1 Executive Summary

1.1 Overview

Since the early 1990s, the U.S. Department of Energy has promoted a national movement away from the use of imported petroleum as a transportation fuel. This change was made for reasons that are as relevant today as they were twenty years ago:

- Reducing dependence on regions of the world that are hostile to the United States
- Supporting homeland security goals by using domestic fuel sources
- Helping to reduce the trade imbalance by keeping fuel dollars at home
- Creating jobs
- Making domestic business more competitive through reductions in fuel-related operating costs
- Reducing the environmental impacts of burning gasoline and diesel fuels through the use of lower emission alternatives.

This reasoning continues to be relevant to the marine industry today, even in light of the current price drop of diesel fuel due to the drastic drop in the cost of a barrel of oil and continual tightening of environmental regulations. Oil prices historically are volatile, making it hard for marine operators to plan and remain competitive. A movement toward conversion of ferries and other similar vessels to compressed (CNG) and/or liquefied natural gas (LNG) is starting to be seen worldwide, particularly for vessels operating in environmentally sensitive areas (because of the associated overall emissions benefit as discussed in Section 5).

Conversion from diesel fuel to natural gas as a fuel is not a straightforward process. It requires the participation and coordination of multiple industries working toward that common goal. These include vessel owners and operators, liquid natural gas producers, and fuel distributors and retailers, as well as manufacturers of engines, fuel storage vessels, generator sets, and other shipboard components related to fuel change. The conversion process requires close coordination and a significant investment on the part of all of the above parties. However, the return on investment (ROI) could be high and quick, especially with the projected fuel cost savings of 50 percent or more for operators. Opening the natural gas marine corridor could also provide a new market for the rapidly growing shale gas industry throughout Appalachia and the American inland waterways.

1.2 Study Objectives

The Port of Pittsburgh commissioned this feasibility study to examine the viability of the use of CNG or LNG for towboats operating in the Pittsburgh region. The objective of this study is to explore the creation of a natural gas marine corridor that extends along the Monongahela River from the Morgantown area in West Virginia through Pittsburgh, and down the Ohio River. The goal of this effort was to increase awareness of natural gas as a marine fuel and to expand the potential of natural gas to the often overlooked inland waterway system, which is about 12,000 miles of navigable waters, including the Intracoastal Waterway (the 3,000 mile inland waterway along the Atlantic and Gulf

Coasts). The potential for conversion of these inland waterway fleets is significant as the rising cost of diesel fuel becomes a more significant portion of the operating costs. This is especially so for inland vessels and railroads which have recently been required to switch to the ultra-low sulfur diesel (ULSD) fuels used by highway trucking fleets. This fact, combined with the ever increasing and more stringent environmental requirements, makes conversion of marine fleets to natural gas fueled vessels very attractive.

The goal of this study is to evaluate the use of natural gas as an alternative fuel choice for towboat operators in the Pittsburgh Region and to determine whether sufficient fueling infrastructure exists. This study further seeks to address whether natural gas conversion of inland towboats makes sense and to identify the elements necessary to make conversion worthwhile. It is also intended to provide useful information for both the inland river industry and the natural gas supply industry. It should be noted that one intent of this project is to connect these two industries that are not familiar with each other, but have incentives to work together, in order to better set the stage for success in associated demonstration projects.

This study will investigate key elements to determine if a business opportunity exists for future use of natural gas for marine operations in the Pittsburgh Marine Corridor. This study will:

- Identify drivers for natural gas conversion
- Evaluate inland marine business in the Pittsburgh Marine Corridor
- Investigate applicable engine and fuel storage and handling technologies
- Review regulatory and safety requirements
- Perform a cost-benefit analysis
- Develop shoreside and midstream fueling requirements
- Research nexus point in the region that could provide multipurpose natural gas opportunities.

