Lake Michigan Carferry, Inc.

Application for an Individual National Pollutant Discharge Elimination System Permit to Authorize Limited Discharge of Effluent Containing Coal Ash from the S.S. Badger

Supplemental Submission by Lake Michigan Carferry in Response to
February 24, 2012 Letter from Region 5, U.S. Environmental Protection Agency

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I. SUMMARY

A. Permit status

The current vessel general permit ("VGP") authorizes the discharge of coal ash from Lake Michigan Carferry, Inc.'s ("LMC") S.S. Badger ("Badger"), an existing facility. That authorization expires on December 19, 2012. LMC seeks an individual National Pollutant Discharge Elimination System ("NPDES") permit to renew the authorization for that discharge, to become effective upon expiration of the current authorization. All other discharges incidental to normal operation of the vessel will continue to be covered by the current VGP and by the proposed 2013 VGP when it becomes effective. Those other discharges are therefore not included in this application, as discussed with counsel for the Environmental Protection Agency ("EPA"), Region 5.

B. Recommended Best Available Technology

We understand that the agency has promulgated no industry-specific guidelines applicable to this sector, nor are there effluent guidelines promulgated for this particular discharge other than that which exists in the current VGP. LMC is seeking authorization to discharge coal ash using the same Best Available Technology ("BAT") approved by EPA in the 2008 VGP authorization, but modified with additional conditions, as set forth below:

a. Minimization of coal ash slurry discharge.

Permittee must minimize the discharge of coal ash slurry into waters subject to this permit. Minimization techniques shall include:

- Efficient combustion of coal,
- Minimize the ash content of the coal used onboard, but in no event may the ash content exceed 9.5% (by weight and as received), and

- Limiting discharge quantities to those necessary for the safe and efficient operation of the vessel.

b. Coal sulfur content.

Permittee must minimize the sulfur content of all coal ash slurry discharged into waters subject to this permit by using coal with the lowest sulfur concentration technologically feasible and economically practicable and achievable, but in no event may the sulfur content of the coal exceed 1.023% (by weight and as received).

c. Limitations on coal ash discharge locations.

Except in emergency situations, as determined and documented in the ship's log by the vessel's master, coal ash discharge may only occur when the vessel is:

- If in waters subject to this permit, more than 5 nm from any shore and in waters over 100 feet in depth, and

- Underway at a speed of at least 6 knots.

d. Efficiency improvements.

Permittee will continue to work to improve the efficiency of its engines, and the reduction in use of coal, and on an annual basis report to EPA such improvements that are implemented.

e. Development of new technology.

Permittee will monitor, and to the extent economically practical, research and contribute to the development of a technology that will result in the complete elimination of the discharge of coal ash, preferably through the use of alternative fuel or an alternative propulsion system. On an annual basis (permit anniversary date), permittee will report to EPA on its efforts. When an alternative technology that would eliminate the discharge becomes technologically feasible and economically achievable and practicable, LMC will enter into an agreement with EPA establishing a schedule with reasonable milestones for implementation of this system.

C. Environmental impact of recommended BAT

The continued conditional discharge of coal ash under the recommended BAT, until an alternative technology is both technologically feasible and economically achievable and practicable, presents no risk to human health or the environment. *See* Section V.B.1 below. In analyzing the coal ash discharged from the Badger, only 18 of the 110 constituents analyzed were present, and of those, the levels were far below water quality limits set by applicable Michigan, Wisconsin, and federal law, procedure and guidance. The Badger's total discharge of mercury – 0.0013 pounds per year – less than *two one-hundredths (0.02) of an ounce per year* – is well below the levels granted in many NPDES permits issued by Michigan (under the Michigan Department of Environmental Quality's ("MDEQ") Multiple Discharger Variance ("MDV") for Mercury for Fiscal Years 2010-2014, *see* Attachment CC at CC-100), and Wisconsin (as alternative mercury effluent limitations allowed by WIS. ADMIN. CODE NR § 106.145 (2005). *Available at* http://dnr.wi.gov/org/water/wm/wqs/codes/nr106.pdf (*last accessed on* May 15, 2012)), both of which have been approved by EPA. In fact, the average daily mercury load from NPDES-permitted point sources discharging into Lake Michigan is approximately ***36 times*** higher than the amount discharged by the Badger. In sum, there is no scientific basis to conclude that the scope, extent, or manner of coal ash discharge from the Badger creates a risk to human health or the environment.

II. BACKGROUND INFORMATION RELEVANT TO PERMIT APPLICATION

A. History of the Badger

Built in 1953, the original mission of the Badger was the transportation of railroad cars and freight across Lake Michigan; the Badger is one of a fleet of rail car ferries that once operated on the Great Lakes. After ceasing operations as a rail car ferry in 1990, the Badger sat idle until service was restored in 1992 in its current incarnation as a vessel transporting passengers, their vehicles, and commercial vehicles between Ludington, Michigan and Manitowoc, Wisconsin. Today, the Badger has a capacity of 600 passengers plus 180 autos, or a combination of autos, trucks, tour buses, recreational vehicles, motorcycles, and other vehicles. It provides substantial economic and environmental benefit to the communities on both sides of Lake Michigan, moving thousands of cars, trucks, equipment and people during its annual five-month operating season and creating a tourist industry that otherwise would not likely exist. The Badger currently operates about 140 days per year.[1] During the height of the season, it operates 24 hours, seven days a week, making two round-trips between Ludington and Manitowoc every 24 hours. Approximately 59% of the Badger's sailing days are double sailing days (making two round-trips per day). There is a 1-2 hour layover in each port to load and unload passengers and equipment, load coal and perform other necessary tasks.

The Badger is 410 feet in length and more than 50 feet in width. Its height is 106 feet or seven stories, and its weight is 6,650 tons displaced. Schematics and photographs of the vessel can be found at Attachments A, B, C, and D.[2] There is no other operating ship like it, an important reason why it has become a major tourist destination in the Midwest. The Badger's uniqueness is recognized in a number of awards:

- Its propulsion system was designated a mechanical engineering landmark by the American Society of Mechanical Engineers (1996).
- It was officially named a registered Michigan historic site by the Michigan Historical Commission (1997).
- It was officially named a registered Wisconsin historic site by the Wisconsin Historical Commission (1997).
- It was designated a Michigan Centennial Business by the Historical Society of Michigan (1997).

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[1] In 2008, it operated 154 days, but the downturn in the economy reduced that.

[2] In addition, the schematics contain numbered reference points that relate to photographs that are included here in Attachment C. These are discussed throughout this submission.

- It was named Ship of the Year by the Steamship Historical Society of America (2002).
- It was named to the National Register of Historic Places (2009).

B. Economic benefits of the Badger

Operation of the Badger provides economic benefits to both of its port destinations and its passengers. According to a study performed in 1991 by West Shore Community College for the Mason County Economic Development Alliance, the continued operation of the Badger will provide approximately $867 million in economic benefits to the towns of Ludington, Michigan and Manitowoc, Wisconsin in the 20-year period ending in 2029. *See* Attachment E. Shutting down the Badger would erase these economic benefits and cause significant harm to the economies of these towns. Attachment F illustrates the economic benefits the Badger provides its customers, including savings in travel time, fuel, and accident avoidance costs.

Additionally, as described below, the Badger significantly reduces highway travel around Lake Michigan. If the Badger ceases to operate, studies suggest that it would likely significantly increase the costs associated with travel time and cause marked increase in traffic fatalities. *See* Attachment G.

C. Environmental benefits of the Badger

Operation of the Badger significantly reduces vehicle gas and diesel consumption, car and truck emissions and noise pollution, and relieves vehicular congestion. Attachment F. The Badger provides ferry service to thousands of cars, trucks, and passengers each year because those vehicles need not drive the 400+ miles around Lake Michigan, and saves an estimated 1 million gallons of gasoline and diesel fuel. These reductions equate to annual air pollution reductions of more than 4.3 tons of total hydrocarbons, 100 tons of carbon monoxide, 20 tons of nitrogen oxide, and 1000 pounds of particulate matter. *See* Attachment H. Moreover, an overall cost-benefit analysis done years ago and not adjusted for inflation reveals that the net economic value of these benefits would exceed over $42,000,000 between 2011 and 2020. Attachment F.

D. History of EPA review of the Badger

EPA in Washington and Region 5, Wisconsin, and Michigan have been provided with extensive information regarding the environmental impact of the Badger, dating back to 2008. On June 26, 2008, LMC provided Region 5 with extensive and detailed responses to an information request submitted under Section 114 of the Clean Air Act ("Section 114 CAA Response"). On October 27, 2008, LMC provided Region 5 with extensive and detailed responses to an information request pursuant to Section 308 of the Clean Water Act ("Section 308 CWA Response"). Both responses were also provided to Michigan and Wisconsin authorities. On October 10, 27, and 29, 2008, LMC made extensive submissions to EPA in Washington in connection with the development of the current VGP that governs incidental discharges from vessels.

On December 19, 2008, based on these submissions, EPA determined that the Badger's coal ash discharge with conditions is BAT until December 19, 2012. This was based on LMC's belief that it could find a technically feasible and economically achievable solution to eliminate the coal ash discharge before the 2013 season begins. *See* Attachments I, J at 5-10, and K at 2-4. EPA indicated that if this was not possible, and if further authorization was needed, LMC should pursue it as an individual permit as to the discharge because it is the only one of its kind. Proposed VGP: EPA's Response to Public Comments, (Dec. 19, 2008) (Attachment L at 6-558) and 2013 VGP Fact Sheet (Attachment M at 176).

While pursuit of an ash retention alternative is extremely challenging, LMC continues to utilize expert engineers to try and resolve these issues. LMC recognized in mid-2011, after already expending significant effort at a cost of about $250,000, that there was no technically feasible or economically achievable means of eliminating the discharge by the December 2012 expiration date. As a result, in June 2011, LMC met with EPA in Washington (along with Region 5 officials who were present by phone) regarding seeking an individual permit. At EPA's direction that LMC seek an individual permit, LMC met with Region 5 in Chicago two weeks later to discuss the requirements for an individual permit. In October 2011, Region 5 advised LMC that it was required to file a petition for authorization to file an individual permit application. While LMC did not think it needed permission to file a permit application, it complied with Region 5's request on November 2, 2011. The petition, including all of the information referenced above, is posted on EPA's website, available at http://epa.gov/r5water/npdestek/badger/ (*last accessed on* May 9, 2012).

