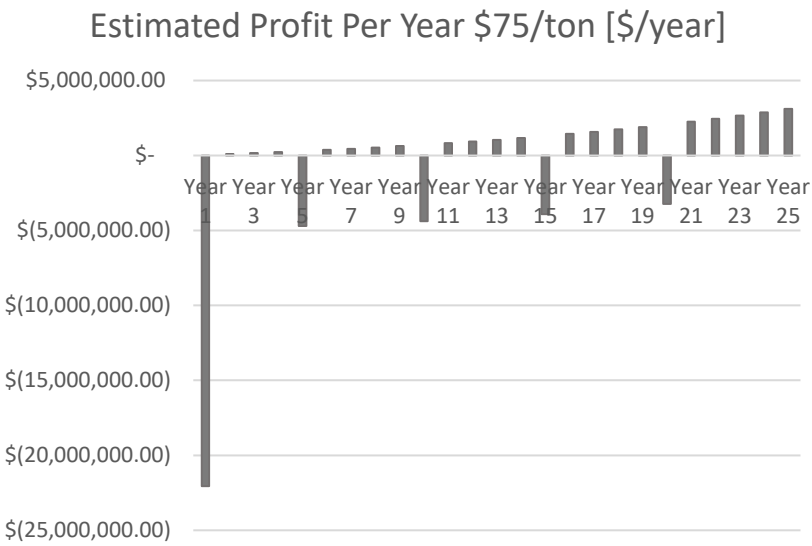
Profit Per Year was Determined at Different Costs Per Ton of Material Transported by the Vessel.