1.3 Summary of Results and Findings

1.3.1 Conclusions and Recomme ndations

The inland waterway industry in the United States today comprises operators of all business types and sizes. Operators are compliant with current local, state, and federal requirements including the use of ultra-low sulfur diesel and EPA engine Tier requirements. The inland waterway industry has a proud safety and business record that can be traced from the days of the human powered pole flat boats. A big part of this success can be attributed to their conservative approach to adapting changes to technology and operations. Conversion to natural gas use as a fuel on their towboats poses a significant change to the operators and will require something to drive them to do so.

1.3.1.1 Drivers for natural gas conversion

The main factors driving conversion to alternative fuels such as natural gas in the marine industry are emission regulations and economic considerations. Emergent emission regulations continue to require innovation from the operators and engine manufacturers working to keep up with the more stringent

standards. Under the recent EPA Emission Control Areas (ECA) regulation, vessels operating within 200 miles of North America must switch to low sulfur fuels with less than 0.1 percent sulfur content. The American inland waterway system is within this zone, but inland operators will not be affected by this new regulation because they are already utilizing ULSD (0.015 percent) following an EPA decree in 2012. As the more stringent Tier 4 requirements come into effect there may be additional incentives for inland operators to examine different fueling technologies, but for now operators are only required to meet the more stringent EPA Tier requirements when they replace engines.

Given inland waterway vessels already comply with current regulatory requirements, economic factors are the only remaining driver for conversion. The key economic factors are fuel cost differential, vessel operation characteristics, and energy security. When the cost differential of ULSD to natural gas is combined with the amount of fuel a vessel uses and the cost of technology insertion, then a simple cost analysis can be made to determine the cost-benefit of natural gas conversion. Section 10 discusses the cost-benefit surrounding vessel conversion to natural gas.

Fuel cost differential is the difference in the delivered cost between the current fuel (ULSD), and the replacement natural gas fuel. This cost differential is the basis for justifying the conversion cost and will determine the payback period for the investment. When this study was being considered in 2013, according to the EIA, the American crude oil prices were the most stable in more than a decade. While they were not historic highs they were much higher than they are currently. Various factors including economic downturn and market supply have driven the prices down significantly to some of the lowest levels in years. This creates less of an incentive for operators since the gap between ULSD and natural gas has closed significantly, extending the payback period associated with a fuel switch investment.

Recent cost differential changes are similar to what the Ohio River Company faced during the early 1980s. The Ohio River Company took the risk of investing in new engine technology to take advantage of the cost differential between diesel and heavier blended intermediate fuels. In the delay between the decision to build and actual operation, diesel fuel prices dropped to much closer to the price of the heavier fuel. The extra equipment cost and maintenance associated to allow for the use of the heavier fuel was no longer offset sufficiently by the fuel price differential. Eventually the two towboats built were repowered and the fuel tanks were converted again to use conventional diesel fuel.

The characteristics of how a vessel is utilized play a key role in determining the economic viability of natural gas conversion. As anticipated, the long range line haul vessels have the best payback period since they operate long distances and with higher periods of operational stability. The smallest class of vessel this study evaluated was the harbor towboat, representing over 60 percent of the vessels operating in the Pittsburgh region, which had the longest payback periods. Natural gas conversion is more viable the more fuel a vessel uses, the further the vessel goes, and the more consistently the vessel operates at higher loads. Finally, as more conversions are done and natural gas technology matures, the cost of insertion of the technology will lower. This has the impact of reducing the amount of money required for the conversion, which in turn helps to reduce the payback period for the same price differential.

The final factor, energy security, is a much less tangible element. Historically, world events have had a significant effect on the availability and price of fuel. Although the United States has made great strides to increase its petroleum output, production is still nowhere near domestic usage. Through boycott, conflict, or war the supply of petroleum may be disrupted. Using domestically produced natural gas from the Marcellus Shale region would provide a secure supply of fuel for inland operators in the Pittsburgh region and beyond.