On February 6, 2012, EPA responded to the petition, and officially notified LMC that it was required to file an individual NPDES permit application by June 29, 2012 if it wished to continue to discharge coal ash, but indicated that further instructions would be forthcoming. Attachment N. On February 24, 2012, EPA provided LMC with twelve pages of further instructions. Attachment O. On March 6, 2012, EPA and LMC had a conference call to answer any questions LMC had regarding the February 24, 2012 instructions. On that date, EPA requested that LMC put those questions in writing and LMC did on March 9, 2012. Attachment P. EPA responded on March 27, 2012. Attachment Q.

III. EPA REQUEST FOR SUPPLEMENTAL INFORMATION: ENCLOSURE 1 TO LETTER OF FEBRUARY 24, 2012[3]

A. Provide specific details on the age of the vessel and equipment installed on board the vessel associated with the generation and transport or discharge of coal ash. Please specify any equipment that has been installed, replaced or substantially modified since January 1991 and the date of installation, replacement or modification.

1. Age of the vessel

As described in Section I above, the Badger was constructed in 1953 for the purpose of transporting railroad cars and freight across Lake Michigan. After ceasing operations as a freight and railroad car ferry in 1990, the Badger was restored in 1992 as a passenger and vehicle ferry traveling between Ludington, Michigan and Manitowoc, Wisconsin.

2. Equipment associated with the generation, transport, and discharge of coal ash

The equipment installed on the vessel associated with the generation, transport, and discharge of coal ash was explained in great detail in the Section 308 CWA Response and specifically questions 1, 2 and 3 and the various attachments thereto which are incorporated herein by reference and can be found on the EPA's website (http://epa.gov/r5water/npdestek/badger/) and as part of Attachment J to this submission. To make sure LMC is fully responding, we are again providing detailed descriptions of every step in the process from the delivery of coal to its storage, transfer to the boiler, and the subsequent generation of ash, the collection of ash in three locations, and its transfer and discharge.

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3 EPA's February 24, 2012 letter indicated (as it also said in its February 6, 2012 letter) that it "does not believe that the petition documents submitted on November 2, 2011, contained adequate support for the conclusions about the availability or feasibility of technologies/control techniques to address the coal ash discharges. EPA requests the following information to assess the coal ash discharges as a result." It therefore included a 14-page list of instructions, and permitted LMC to resubmit relevant prior information in a way that addressed EPA's instructions.

We start with a diagram of the Badger showing locations of coal storage bunkers, boilers, storage areas for the coal ash, the coal ash conveyor system, and the coal ash discharge points to Lake Michigan. Attachment A shows an outboard and inboard profile of the Badger.[4] The coal storage bunkers ("coal bunkers") and boiler room are labeled. Coal ash ("bottom ash") accumulates in the bottom of the boiler itself and is not separately shown. Smaller amounts of coal ash also accumulate in the economizer ("economizer ash"), which is noted on Attachment B at Location 2. Even smaller amounts of coal ash accumulate in the storage hoppers for the dust collectors ("fly" or "collector ash"), which are marked on Attachment A as "Dust collector storage hoppers."

Attachment B shows Engine Room Overhead View and Engine Room Elevation drawings. The Engine Room Elevation drawing depicts the location of the coal bunker (labeled next to the number "8").[5] The four boilers are depicted on the Engine Room Overhead View. The location under each boiler where bottom ash accumulates is labeled on the Engine Room Elevation view as "bottom ash collection points." The vacuum conveyor system for the ash is depicted in blue on both views. The coal ash discharge points on the vessel are depicted at the end of each arrow where the words "Frame 95"[6] are written. The original blueprint for this system, which was constructed into and as part of the Badger and still exists in its original structure, is included as Attachment D.

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4 It is important to note that these drawings cannot fully depict all of the equipment that is present. There is an extraordinarily large amount of equipment that was designed and built into confined spaces. Depicting all of this equipment on a single drawing would result in an almost illegible document.

5 These are location points on Attachments A and B. Those points correspond to photographs with the same numbers that are referenced below and grouped as Attachment C of this Submission.

6 Locations on ships like the Badger are determined by "frames" and "strakes" on the hull plate. Each frame is numbered, starting with 1 at the bow and moving from bow to stern (front to back), at two-foot intervals. Each strake is labeled starting from A on either side of the keel and with subsequent letters at variable distances as one moves up the hull from the keel. Thus, the discharge points for the coal ash are located at Frame 95, Strake K.

The other equipment associated with the generation of ash is the boiler system described in Section III.B.3.

3. Equipment installed, replaced or substantially modified since January 1991 and the date of installation, replacement or modification

LMC understands from the March 6, 2012 call that this question refers to equipment associated with the generation, transport or discharge of coal ash. The Badger continually works to ensure that its engines are operated as efficiently as possible, and its environmental footprint is as benign as possible. Examples of these efforts include:

- The original Wager smoke-eyes allow the Badger's crew to monitor individual boiler emissions from the boiler room, and a video monitor system installed in 2000 allows the engineer to observe overall stock gas opacity and feed rate from the engine room. This information is used to help the fireman adjust the combustion air in order to burn fuel more efficiently which reduces the generation of ash.

- In 1992, LMC designed and installed solid state circuitry to replace obsolete vacuum tube balance circuits in the plant master steam pressure control. LMC also designed and installed solid state circuitry to replace obsolete vacuum tube circuits in coal stoker drive controls. This was LMC's first attempt to automate, rather than to manually control, the system to produce more efficient fuel burn, which in turn reduces the generation of ash.

- In 1993, LMC replaced the solid state circuitry that LMC previously designed, and installed a Johnson Yokogawa PID microprocessor controller to replace the plant master control. LMC also installed a Johnson Yokogawa steam pressure transducer to send steam pressure signals to the new plant master. These reforms allowed LMC to better control its fuel input and fuel combustion, thus reducing the generation of ash. *See* Attachment J at LMCF00196-00216.

- LMC installed Honeywell drive motors to interface the plant master signal to coal stoker drives. This was done in an effort to modernize the system and automate, rather than to manually control, the system to burn fuel more efficiently, which contributes to the reduced generation of ash.

- In 1993, LMC hired a consulting firm to evaluate the Badger's boiler operations and make recommendations.

- In 1994, LMC installed four new Beck drive motors on coal stokers and four API process control isolators to interface with the Johnson Yokogawa plant master to Beck drive motors. This installation completed the replacement of the previous circuit system that began in 1992, and in 1994, LMC installed Wechsler digital bar graph gauges to indicate the percentage of coal feed. This provides the operator with a visual indication of the amount of fuel being fed into the boiler and immediately alerts the operator when the vessel has a high rate of fuel feed, which can lead to less efficient fuel combustion boiler operation, and greater ash generation.

- LMC installed Dwyer differential pressure switch gauges to monitor combustion chamber pressure and to operate flue dampers to maintain constant pressure. LMC also installed Duff-Norton actuators on flue ID inlet dampers, which are operated either manually or automatically by the Dwyer pressure switch gauges to allow the vessel to maintain the most appropriate air-fuel ratio, which is crucial for running a cleaner stack and more efficient fire.

- In 1995, LMC obtained a spare Johnson Yokogawa PID controller and a spare Johnson Yokogawa master pressure transducer for use in the event of microprocessor failure.

- In 1997-1998, LMC replaced all wall and floor boiler tubes in all four boilers. This repair increased the efficiency of the boiler operation, thus contributing to the reduction in the amount of ash generated.

- In 1999, LMC installed four additional Beck motor drives to operate forced draft dampers under direct manual operation by the ship's crew. This conversion allowed the vessel to better control its air-fuel ratio consumption which contributes to greater efficiency.

- In 1999, LMC installed four Wechsler digital bar graph instruments to indicate the percentage of forced draft primary combustion air, which allows the crew to monitor the positioning of the forced air damper feed back.

- In 1999, LMC again retained Maurice L. Kelsey & Associates, Inc. to review some of the recent additions and installations and offer more recommendations for achieving a more efficient fuel combustion, which helps reduce ash generation.

- In 2000, LMC added a stack cam video camera, which focuses on the top of the stack and allows the engineer on duty below to monitor the stack smoke and ensure that the vessel's smoke emissions are as low as possible.

- In approximately 2000, LMC replaced generating, screen, and superheater tubes, as well as related brick work for the forward and after starboard boilers. These replacements allowed the boilers to operate more efficiently, which in turn reduces the generation of ash. Stokers are overhauled during every off season, and all force draft fans, induced draft fan turbines, and over fire air fans have been overhauled in the last five years.

- In 2004, LMC replaced the superheater tubes in the afterport and forward port boilers, some of which were plugged and operating inefficiently. This replacement increased the efficiency of the boiler operation, thus helping to reduce generation of ash.

- In 2008, the stoker secondary air supply was ducted so that it is fed from the forced draft, which allows greater flexibility and results in more burn efficiency and reduced ash generation.

- The dump grates on all four boilers have been replaced with a redesigned pattern to allow improved forced draft, which has decreased gas velocity through the furnace to allow more air into the boiler so that the boilers burn cleaner.

- Tachometers have been installed to allow remote monitoring of the induced draft fan turbine speeds to better control the fuel combustion and ash generation.

- In 2007/2008, LMC replaced all the condenser tubes on the port and starboard side. A number of these tubes were plugged and were causing the vessel to operate less efficiently. Because of the added cooling capacity, the Badger has a better vacuum, which allows the vessel to have more torque and use less fuel when maneuvering. This also helps the Badger to reduce its smoke.

- In 1992 when the Badger resumed operation, a decision was made to cease using four boilers, and using the fourth boiler as a standby, which reduces fuel consumption, and therefore ash generation. Previously the Badger frequently ran four boilers. This reduced fuel consumption by approximately 20 percent and, therefore, reduces ash generation as well.

- In 2009, LMC undertook a program to replace generating tubes, surveyor tubes, feeder and floor tubes throughout the boiler.