Truck Comparison

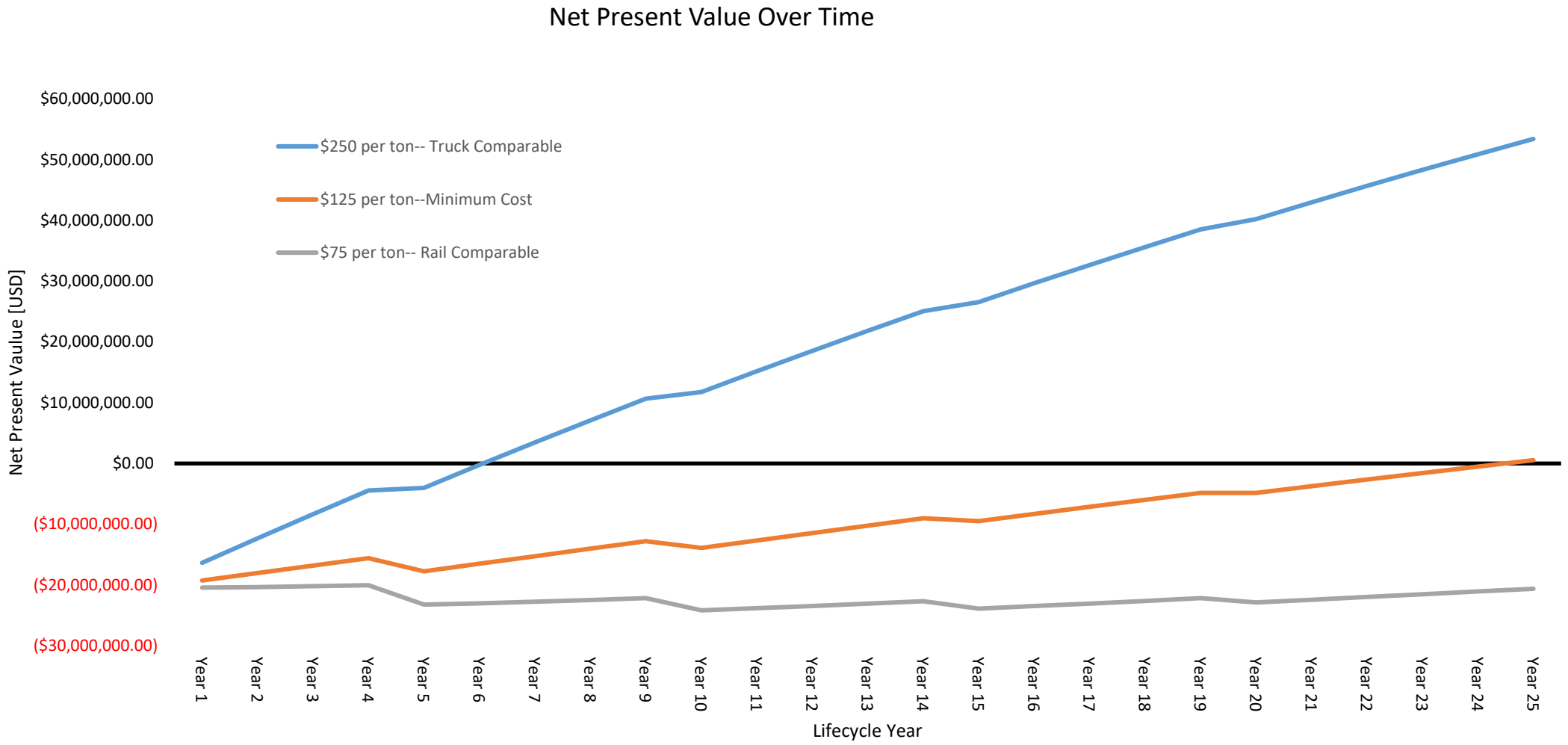


Break Even Point



Rail Comparison

After Conducting a Preliminary Net Present Worth Study, the Investment has Potential for Financial Returns with High Risk.



Renovating the Canal to fit More Economical Sized Vessels Can Aid In Vessel Economics.