1.3.1.2 Inland Marine Business in the Pittsburgh Marine Corridor

According to the Port of Pittsburgh there are 76 regional operators within the study area that together have 261 vessels of various sizes. While most of these operators chose not to participate in the study, those that did reported that in 2012 they used over 14 million gallons of diesel fuel. The largest fleet used over 7 million gallons and the single largest vessel used over 626,000 gallons. Since this data represents only half of the fleet of record for the Pittsburgh region, the potential for more fuel usage and savings is even higher. Using the 1.7 factor to make LNG energy equivalent with diesel (see 3.4.1), the potential exists to use over 23 million gallons of LNG in the Pittsburgh region if all of the vessels were converted to use 100 percent natural gas.

Using U.S. Army Corps of Engineers lock data for the study region, 307 other vessels were identified that are owned and operated by companies not located in the Pittsburgh region. While many of these vessels may not fuel here, it does provide additional opportunity if LNG were available in this region.

1.3.1.3 Availability of Applicable Engine and Fuel Storage and Handling Technology

Part of the inventory effort included obtaining vessel information and specific engine information. This data provided insight into the age of towboats and the engines they use. Unlike the ocean (salt water) going industry, the inland river (non-salt water) industry tends to keep vessels in service for much longer than ocean going vessels exposed daily to the corrosive effects of salt water. This means towboats have a longer life, and while many are uniquely designed vessels, they tend to use the same brand of engines across the fleets. The most commonly used engines across the fleets include Caterpillar, Cummins, Detroit Diesel (now Rolls-Royce), EMD (now Caterpillar), and John Deere. The manufacturer and model engine are dependent on the size and type of service the towboat performs.

The inventory also included evaluating the exhaust emission inventory of the vessels and comparing it to the EPA reported towboat exhaust emission inventory. This was a very difficult challenge, since the numbers reported by the EPA for 2008 were in line with what we estimated using current actual fuel numbers. The 2011 EPA inventory, however, had a dramatic reduction of marine vessel generated exhaust emission, with less than half in every exhaust emission category. The models used by the EPA for estimating vessel emissions seem suspect because they do not reflect the different vessels and operating ranges of vessels in the region, nor are the emission factors used based on marine vessels, but instead locomotives. According to the Pennsylvania Department of Environmental Protection, the EPA is modifying its modeling methodology for future marine vessel inventories. Therefore while it appears that the insertion of natural gas into the towboat fleet should have a positive effect by reducing emissions like NO_X, SO_X, and particulate matter, it is difficult to estimate the impact.

1.4 Key Recommendations

Key recommendations include:

1. Continue Clean Fuel/Clean Rivers initiative to communicate natural gas opportunities as well as other alternative fuel and environmental initiatives for the marine towing industry in the Pittsburgh region.
2. Initiate a natural gas conversion demonstration project in a smaller harbor size (less than 1,500 horsepower) towboat. This type of towboat tends to operate in a specific location within the Pittsburgh region and have an operating profile much different than typical line haul vessels. Smaller towboat also means smaller fuel consumption which makes payback much longer for any investment. Since all of the work currently being done around towboat conversion is for larger vessels, a demonstration for this smaller sized vessel will help to develop realistic conversion prices instead of scaled prices.
3. Maintain a dialogue among operators, LNG suppliers, and regulators through communication with the Port of Pittsburgh. Currently most inland operators are focusing on meeting the impending Subchapter M requirements (addressing U.S. Coast Guard regulations governing inspections, standards, and safety management systems of towing vessels – see 8.2).
4. Develop better models for towboat operations for the different types of vessels in the Pittsburgh region. This will provide better opportunity to evaluate technology insertion to increase fuel efficiency, use of alternative fuels, and lowering exhaust emissions.
5. Continue moving forward with designs and concepts for LNG conversions of towboats. Currently the economics may not be there; however, if petroleum prices increase dramatically again conversion may become financially practical.
6. Investigate opportunity to carry LNG as a cargo fuel in river barges for transit domestically and internationally.