- In 2009, LMC modified the piping system to run simultaneously.

- In 2010, LMC overhauled and refabricated the coal conveyor systems, which allow coal to be delivered in better conditions so as to improve burn efficiency and thus reduce ash generation.

- In 2011, all forward and port boiler tubes were replaced, which increases efficiency.

B. Provide a detailed description of the processes required for daily operations and discuss how coal ash is handled onboard the vessel from the loading of coal to the discharge of the coal ash into waters of the U.S. This should include at minimum, boiler operation, ash handling systems, ash collection/transport systems and the coal ash discharge system.

Below is a narrative description of all processes for the utilization and ultimate disposal of coal ash from the Badger, including but not limited to, the transport of coal on board, the storage of coal prior to use in boilers, any pulverizing or other preparation of the coal, the transfer of coal to boilers, boiler operation, the removal of coal ash from boilers, the quenching and/or storage of coal ash after removal from boilers, the transfer of coal ash to the conveyor system, the conveyor system for moving the coal ash, and the ultimate discharge (identifying the point of exit from the Badger to Lake Michigan). References to diagrams, illustrations, and photographs are included. It should be noted that dating back to 2008 EPA has been, and continues to be, invited to come on board and see this entire operation.[7]

1. Fuel purchase

Coal is typically purchased from the Manitowoc Public Utility, located next to the slip where the Badger docks in Manitowoc, Wisconsin. A photograph of the coal storage area is attached as Attachment C-15. A driver transfers coal from the facility onto a Hopper semi-trailer ("Hopper"). Using the Hopper, the driver then transfers the coal approximately 500 yards onto the Badger, where it is deposited in the Badger's bunker. Attachment C-16 shows the truck

[7] Most of this information is drawn from the previous submission to EPA, Michigan, and Wisconsin described in Section II.D above.

leaving the coal facility. Attachment C-17 shows a close-up of the bottom of the truck sitting on top of the bunker before it deposits the coal into the bunker.[8]

After delivery aboard by the Hopper truck, there are three stages of coal handling aboard the Badger: fuel transfer, combustion, and ash discharge. The systems used are original to the vessel and have not been significantly altered since the vessel was built in 1953.

2. Fuel transfer

Coal is stored aboard the vessel in a space designated as the "main bunker," located forward of the boiler room between watertight bulkheads 61 and 82, athwartship the width of the vessel and vertically from the bunker floor to the deckhead under the car deck. The coal bunker is shown on Attachment B at location 8 and is pictured on Attachment C-8 to this submission. The coal bunker is approximately 42 feet long, 56 feet wide, and 20 feet high.

Coal is transferred from the main bunker to the day bunkers (location noted on Attachment B as "Day bunker" between Frames 110 and 90 (or approximately Frame 100)), which delivers the coal for use in the boilers. This is accomplished by manually operating a series of Stephens-Adamson conveyor systems. Specifically, Simplex quadrant gates are manually adjusted to allow the coal to drop vertically a distance of 24 inches onto one of two Style "F" apron conveyors. This pair of conveyors moves the coal from either the port or starboard side of the main bunker as needed. These conveyors are not operated simultaneously. The "Port apron conveyor" and "Starboard apron conveyor" are labeled on the Engine Room Overhead View drawing in Attachment B and as "apron conveyor" on Attachment A.

8 This is explained in the Section 114 CAA Response posted on EPA's website at http://www.epa.gov/r5water/npdestek/badger/ at Petition Attachments E-1a, E-1b, and E-1c (*last accessed on* April 18, 2012). A copy is also part of Attachment J to this submission, after page 11.

(Attachment C-11 is taken from between the two conveyors looking toward the port side conveyor.) Each conveyor transports the coal aft (toward back of vessel) to Frame 83, where it is delivered to a pair of Ring-type, single rotor, Knittel crushers.

The coal passes through the Knittel crushers, which are shown on Attachment B on both the Engine Room Overhead View and the Engine Room Elevation View. The coal is then delivered through a watertight closure at location Frame 83 into hopper-fed 9" L-type Redler conveyor-elevators. These locations are depicted on Attachment A. (Attachment C-2 shows a long, square piece of equipment, which is the Redler conveyor.) There are two of these crusher-elevator systems for redundancy; however, only one is operated at a time. The Redler conveyor-elevator moves the coal aft, passes under and between the forward boilers for a distance of 30 feet (Attachment C-3), and then vertically 30 feet (Attachment C-12 to location 12 on Attachment B), delivering the fuel into another hopper on the center-line at Frame 98. From this hopper, coal is fed outboard to the port and starboard day bunkers, via four variable pitch screw conveyors, to each port and starboard bunker. The port and starboard conveyors are divided both longitudinally and transversely, forming four chutes to feed the coal by gravity, vertically downward into each of two Hoffman Type-C overfeed stokers mounted to the front of each boiler (Attachment C-1). The day bunkers are just above the area labeled "Day bunkers" on the Engine Room Overhead View on Attachment B. This transfer process from the coal bunkers to the day bunkers takes approximately 30 minutes and is repeated once during each four-hour watch.

3. Combustion

Each of the four Foster Wheeler D-type main propulsion boilers is fitted with stoker fronts designed by Hoffman Combustion Engineering.[9] Two Firerite Model 41 Type-C spreader stokers (Attachment C-1 and labeled "Stokers") receive coal from their respective day bunkers via chutes delivering to the top of the variable feed plate. Feed rate is controlled through mechanical linkages with input transmitted from a Yokagowa processor interface drive, which derives its signal from main steam manifold pressure. (In other words, the rate at which coal actually enters the furnace is determined by sensors that monitor the steam pressure to determine feed input rate.)

Each boiler furnace contains two zones, one inboard and one outboard. The stokers, used singly or in pairs as required to accommodate steam demand, deliver fuel for combustion onto "dump grates" in each of their respective zones in each furnace. When the Badger is in port, three stokers (one for each boiler) are manually disconnected to prevent coal from entering the boiler. This allows the fire in one zone of each boiler to substantially burn out. This takes approximately 15 minutes. The fireman then tips the dump grate so that the ashes drop down into the floor of the boiler below the grate where it enters the removal and discharge system.[10] The collection points are shown on Attachment B near the boiler and are labeled "bottom ash collection points." The grates are then replaced to their horizontal position, the stoker is reconnected, and coal enters the boiler to renew the fire in that zone. Once the boilers stabilize,

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[9] Related descriptions of the Boiler system operation are in Attachment I at 4, and Attachment J at LMCF00091 (Operator Manual for Boiler).

[10] There is no appreciable reduction in the generation of coal ash when the vessel is at the dock or because three stokers are shut down. This is because steam demand is what drives fuel demand, and the difference in steam demand while in port is minimal because other systems on the vessel require power to continue to operate (electricity, hot water, etc.). When several stokers are shut down, others work harder. The clean stokers also operate more efficiently.

the same process is followed with the three stokers serving the other zones in each boiler. Thus, by the time the Badger is ready to leave the port, the bottom ash is collected in the bottom of the boilers, in each of two zones in each boiler. The ash is held here until such time as the vessel is in waters suitable for ash discharge.

4. Ash removal and discharge

The ash removal and discharge system has two components: 1) the United Conveyor vacuum conveyor system, which was constructed as part of the Badger's original furnace system, into which ash is moved from various locations, and 2) the pumping system, also a part of the original construction, which uses water flow to create an air vacuum in the conveyor system that pulls the ash from the conveyor system into the water stream and discharges it from the vessel. The current ash conveyor system is depicted on Attachment B in blue, and the pumping system is depicted in green. Below is a description of how the ash conveyor system is connected to the boiler system, how solid ash enters the system, and how the pumping system creates a vacuum for the ash conveyor system and pulls the solid ash into the water for discharge. Each of these systems was designed and constructed into the vessel such that its various components (especially piping) weave in and out of very small and confined locations, into and out of several decks, and are constructed to avoid breaching watertight compartments.

a) Ash Conveyor System

The solid ash from the bottom of each boiler is manually pulled out of the boiler and into a receiver constructed into the system about 16 inches from the boiler. These receivers are depicted on Attachment C-1 and on Attachment B at location 1 and at various locations labeled as "R" near the boilers. To remove the ash from the bottom of a boiler, the fireman must close the damper in the back of the boiler through which air is fed for combustion (called forced draft), and then he can safely open the access door to the front of the boiler. Using special tools, the bottom ash is then pulled out of the bottom of the boiler zone through the access door and directly into the receiver and ash discharge system, in which the ongoing vacuum immediately carries the solid ash to the discharge point. Attachment C-1 depicts the boiler, access doors, damper linkage, and the receivers.

This process is repeated for each boiler zone, until all six zones (two in each boiler) have been emptied.[11] Each zone takes roughly 10 minutes of labor to feed into the conveyor with about five minutes required to move to the next zone and to allow the combustion process to restabilize before beginning the process in the next zone. The ash is only actually being discharged while the receiver is accepting the ash. Being a manual process, the variation in time needed to move the ash into the system from each boiler zone is dependent on a variety of factors (*e.g.*, who is removing the coal, are there interruptions, etc.).

During operation, ash is also collecting in the economizers and the dust collectors. Each boiler has its own economizer. The economizer uses the exhaust gas from the boiler to heat the feedwater prior to its entry into the boiler. As the exhaust gas moves up the stack it changes direction (horizontal to vertical flow) and when that happens, solid ash falls to the bottom of the economizer. The economizer box is shown on Attachment C-2, and its location is depicted on Attachment B at location 2. Receivers were constructed as part of the structure such that they are located to remove coal ash collected in the economizer boxes. The operating rod that opens the valve in the economizer to allow for this removal is depicted in Attachment C-2, and is shown in

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[11] The Badger only operates three of its boilers at any given time. *See* sixth bullet point on page 12 above.

Attachment B at location 2. The receiver for each economizer is labeled as "RE" on Attachment B.