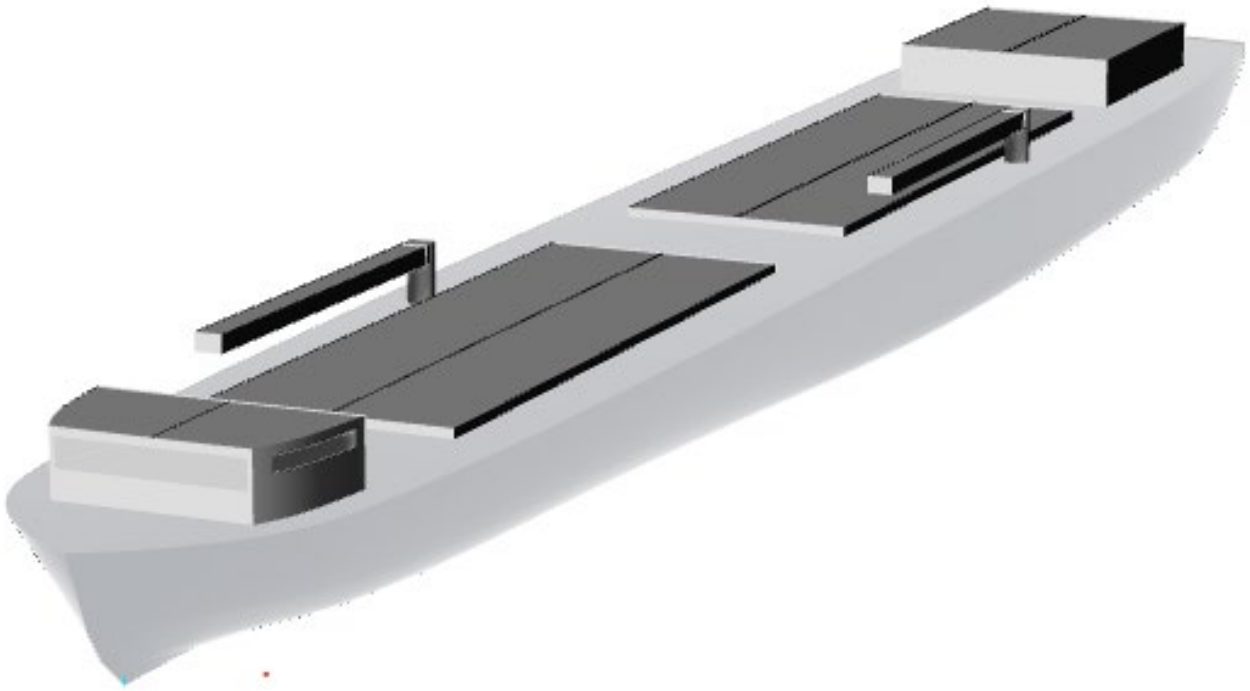


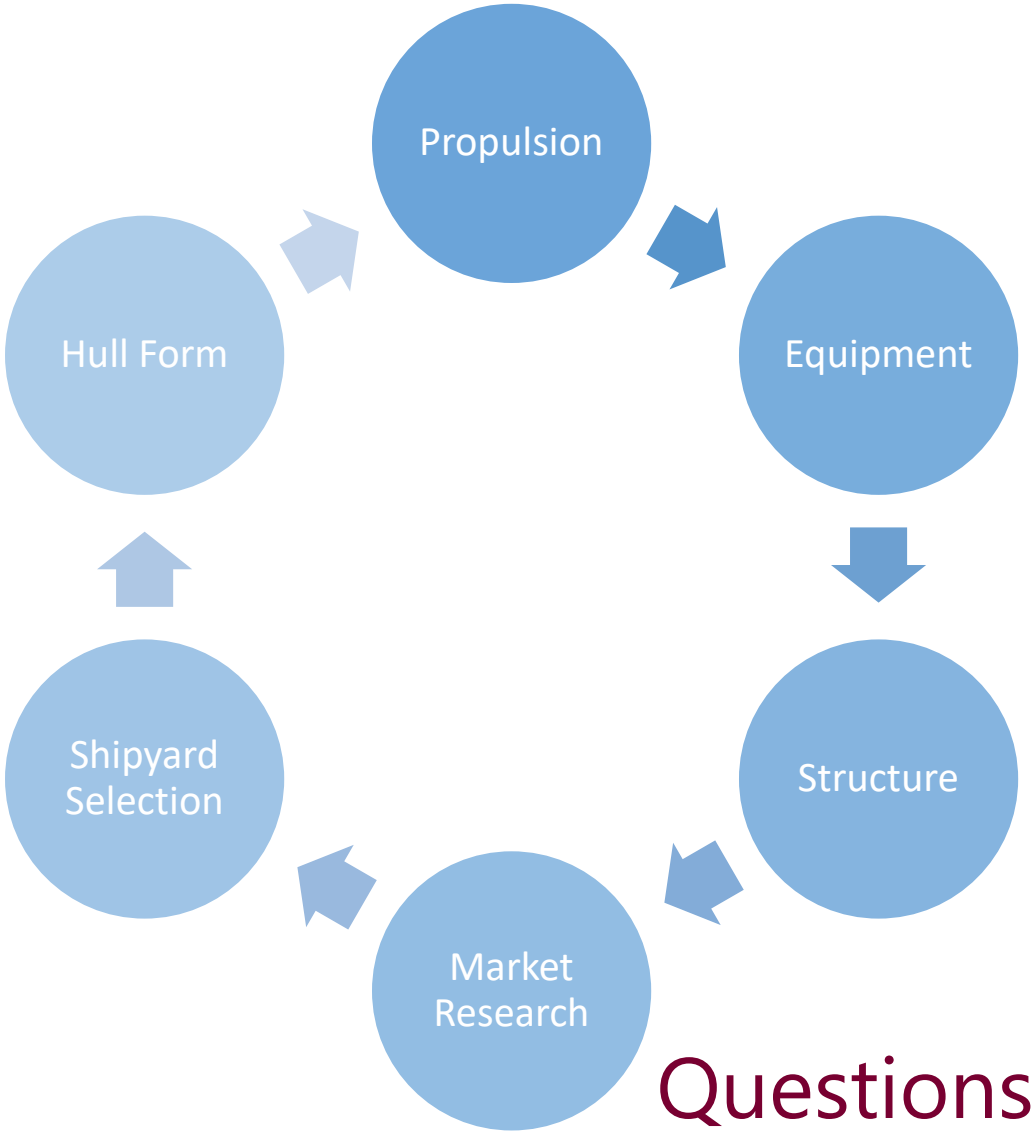
Air Draft of 21 feet

Dredge to Original 12 feet

Image Sources (www.canals.ny.gov and eriecanal.org)

Further Design Work is Required for the Vessel.





Questions?

References 1/3

G. Uttmark, "Assessment of Green Ship Technologies and Plan for Deployment on the Erie Canal / NYS," TransTech Marine Co. , Brooklyn, NY, 2015.
K. Andersson, F. Baldi, J. F. Lindgren, L. Granhag, E. Svensson and M. Wilewska-Bien, "Shipping and the Environment," in Shipping and the Environment, Improving Environmental Performance in Marine Transportation, Berlin, Heidelberg, Springer, 2016, pp. 3-27.
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Thank You!