To remove ash from the economizer box, an operating rod must be moved to open three valves (depicted on Attachment C-2) to allow the vacuum system in the ash conveyor to draw ash from the box. The economizer box access door is then opened and a special tool is used to move the collected ash into the system, where it is immediately carried out of the economizer box via the vacuum conveyor system to the discharge point. This process takes roughly 10 minutes per economizer. There are typically three[12] economizers to address. As with the boilers, ash is only actually being discharged while the receivers serving the economizers are opened and receiving ash.

The dust collectors gather solid ("fly" or "collector") ash that is precipitated out of the exhaust stream by the Pratt-Daniel Cyclone separators located in the up-take just below the induced draft fans, which are in the stack, between the dust collector and the exit from the stack itself. This fly ash collects in storage hoppers (designated on Attachment B as "Dust collector storage hoppers"). The blue vertical line below the dust collector storage hoppers is ash conveyor piping constructed into the hoppers that draws the collector ash into the ash discharge system. Attachment C-13 shows the piping and valve that is opened to permit the ash to enter the discharge system. That valve is also depicted on Attachment B at point 13. The valve depicted in Attachment C-13 is then opened, allowing the ash conveyor vacuum system to draw the ash down into the conveyor system. The vacuum pulls the fly ash toward the discharge point. Both collectors are emptied at the same time, which takes approximately 15 minutes and is subject to

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[12] There is one economizer for each boiler. Since the Badger only operates three boilers at any given time, there are only three economizers to address.

variation. As with the boilers and economizers, ash is only being discharged when the valve is opened.

In summary, ash is collected from three locations: the bottom of boiler, the economizer, and the collectors. The three types of ashes are never discharged at the same time and so never actually combine with one another. In terms of relative amounts, we estimate that, by volume, about 50% of the ash is bottom ash, 35% is economizer ash and 15% is collector ash.[13]

b) Ash Discharge System

Lake water is supplied by the ship's fire and general service pumps at 160 psi/600 gpm to a 6 inch Hydroveyor exhauster located in the ship's port and starboard boiler rooms, immediately aft of Frame 95 in strake "K" (near point 10 as depicted on Attachment B), Engine Room Overhead View, labeled as "ash ejector." The service pumps are also labeled on the Engine Room Elevation View at the blue dot near the word "Boiler". The "nozzle block" is part of the exhauster. Attachment T shows a schematic of the nozzle block, and the location of the pipe in which it is located can be seen in Attachment C-19. The exhauster uses water pressure pumped through the nozzle block to create a vacuum, which draws air through the ash conveyor system. It is this air flow that entrains or pulls the coal ash as it is fed into the conveyor and carries it from the receivers described above (labeled in Attachment C-1) to the nozzle block. This system also draws the fly ash from the dust collector and economizers when the valves are opened as described above. Anytime the pumping system is on, the vacuum is necessarily operating, even if ash is not being actively moved into the system.

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13 This estimate is based on engineers making personal observations and recordings regarding the levels of accumulation during actual operations. This is discussed in more detail at Attachments R and S. *See also* the discussion at Section IV.C.3 below.

The vacuum system pulls the solid ash toward the nozzle block. As the ash passes through the nozzle block, the ash and high pressure water come together in a combining pipe (about 24 inches long) and the resulting "slurry" immediately exits the Badger via a 36-inch outboard pipe through the shell plating. The point at which the two materials combine is shown at the intersection of the blue and green lines on Attachment B (just to the left of the number 10). The combining pipe can be seen in Attachment C-19.

The discharge stream exits the shell plating (through a port approximately 6" in diameter) at high pressure and immediately hits the hardened alloy target plate, pulverizing, deflecting and dispersing the materials. This is shown on Attachment C-14. It is important to note that even though the conveyor system is operating (water is being pumped and therefore the vacuum is created), ash is not necessarily being discharged, as explained above. Rather, ash is discharged at varying times to meet operational needs and when the vessel is in the locations where the current permit authorizes discharges to occur.

As noted above, each zone takes roughly 10 minutes of labor to feed into the conveyor with about five minutes required to move to the next zone and allow the combustion process to restabilize before beginning the next zone. The ash is only actually being discharged from the vessel while ash is fed into the receiver. The variation is dependent on a variety of factors (*e.g.*, who is removing the coal, are there interruptions, location of vessel, etc.) Thus, ash is being discharged from each boiler for a total of roughly 60 minutes, in 10-minute intervals, with a several-minute non-discharge period occurring between each interval.

The removal of ash from the economizers occurs after removal of ash from the boilers is complete. This process is described above in Section III.B.4. As noted previously, this process takes roughly 10 minutes per economizer, with intervals between lasting a few minutes, allowing time to close and adjust valves and reconfiguring the system. During those intervals, ash is not discharged. Thus, actual discharge of the ash from the economizer takes about 30 minutes, comprised of three roughly 10-minute periods.

The removal of the fly or collector ash collected by the cyclone separators in the up-take occurs next. The process for removing the ash is also described above in Section III.B.4. As noted, it takes approximately 15 to 20 minutes to allow this fly ash to enter the conveyor system, where it immediately moves through the system by vacuum, enters the combination pipe after it passes the nozzle block and is discharged. As with the boilers and economizers, ash is only actually being discharged when the valve is opened.[14]

Coal ash is discharged while the vessel is underway in Lake Michigan in accordance with the current permit. The discharge begins when the Badger passes approximately the 100 foot depth line and is more than 5 nm from any shore, about 20 minutes out of port. The ash is removed sequentially from each of the six boiler zones, then the three economizer boxes, then the dust collectors. The conveyor system operates on a more or less continuous basis (that is, the vacuum is created whenever the pumping system is on, and the pumping system is on to serve fire and general service most of the time). However, unless the ash is entering the system through the various receivers and pipes, the ash is not being actively drawn toward the combining pipe from which it is ejected.

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[14] In EPA's February 24, 2012 letter (Attachment O), the agency noted what they thought was a discrepancy because LMC had referred to the time for discharging ash as 150 minutes rather than 105 minutes. That 150-minute reference included the 5-minute intervals between removal of ash from each of the six boilers and the five minute or so delays between removal from each economizer. This ash removal process is not inflexible, but rather varies a bit depending on circumstances. All sampling concentrations are based on the assumption of an average 110-minute discharge duration, which takes into account the most conservative estimate of the 15-20 minute discharge duration range.

The relevant 100-foot depth lines for Lake Michigan, at the closest points to the Michigan and Wisconsin shores, are 6.5 miles and 4.5 miles, respectively. Water depth varies from 100 feet to over 520 feet during discharges. The locations of discharges vary considerably, depending on the Badger's course and weather conditions. The cumulative course of the Badger over a season tends to look like a bow tie. *See* attachment to NPDES Permit Application Form 1. Based on experience, it is believed that the Badger's course could cover an area in excess of 1,000 square miles over the course of the season. The intermittent nature of ash discharges means the discharges occur in a smaller area.

C. Please describe the engineering aspects of the application of the following technologies/control techniques for the Badger

1. Retention of the ash onboard the vessel.

Since 2008, LMC has been actively evaluating a variety of control techniques for retaining the ash on board, removing it while in port, and disposing of it landside. Thus far, none has proven to be technologically feasible and economically achievable or practicable. These include (1) retaining the ash on board in place and removing it using a vacuum truck and disposing of the ash landside; (2) constructing permanent storage areas on board for the ash and designing and constructing a system to move the ash to storage compartments and then removing it while in port with a larger land-based permanent vacuum system, and then disposing of it landside; and (3) constructing removable containers on board to accept the ash, inventing a system for conveying the ash to those containers, then removing the entire container and replacing it with an empty container, and disposing of the coal ash landside.

a) Questions common to all onboard storage options

It is important to understand the fundamental engineering issues associated with any onboard option. LMC has been actively analyzing these for several years.

As with other vessels, all equipment on the Badger is manufactured for the marine environment and approved by multiple agencies. This environment involves special consideration for space, weight, motion, and corrosive atmosphere. Thus, off-the-shelf conveyor systems that might work at land-based operations have no application to a vessel. Installing virtually any system would require piercing watertight compartments. While constructing these systems into vessels when they are built is possible, restructuring the vessel after the fact presents far more technically complex and challenging issues. Three engineering questions must be answered for any onboard storage space: (a) Can the ash be safely stored on board; (b) How is the ash to be conveyed from the boiler to a storage area; and (c) How will the ash be moved from the storage areas to land? Each of these is discussed below.

(1) Can the ash be safely stored on board the vessel?

(a) Location issues

Currently the ash is conveyed in its original solid form to the discharge point via the vacuum conveyor system. Based on rough calculations from a single trip done in 2008, it was estimated the Badger consumed roughly 27.95 tons of coal and generated approximately 5,000 pounds of solid ash every 12 hours of operation, for an ash generation rate of 8.94% per ton of coal combusted. That was based on the coal used at the time.[15] Based on the amounts generated,

[15] In 2011, based on coal analytical data, an ash generation rate of 6.72% was assumed in order to calculate concentrations of ash in the effluent for sampling analysis. At that rate, less ash would be generated when the coal is combusted than if you assume an 8.94% ash generation rate. The current permit provides that ash content in the coal may not exceed 9.5%, which, if indicative of actual ash generated during combustion, would mean more ash might be produced than if you assume either a 6.72% or 8.94% ash generation rate. Estimates of ash concentration, and the

and the dimensions of the locations where they were accumulated, approximately 9-10 cubic yards of space are needed to store the amount of ash generated over a 12-hour period (with one round-trip from Ludington to Manitowoc and back). However, because the Badger operates seven days a week during the season, landfills to which the ash might be sent are not open on Saturdays or Sundays, and because weather conditions could affect trip timing, additional storage of up to 50 cubic yards of space may be needed and, therefore, must be assumed.

The Badger has only two locations where this might be physically possible. One would require a substantial reduction in the size of the coal storage bins, impairing the vessel's fuel storage capabilities. The location of storage facilities in the coal bins is illustrated on Attachment B in orange-colored boxes. These locations assume only a 12-hour hold time and do not account for the potential that additional holding areas might be necessary due to unavailability of landfills on weekends.

The other location on board that is large enough to store this amount of coal ash is a currently empty cargo hold (Hold 2 at frame 40-30 on Attachment B). As an engineering matter, however, there is no current means of access to this location without piercing watertight compartments. Piercing watertight compartments creates significant safety issues that require review and approval by the U.S. Coast Guard and the American Bureau of Shipping. LMC has found no vessel that operates a system even remotely resembling this. Thus, despite LMC's extensive efforts, additional engineering aspects of this approach remain highly uncertain.

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presence of analytes of concern in the effluent used through this submission consider all three levels, and generally err most conservatively and assume the highest ash content potential. Regardless of which ash generation rate is used, the analytes are below the levels of concern of applicable water quality standards.

However, at a minimum, there are serious safety issues associated with using this storage compartment to house coal ash.[16]

(b) Heat build-up

The ash from the boiler, and to a lesser extent the economizer and collectors, retains some heat when it enters the current vacuum conveyor system. However, under the current permit, it is mixed with water just before discharge and discharged in intervals. As a result, the thermal impacts in the water are almost nonexistent and are immediately dissipated before the ash reaches the lake or instantly as it reaches the mixing zone. Accumulating ash in confined spaces adjacent to coal bunkers presents issues that to our knowledge have never been addressed on vessels before. Not only would an appropriate compartment have to be designed from scratch, but special equipment would need to be designed and installed as well. LMC is unaware of any technology in existence today that addresses this concern.

By way of illustration, when LMC tried to retain coal ash in 2008 for a single 12-hour period, it needed to wait until the ash was cool before it could be vacuumed out of the system and into a truck, primarily because of the sensitivity of the filters on the vacuum truck. Since this was the last voyage of the season, time was not an issue. LMC waited 36 hours before removing the ash, but it was still too hot for the vacuum system to remove it. If the ash is consolidated into a closed location such as a cargo hold, the cumulative effect of the heated ash likely will be magnified. As more ash is added over the course of time, the heat will continue to be present and have little opportunity to dissipate.

[16] As noted below in Section III.C.1.d), LMC has most recently been evaluating the use of removable containers to store the ash. This would probably address some of these issues.

(2) How will the ash be conveyed to a new storage area on the Badger?

It is not possible to analyze how ash would be conveyed to a new storage area without first knowing where that storage area would be located. As described above, finding an acceptable and safe location remains unsolved. Several issues are clear, however. First, the boilers on the vessel must be operated continuously; they cannot be shut down, the ash cooled, and the solid ash then carried to a location elsewhere in the vessel while underway. Thus, some sort of insulated and protected conveyor system is required that allows sequential removal of bottom ash without shutting down the boiler system. Such a conveyor system cannot use water to move the ash because the weight alone would create safety-prohibitive stability issues for the vessel.[17] It is believed, therefore, that such a system must be based on the same vacuum concept that is currently used.

Second, there currently is no known location for such a system. The system must be directly connected and integrated into the boiler system, including the furnaces, economizers and collectors. Space to install piping alone is at a severe premium. By way of illustration, the photo in Attachment C-10 illustrates the confined and limited spaces that must be considered in the vessel. This photo is taken very near the current confluence of the vacuum conveyor system and the pumping system that creates the vacuum and ultimately discharges the ash. It shows the water piping system, the current ash conveyor, the day bunker, the screw conveyor drive, a steam line, and a 10” permanent support stanchion. All of this equipment is within an area that is just six feet wide. This is also the location where new piping might be installed for a conveyor system that transmits, by vacuum, ash to and from a holding area. Other locations where these

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[17] As described in Section III.B.4, currently, ash is removed via a vacuum system; water does not combine with the ash until seconds before it is discharged.

issues are particularly problematic are depicted on Attachment B in locations 4, 7, and 9 and in the photographs in Attachments C-4, C-7, and C-9.

LMC has been evaluating options for an alternative conveyor system and continues efforts to engineer a solution. Such a system still does not exist today. One location that was considered is shown on Attachment B in red dashes. But even since preparing this potential retrofit plan, LMC has discovered that it needs to be reconfigured. For example, this system would require that the ash be moved in entirely new directions, including potentially a 38-foot vertical rise. Whether a vacuum system exists that is capable of handling this in a vessel environment is unknown. Despite extensive investigation, we are not aware of any vessel that has a system installed that even remotely resembles this.

(3) How will the ash be moved from the storage areas to land?

LMC learned in October of 2008 that removal of ash from the Badger is far more complicated than originally believed. Among other things, (a) LMC waited 36 hours until the ash was cool enough to prevent damage to equipment used to remove it (as it turned out waiting 36 hours was not long enough; the vacuum hose melted); (b) landfills are not open on most weekends to accept the ash; (c) it took 8 hours to remove the ash; and (d) it takes 12 hours to restart the boilers which had to be shut down. This means the Badger would have to cancel well over half its trips in the summer, rendering it economically unviable, as described in Section III.D below. In addition, LMC experienced significant unanticipated dust issues in the boiler room and on the car deck when removing the ash that would need to be addressed in order to assure a safe environment.

Possible options to address these issues are described in the next several sections. In summary, there is currently no commercially available, technologically feasible or economically practical plan, system, technology or process that would allow the vessel to operate but contain its ash onboard for landside disposal.

LMC has been conducting extensive research and development to invent such a system, design it within the constraints of a vessel that was built for a different purpose, obtain all appropriate approvals, build, and then test. The challenges involved in such a reconstruction are considerable and, to date, not solved.

b) Storage in place and truck vacuum removal with no change in infrastructure

In 2008, when the current VGP was proposed, LMC conducted an experiment to evaluate the feasibility of storing ash in place and discharging it in port with no new infrastructure. At that time, there was no storage bin constructed for this purpose. Instead, LMC waited for the last trip of the season and simply stored ash in place for 12 hours. While this experiment was designed to focus primarily on the practical issues associated with discharging ash while in port, it also provided information relating to the practicality and impact of storing ash in place as it is generated.

As this system was evaluated, LMC discovered several problems. During the experiment, the ash pits under the boiler filled with bottom ash and restricted air flow to the boilers, making it difficult to maintain proper combustion within the boiler. The ash pits should be cleaned while underway to ensure more complete combustion, making the system run more efficiently, and producing less ash. After 12 hours of operation, the economizer storage bins and the stack collector bins were filled with ash to the maximum level, causing abrasive wear to the equipment used to operate these systems.

It was also discovered that trying to store and then remove the ash with a truck did not work. The vacuum truck was too slow (it took too long to remove the ash) and generated too much fugitive dust. In addition, the ash was too hot to be conveyed by the non-metallic hose, which melted as it accepted materials. Additionally, there is no expeditious or efficient way to remove ash from the pits once it has accumulated to capacity. As the ash piles up, it becomes increasingly more difficult to remove it from under the boilers. Because the ash under the boiler retains heat, the removal process is even more dangerous and difficult. The experiment confirmed that there would not be enough storage space to safely retain the ash in place for any length of time while the vessel is underway.

The processes by which coal-fired power plants and the Badger burn coal are significantly different. This is also true with respect to the byproducts of these processes. Coal-fired power plants tend to operate within a consistent load range in a stationary environment without space constraints. The Badger, on the other hand, has more varying load demands, is typically in motion, and has very limited space. These factors impact the Badger's byproduct and the way it can be handled. Whereas coal-fired power plants have the luxury of enough space for cooling storage, the Badger does not have the capacity for such infrastructure. Additionally, the differences in combustion conditions create somewhat dissimilar byproducts. Specifically, the Badger's economizer and collector (fly) ash has higher combustibility characteristics, making it more difficult to handle.

c) Constructing storage areas for the ash and a separate system for removing it while in port with a larger land-based permanent vacuum system and then disposing of it landside

In 2008, LMC also tried to design a system to store the ash on board and remove it while in port. Issues relating to storage onboard are discussed above starting at page 24. The onboard storage design is depicted on Attachment B in orange-colored boxes. At the time, LMC thought it could design and install such a system by 2012, but it was wrong and the system proved infeasible. It was originally anticipated that LMC could utilize the existing ash discharge system on the vessel to generate vacuum for the movement of ash into storage. It was discovered that small amounts of residual ash could be picked up by the water used to create the vacuum. In other words, under the current system, it is intended that the ash be drawn via the vacuum system created by the water pumping system, and ultimately drawn into the water stream at the nozzle block, and then discharged with the water while the vessel is underway. Under this option the ash would still be drawn via the vacuum system, but would have to be removed from that system (using another vacuum system) before it reached the nozzle block while the vessel is in port. In the meantime that system would still be running and water would still be discharged while the vessel is in port. Ultimately some ash would almost certainly escape the vacuum system, and become entrained in the water which creates the vacuum system and is discharged at port. Therefore, the existing ash discharge system would not be suitable for onboard ash storage.

In light of this discovery, LMC evaluated alternative methods to generate the vacuum required to pull the ash into containment. One possible solution would be to use a mechanical exhauster. However, LMC determined that a mechanical exhauster would require more electricity to run than is available aboard the Badger. As such, a specially designed, steam-driven exhauster would have to be designed in order to make this option practicable, further increasing the cost of this already high-priced retention system.

LMC also investigated installing a larger, shore-side permanent vacuum system instead of using a vacuum truck to remove the ash from onboard storage. Such a system is very expensive and would require tremendous transmission distance to move the ash from the vessel to the permanent system. That distance would also likely increase instances of failure and equipment damage.

d) Using removable ash storage containers

Most recently LMC considered constructing removable containers on board (the car level deck) to accept the ash, a system for conveying the ash to those containers, then removing the entire container and replacing it with an empty container, and disposing of the coal ash landside. This would require construction of a system to move the ash into the containers and a system for safely removing the containers and replacing them with empty ones. The challenge is that the containment of ash in a closed container can lead to a very high dust environment, the containment and handling of which can be quite difficult. It also retains heat, creating other concerns.

e) Pump off slurry rather than dry coal ash

Another alternative that was considered was to use the existing system to pump ash slurry off the vessel into onshore containment systems created by some sort of connection to the discharge point. Pumping slurry from the bottom of the ship would require a great deal of pump capacity. It is not clear that operating the two current pumps at full capacity would be adequate. Assuming they would be adequate, and that other engineering challenges could be addressed, it would take approximately 150 minutes at port to discharge the slurry. It would create 1,050 *tons of slurry per day* (almost *2 million gallons of slurry per week* that would need to be disposed). The delay alone would reduce the Badger's trips to the point of rendering the entire business not viable. The cost of disposal would be over $150,000 per day assuming a landfill would be willing to take that amount of slurry water. This is described in more detail in Attachment V and also at Section III.D.

2. Conversion of the existing boilers to an alternate fuel

The possibility of retaining the existing boilers but using an alternative fuel such as compressed natural gas ("CNG"), liquefied natural gas ("LNG"), or diesel has also been considered.

We think it will be economically and technologically feasible someday to install an LNG system on the Badger, and that this is the best future alternative technically, economically and environmentally. It is the technology that is being developed for the maritime industry generally, which means it will become available to the Badger at reasonable costs, more quickly. But this concept is still in its nescient stages, and it will not be accomplished by 2012 or 2013. The U.S. Coast Guard just last month issued a policy regarding the potential use of natural gas reflecting the many questions that remain, but that progress is being made. Attachment X. To date, no LNG field systems have been approved in the U.S. There is no infrastructure in Manitowoc or Ludington for the delivery of natural gas to the vessel, and no date certain by which a supplier, such as DTE Energy with whom we spoke and who met with EPA along with us, would install this infrastructure. Additionally, energy companies will require regulatory approval from the state commerce commissions where they are located before they are allowed to sell natural gas commercially. LMC cannot feasibly install the equipment until installation of infrastructure is scheduled. We learned from DTE that, at this time, LMC would have to pay for all infrastructure costs associated with a landside CNG facility. Attachment W at W-31 through W-38.

From a logistical standpoint, retrofitting the existing boilers to run on natural gas presents a number of challenges. New fuel tanks would need to be designed and installed. Onboard storage would require below-deck reconfiguration and regulatory certification. *See also* Attachment W at W-39 and W-80. Also, refueling would need to be completed in less than two hours when the vessel in docked.

We understand that the Great Lakes Maritime Research Institute ("GLMRI") has received a grant from the Maritime Administration to conduct a feasibility study on the use of LNG for the Great Lakes maritime industry. GLMRI plans to use the Badger as a pilot project. All information derived from that study will be made available to others in the Great Lakes maritime industry. For more information about this, you can contact Carol J. Wolosz, Executive Director of GLMRI at 218.726.7446.

Conversion of the existing boiler to run on diesel is technically possible but very problematic. To begin with, tanks and other equipment would have to be installed. Using No. 2 diesel, as described in Section III.D below, is cost prohibitive as it would close to triple the cost of fuel, making the business no longer economically viable. Considering use of cheaper No. 6 bunker fuel also has significant issues. Additional equipment, such as heaters and clarifiers, would have to be installed to treat this oil prior to use. In addition, EPA recently adopted regulations that prohibit the use of this bunker fuel because of air emission concerns. "Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters Per Cylinder," 75 Fed. Reg. 22,896 (Apr. 30, 2010). Investing in a technology that EPA wants eliminated due to air emissions issues does not seem to make sense.

3. Repowering with alternative engines

The possibility of repowering the vessel by replacing its current boilers with diesel or gas turbines was also explored. The very nature of how gas turbine and diesel engines operate makes them very poor options for the Badger. Gas turbine engines operate best at a constant speed and are less responsive to changes in power demand than diesel reciprocating engines. The Badger is currently powered by reciprocating steam engines that are far more responsive than even diesel engines. During docking maneuvers, the Badger is required to make high demand directional changes that would be challenging to most reciprocating diesels, but is likely well beyond any rational expectation of a gas turbine engine. This is exacerbated by the fact that while operating the Badger is docking every four hours. Gas turbine engines operate best when running in open water with an unchanging load demand, not in an application were the vessel is repeatedly docking.

Additionally, gas turbine engines have a propensity for high fuel consumption. Gas turbine engines are lightweight, high horsepower engines designed for a maximum return on horsepower to weight. This lends itself well to applications such as auxiliary propulsion for high speed military craft and ice breakers, where large amounts of horsepower may be required and weight and space requirements are at a premium. The Badger does not fit this profile.

EPA's February 4, 2012 letter asked LMC to consider in its alternatives analysis, the direct final rule issued by the agency that provided financial incentives for steamships operating in the Great Lakes to voluntarily replace their inefficient diesel engines with more efficient

Tier 2 diesel engines, and that would allow the operators to use "less clean" and less expensive residual fuel in the process. The referenced rule, "Great Lakes Steamship Repower Incentive Program," 77 Fed. Reg. 2,472 (Jan. 18, 2012), provides a hardship waiver for vessels otherwise subject to the regulation promulgated in 2010. The "Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters Per Cylinder" rule, 75 Fed. Reg. 22,896 (Apr. 30, 2010), "sets out the next step in this ambitious effort by addressing emissions from the largest marine diesel engines, called Category 3 marine diesel engines," and is part of "EPA's strategy to control mobile source diesel emissions . . ." and to "reduce annual SO_2 emissions from these diesel engines by 1.3 million tons. 75 Fed. Reg. at 22,897, 22,900. Given the core purpose of the provision – to reduce emissions from diesel engines, it seems counterintuitive to have the Badger invest in creating a new diesel source of SO_2 emissions.

Finally, it is not at all clear how LMC could use this new provision to its advantage. As we understand this program, it is designed to incent companies to convert to more efficient engines earlier, by allowing them to use less costly heavy diesel in their fuel mix, which would save them fuel costs, thus offsetting the costs of conversion. But these companies are converting from one type of diesel to another, not from an entirely different type of fuel system. Those vessels already have the ability to process heavy fuel for this use, and already have the equipment to undertake fuel mixing. The Badger has no such capabilities. It would not only have to convert the system to use diesel (believed to be in the range of $18 million), but also would have to install the equipment necessary to process heavy oil. The financial incentive associated with being allowed to use heavy oil for a limited period of time would not begin to materially offset the costs of installing this technology.

D. Provide estimates of the costs associated with implementation of the technologies/control techniques discussed in Section III.C above including supporting information showing the basis for the cost estimates.

Estimating the costs of implementing the technologies/control techniques described in Section III.C requires consideration of a wide range of factors. Cost estimates for each alternative are summarized on the chart below.

Alternatives	Capital Costs	Annualized Costs including Maintenance/Fuel/disposal and other costs (compared to present BAT)	Comments
1. Ash discharge subject to VGP conditions	n/a	Current fuel costs = $1,120,000.00 ($8,000/day x 140 days of operation)	Current Practice.
2. Ash storage and landside discharge; Vacuum truck	n/a (use current infrastructure)	86% reduction in trips.[18] + $1,120,000.00 current fuel costs	Not feasible; high dust factor; too slow; safety concerns.
3. Ash storage and landside discharge; Permanent vacuum system	$2,228,784.00	+ $705,225.60 annual operating costs + $1,120,000.00 current fuel costs *See* Attachment Y.	Too slow, untested and inherent concerns with technology.
4. Ash storage with container removal	Unknown	Unknown + $1,120,000.00 current fuel costs	Ongoing research and development; requires new propulsion system for ash; $65,000.00 at present invested into engineering concept.
5. Ash Slurry Pump Off		+ $21,168,000.00 + $1,120,000.00 current fuel costs *See* Attachment V.	Would create approximately 252,000 gallons of slurry daily; some ash discharge likely in port; not feasible.
6. Replace fuel: LNG[19]	$7,559,469.96	+ $962,158.92 annualized capital costs + $812,000.00 fuel costs *See* Attachment Z	Fuel estimate based on projected availability, not currently available.

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[18] For each of the alternatives requiring holding ash onboard, the Badger's trips would be reduced by at least 86% or more, because it would have to:

- shut down the boilers (they would be so full of ash they would not be able to operate);
- allow 36 hours to permit the ash to cool;
- allow for 8 hours to remove the ash;
- allow for 12 hours to fire up the boilers again; and
- not operate on weekends since landfills are not available to accept ash at that time and the vessel cannot hold more than 12 hours of ash from 2 round-trips.

Such a reduction in gross revenue would force the Badger to shut down operation. *See* further discussion in Section V.B.4 below.

[19] Using high pressure fuel such as compressed natural gas ("CNG") was seriously considered in 2011 and discussed with EPA. Attachment W at W-31. It is both technically infeasible and economically unachievable. One

Alternatives	Capital Costs	Annualized Costs including Maintenance/Fuel/disposal and other costs (compared to present BAT)	Comments
7. Replace fuel: Diesel	Low	+ $4,200,000.00 fuel costs *See* Attachment AA.	Economically unviable.
8. Repowering: Diesel	$15,666,125.21	+ $1,903,342.80 annualized capital costs + $120,000.00 fuel costs *See* Attachment BB.	Economically unviable.
Repowering: Gas Turbine	N/A	Unknown *See* Attachment BB.	Typically for high speed application; high performance, low efficiency applications; not feasible for application.

Thus far, LMC has spent over $250,000 trying to engineer a solution and continues to monitor and evaluate these and other alternatives to try and identify one that is technologically feasible and economically achievable.

E. Describe in detail the non-water quality environmental impacts, if any, that you have determined will occur from the use of each technology and the current approach used.

1. Current approach

Permitting the continued conditional discharge of coal will present no new, increased or different non-water quality environmental impacts. The scope and extent of air emissions from the Badger are minimal at best. *See* Petition Attachments E-1a, E-1b, and E-1c: Section 114 CAA Response (June 26, 2008), *available at* http://www.epa.gov/r5water/npdestek/badger/ (*last accessed on* May 9, 2012). Moreover, the limited use of coal-powered steam engines exist elsewhere in the country and it has never been suggested that they present any material or measurable environmental issue. *See, e.g.*, http://www.steamlocomotive.com/colorado (*last accessed on* May 21, 2012). In EPA's recent rulemaking addressing the air emissions impacts of the maritime industry on the Great Lakes, 77 Fed. Reg. 2,472 (Jan. 18, 2012), there is no

would need about 4500 psi onshore to fuel the vessel at 3500 psi, which creates significant technical and economic barriers. No infrastructure currently exists to economically deliver and store CNG to the port where the Badger docks.

suggestion that the air emissions from the Badger, which is the only coal-fired vessel operating on the Great Lakes, contributes in any measurable way to the air emissions issues addressed in that rulemaking. Nor is there any suggestion that, given the amount of coal burned by the Badger during its 140+/- days of operation every year (about 8,100 tons per year), it contributes in any material way to concerns regarding air emissions from coal burning utilities, which we think collectively burn more coal in an hour than the Badger burns in one year. As a result, the effects of air emissions from the Badger cannot be said to have any measurable non-water quality environmental impacts.

2. Retention of the ash onboard the vessel and landside disposal

The non-water quality environmental impacts of any system associated with landside disposal of coal ash focus primarily on the environmental impacts of unloading, transporting, and disposing of coal ash in a landfill. Experiments suggest that unloading via a vacuum system may produce new levels of dust in the air at a time when passengers may be embarking or debarking from the vessel, although the removal points would be several hundred feet from passengers.

Disposing of coal ash in landfills or other sites would also have some environmental impact. Transportation of this material would generate additional emissions from trucks as well. Placing coal ash in landfills or other impoundments consumes landfill space.

3. Conversion of the existing boilers to an alternate fuel

The non-water quality environmental impacts of using either oil or diesel fuel as an alternative to coal to power existing boilers would likely include new air emissions. As discussed above at Section III.C.2 and 3, EPA is currently imposing increasingly stringent regulation on the use of diesel fuel by the maritime industry based on the agency's concerns regarding air emissions. *See* http://www.epa.gov/otaq/oceanvessels.htm (*last accessed on* May 2, 2012). It would not seem to make much sense for the EPA NPDES program to impose a new requirement that would increase the use of diesel fuel while at the same time the Office of Transportation and Air Quality has imposed greater and greater restrictions on the use of that fuel.

There would be fewer non-water quality environmental impacts arising from the use of LNG. These could include the transportation impacts associated with delivering LNG to the port, as well as the impacts associated with fuel manufacturing.

4. Repowering with alternative engines

In addition to the potential environmental impact associated with using a different fuel, if the alternative also includes replacement of boilers, and use of alternative fuels such as LNG or diesel, there will be some adverse non-water quality environmental impacts associated with the renovation of the vessel. Certain equipment would be removed and presumably either recycled or discarded as waste. Other new equipment would have to be manufactured, which could generate environmental impacts from manufacturing and transporting the equipment. Because the technology currently does not exist commercially, LMC is not in a position to further estimate or quantify the potential impacts.

IV. EPA REQUEST FOR SUPPLEMENTAL INFORMATION: ENCLOSURE 2 TO FEBRUARY 24, 2012 LETTER - SAMPLING REQUIREMENTS FOR S.S. BADGER DISCHARGES

When LMC responded to the EPA's Section 308 Information Request, the issue of how sampling of the coal ash could be done safely, feasibly, and economically was discussed at length. Region 5 was invited to visit the vessel and offer its views. To our knowledge, EPA has no protocols for sampling this type of discharge from a moving vessel. Among other things, it was noted and agreed that given the location of the discharge points and the rate of discharge, it would be dangerous and likely impossible for anyone to actually collect samples while the coal ash is ejected from the ship. Nor are we aware of any mechanism that would allow for safe and reliable sampling during operation, given the nature of the discharge. It appears that the only sampling system available involves simulated sluicing. This method is extraordinarily expensive. LMC did undertake this in 2011 and 2012, and the results are described below. *See* Attachment CC.[20]

A. Coal Ash Slurry Sample Collection

1. Option 1 - Collect Coal Ash Slurry Samples at the Point of Discharge

EPA has requested sampling of ash at the point of discharge. As we explained in 2008, sampling at the actual point of discharge is not possible, safe, or representative of the discharges. Nor would ash sampling within the vacuum system that carries the ash to the discharge point be feasible or representative.

It is important to understand the dangers and logistical challenges associated with trying to sample the ash as it is discharged or just after it is discharged as is usually done for the NPDES permitting process. The Badger's discharge system does not create an ash slurry that is carried in a lengthy piping system and then discharged, as might be the case with other materials carried out in effluent or wastewater streams.

As explained in Section III.B.4 above, the ash removal system aboard the Badger works by using water flows from the general service pumps. High volumes of water at relatively high

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[20] Coal ash data from 2006 and 2008 is also provided in Attachment CC at CC-63 through CC-97. This analysis was performed to determine and ultimately confirm that coal ash is not hazardous waste under the Resource Conservation and Recovery Act.

pressure are pumped through nozzle blocks located internally on both sides of the ship at the point of discharge. The intersection of the blue and green lines on Attachment B shows the location of the nozzle blocks on the vessel; Attachment C-19 shows the point in the piping system where they are located; and Attachment T is a schematic of the nozzle block. The vacuum created at the nozzle block draws or pulls air through the ash conveyance system. It is this air flow that pulls the ash from various points through the system, not the water. As the air and ash enter the nozzle block at the side of the ship, they come into contact with the water exiting the high pressure pumping system. They combine with the water in a 24-inch combining pipe and are immediately expelled from the vessel through a 36-inch overboard pipe. The ash within the nozzle block becomes "slurry" as it travels this short distance and is expelled from the vessel at high pressure and volume. The water/ash/air combination hits the target plate, which is located externally in front of the discharge port. Because the ash slurry is being discharged at high velocity, when it hits the target plate, the particulate size is broken down into far smaller, almost dust size, particles.

The combining pipe where the ash and water meet is only about 24 inches long and is located 36 inches from the discharge point. It is not possible to install any sort of automated sampling mechanism in this pipe because such mechanisms are only appropriate for capturing slow moving streams of effluent. The intermittent nature of the ash removal process also makes it difficult to ensure that any sample collected would, in fact, contain ash and not just the water creating the vacuum. It would be difficult to obtain a representative sample, even if installing a sampler were feasible. In addition, the effluent is moving at a high velocity.

It is also not feasible to test the discharge after it hits the target plate and then disperses into Lake Michigan. The discharge is physically inaccessible while the vessel is moving;

between the velocity of the discharge and the movement of the vessel, the discharge disperses immediately, even before it hits the water. The size of the vessel makes it impossible and unsafe to take samples in the water below the vessel as it moves at, on average, 14-15 knots.

Having a vessel follow the Badger as it discharges is also impractical. To begin with, the sampling boat would have to be positioned at least 400 feet behind the vessel to avoid the danger of the wake zone from the vessel's propellers. The actual effluent discharge point is 220 feet forward of the stern. Thus, a safe sampling point would need to be at least 620 feet from the discharge point. The ash would be so dispersed at that point that the samples would almost certainly not detect anything.

Stopping the vessel before the ash is discharged, discharging it and collecting samples as it hits the water and while the vessel is stopped would be impractical and inconsistent with VGP condition § 5.3.2.3.3, which requires that the vessel be moving when discharge occurs.

Because of the nature of this discharge, it is not comparable to ballast water discharges, and sampling techniques associated with those types of discharges are not applicable. The coal ash discharge is not stored in tanks that would permit the kind of testing to which ballast water stored in ballast tanks is subject. *See* http://serc.si.edu/labs/marine_invasions/publications/PDF/BWEV_SamplingProtocol_Feb2005.pdf (*last accessed on* May 9, 2012).

2. Option 2 - Collect Coal Ash Samples and Simulate Sluicing

As an alternative to taking in-process samples, LMC has developed procedures for preparing representative samples of the coal ash via simulated sluicing. LMC believes this process substantially meets and in some respects refines the process described in EPA's February 24 letter. Attachment O. This is an extraordinarily expensive process, since professionals must not only be engaged for the entirety of each day when sampling is taking place, but must separately travel out to areas on Lake Michigan for water samples. It is estimated that the cost of this effort, just to collect one set of representative samples on one voyage (a single sampling event), will likely range from $8,700 - $11,200. Since the Badger purchases its entire season's coal at one time from one "batch" and uses only that "batch" for an entire season, there will necessarily be very little if any variation during a single season in the nature of the fuel and its combustion characteristics. Given that, and the sampling cost, we believe that sampling during one round-trip voyage per season (resulting in two samples) is fairly representative of the nature of the effluent all season and reasonable. This is further supported by the fact that even when the Badger assumed different fuel profiles (three different ash concentrations for its 2011 and 2012 tests), the results did not exceed applicable water quality standards using NPDES testing protocols.

Under this procedure, coal ash samples will be collected from each ash source (bottom ash, economizer ash, and collector (fly) ash). For each type of ash, a composite sample will be collected as follows:

- Bottom ash: Samples will be collected from each of the six boiler zones as the fireman manually pulls the ash into the ash receiver. Three individual samples will be collected from each boiler zone using a long-handled metal scoop: one at the beginning, one near the mid-point (about 5 minutes after the initial sample), and one near the end of the ash removal for each zone. The resulting 18 individual samples will be combined into a single composite bottom ash sample.
- Economizer ash: Samples will be collected from each of the three economizer boxes as the collected ash is manually moved into the collection system. Three individual samples will be collected from each economizer box using a long-handled metal scoop: one at the beginning, one near the mid-point (about 5

minutes after the initial sample), and one near the end of ash removal. The resulting nine individual samples will be combined into a single composite economizer ash sample.

- Collector (fly) ash: Samples will be collected from the two dust collectors. Three individual samples will be collected from the collection chamber using a long-handled metal scoop: one as the emptying of the collectors begins, one mid-way through the process, and one near the end. The resulting individual samples will be combined into a single composite collector ash sample.

Each sampling event will result in the collection of three composite samples, one for each type of ash. These samples will be allowed to cool, then placed in appropriate containers provided by the analytical laboratory, thoroughly mixed using a spoon or mixing rod for at least two minutes, and sealed and stored on ice until the vessel returns to Ludington, when they will be delivered to the laboratory. Identification and chain of custody will be documented for each sample. The storage location for each sample will be secured by the sampler. Samples will be transported to the laboratory for analysis.

The laboratory will grind the ash into sand-like particles using a ceramic mortar and pestle, in order to replicate the size of the ash particles after they hit the target plate and before they hit the water. Each type of ash will be mixed with ambient lake water to represent the expected concentration in the discharge, as follows:

Table 1. Coal Ash Discharge Concentrations for Sluice Sampling

Ash Source	Ash density (lb/ft^3)	% of total by volume	Ash source contribution (lb/ft^3)	% of mass	Mass Discharged per Crossing (lbs)	Discharge Duration (min)	Water Pumping Rate (2 pumps) (gal/min)	Ash Concen-tration (lb/gal)	Slurry Concen-tration (mg/l)
Boiler	22	50%	11	58.0%	3,198	60	1,200	0.0444	5,323
Economizer	15	35%	5.25	27.7%	1,527	30	1,200	0.0424	5,081
Collector	18	15%	2.7	14.2%	785	20	1,200	0.0327	3,920

Note that these ash slurry concentrations are "high-end" estimates, based on the vessel making two crossings per day. The boilers continue to run when the ship is in port. Ash is therefore produced and stored during this time, to be discharged when the vessel reaches the location where discharges are allowed. Based on our knowledge of the process, there is no significant difference in how much coal is used when the vessel is in port, compared to when it is making a crossing. Similarly, it is our experience that the difference in the amount of coal used over a 24-hour period with one round-trip voyage and the amount used over a 24-hour period with two round-trip voyages, is inconsequential. Thus, for testing purposes, we have used the most environmentally protective assumption, that the same amount of ash is produced whether the vessel is underway or in port.

When the vessel makes only two crossings of the lake per day, the entire daily mass of ash is discharged during the two crossings. When the vessel makes four crossings, the same amount of ash is discharged over the course of four crossings (therefore using twice as much water), and the ash would necessarily be less concentrated, as would the concentration of analytes. ***Due to the expense of slurry preparation and analysis, future sampling associated with the preparation of the NPDES permit application will assume high-end ash concentrations associated with only two crossings per day.***

The laboratory will mix the ash samples with the lake water in the appropriate proportions, and an ISCO peristaltic pump will be used to mix the ash and water for 15 minutes. Subsamples of the slurries will be collected and preserved as appropriate for analysis (for example, one subsample will be filtered through a 0.45 µm membrane filter and preserved with nitric acid for dissolved metals analysis, while another subsample of the unfiltered liquid will be preserved with nitric acid for total metals analysis). A complete list of analytes and associated analytical methods is provided in Table 2. Metals analysis will include both total and dissolved metals.

Table 2. Coal Ash Slurry and Lake Michigan Water Analytes and Associated Methods

Analyte	Method
Antimony	200.8 (1638 for lake water)
Arsenic	200.8 (1638 for lake water)
Cadmium	200.8 (1638 for lake water)
Chromium	200.8 (1638 for lake water)
Copper	200.8 (1638 for lake water)
Lead	200.8 (1638 for lake water)
Manganese	200.8 (1638 for lake water)
Nickel	200.8 (1638 for lake water)
Selenium	200.8 (1638 for lake water)
Silver	200.8 (1638 for lake water)
Thallium	200.8 (1638 for lake water)
Vanadium	200.8 (1638 for lake water)
Aluminum	200.7 or 200.8 (1638 for lake water)
Barium	200.7 or 200.8 (1638 for lake water)
Beryllium	200.7 or 200.8 (1638 for lake water)
Boron	200.7 or 200.8 (1638 for lake water)
Calcium	200.7 or 200.8 (1638 for lake water)
Cobalt	200.7 or 200.8 (1638 for lake water)
Iron	200.7 or 200.8 (1638 for lake water)
Magnesium	200.7 or 200.8 (1638 for lake water)
Molybdenum	200.7 or 200.8 (1638 for lake water)
Potassium	200.7 or 200.8 (1638 for lake water)
Sodium	200.7 or 200.8 (1638 for lake water)
Tin	200.7 or 200.8 (1638 for lake water)
Titanium	200.7 or 200.8 (1638 for lake water)
Zinc	200.7 or 200.8 (1638 for lake water)
Mercury	1631E
2-Methylnaphthalene	625M
Acenaphthene	625M
Acenaphthylene	625M
Anthracene	625M
Benzo(a)anthracene	625M
Benzo(a)pyrene	625M
Benzo(b)fluoranthene	625M
Benzo(ghi)perylene	625M
Chrysene	625M
Dibenzo(a,h)anthracene	625M
Fluoranthene	625M
Fluorene	625M
Indeno(1,2,3-cd)pyrene	625M
Naphthalene	625M
Phenanthrene	625M
Pyrene	625M
Total Suspended Solids	2540 D
Total Dissolved Solids	2540 C
pH	4500 H+B
Temperature	Thermometer
Hardness	130.1

Analyte	Method
Turbidity	180.1
Conductivity	120.1
Salinity	2520 B

EPA's sampling procedure notes that aqueous samples containing suspended or particulate material greater than or equal to 1% should be extracted as solid type samples. It is our understanding that a particulate concentration of 1% would be equivalent to 10,000 mg/l; because the ash slurry samples will have ash concentrations of approximately 5,300 mg/l or less, we do not believe it will be necessary to use the biphasic approach. However, the analytical laboratory will make the final determination as to the appropriate handling of these samples.

B. Coal and Lake Water Sample Collection

1. Coal ash characteristics

During our March 6, 2012 call, EPA advised that standard testing analytics used to identify coal characteristics (BTU, ash, etc.) were sufficient. Coal analytical testing for 2000-2011 as received from our suppliers can be found at Attachment DD.

2. Ambient lake water

Ambient Lake Michigan water will be collected from the open waters of Lake Michigan near the location where the discharges commence, prior to the discharge of any ash. The sampling crew will take a small boat to the area where the Badger typically commences discharging (no less than 5nm from shore) and collect a large volume of water using an appropriate, non-metal sampler. Samples will be collected prior to the first voyage of the sampling day, to avoid any influence of ash discharges on the ambient water. EPA Method 1669 will be used to collect lake water samples. A volume of water sufficient for both the preparation of ash slurry samples and analysis for background concentrations will be collected in an appropriate container and transported to the laboratory for analysis and preparation of slurries. Lake Michigan water will be analyzed for the analytes listed in Table 2 above.

C. Operating/Process Data Collection

1. Sluice water flow rates

As explained in Section III.B.4 above, ash is moved to the discharge point as a result of a vacuum created by the water pumping system. It is combined with water briefly as it discharges. There are two separate pumping systems, one on each side of the vessel, and each has a flow rate of approximately 160 psi/600gpm. The total volume of effluent (including coal ash) discharged during each crossing when there is one round-trip per day is approximately 134,175 gallons. The total volume of effluent discharged during each crossing when there are two round-trips per day is approximately 133,087 gallons.[21]

2. Discharge duration

As explained in Section III.B.4 above, the actual duration of coal discharge is approximately 110 minutes, but the discharges are separated. There are intervals between discharges and no individual discharge lasts more than about 20 minutes.

3. Amount of coal combusted and combustion characteristics

As mentioned above in Section III.C.1, in 2008, LMC conducted an experiment in order to provide some basis for estimating coal ash discharges in the Section 308 CWA Response.[22] This experiment is further described below. Since that time, LMC did additional, more detailed

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[21] This is further explained at page 46 above.

[22] A copy of LMC's response is at Attachment J to this submission, beginning at LMCF00027. It is also on EPA's website at http://www.epa.gov/r5water/npdestek/badger/ at Petition Attachments E-2a and E-2b (*last accessed on* April 18, 2012) and was provided as part of LMC's Petition to Region 5 for permission to seek a permit on November 2, 2011. It was also submitted to EPA during consideration of the current VGP.

analyses, and has been able to more precisely estimate the ratio of bottom ash to economizer ash to fly ash. In 2011, the ash specification for coal as provided by our supplier ranged from 8-9% (it varies widely due to market conditions and availability, and the size of LMC's demands, which greatly limits its sources of coal).[23] The actual ash generation rate – 8.94% – was lower than the level of ash allowed in the current permit. Attachment DD. In order to be as conservative as possible, and due to varying conditions, as explained below, LMC assumed an ash generation level equal to the highest amount permitted under the VGP: 9.5%.

On its last trip of the season on October 12, 2008, the Badger retained all of the ash generated (from the boiler, economizers, and collectors) during a 12-hour period, which included one round-trip from Ludington, Michigan to Manitowoc, Wisconsin. As it left Ludington at 7 a.m., the boiler room crew was instructed that the only ash to be discharged was that which was generated before 7 a.m. on October 12. The Badger arrived in Manitowoc at about noon and began its return trip at about 2 p.m. The Badger returned to Ludington at about 7 p.m.

When the vessel arrived at Ludington, the ash that had accumulated in the boiler, economizer, and collectors was allowed to cool for 36 hours and was then removed using a vacuum truck. The removal process took approximately 7½ to 8 hours. The truck was weighed before and after the bottom ash was removed. The difference was approximately 3,500 lbs. Then, the economizer and collector ash was removed. Together, this ash weighed approximately 1,500 lbs.[24] Thus, the total amount of ash generated over the 12-hour period from 7 a.m. to 7 p.m. on October 12 was approximately 5,000 lbs (2.5 tons). Based on the amount of coal purchased over

[23] LMC's annual coal purchases – around 8,000 tons – are considered minuscule when compared to most users, like coal-fired power plants. As a result, LMC is unable to go to any truly open market to obtain coal, and instead is limited. That limitation impacts LMC's ability to demand coal with particular specifications.

[24] There was not enough time to shut down the system in order to weigh the truck separately for collector and economizer ash, as the truck had to be at the landfill prior to 6 p.m. on October 14.

the 2008 season (8,610 tons) (Attachment EE), and the fact that the vessel operated 154 days, we concluded that, during each 24-hour period of operation, the Badger consumed about 55.90 tons. Thus, the 12-hour test period consumed 27.95 tons of coal (55,900 lbs) and generated approximately 5,000 lbs of ash, resulting in an 8.94 percent ash generation rate. Assuming an 8.94 percent ash generation rate, it was estimated the Badger generated (and discharged) approximately 1,539,468 lbs of ash (769.7 tons) in 2008.

Under the current VGP, LMC is permitted to use coal with an ash content not to exceed 9.5%. During calendar year 2011, the Badger burned about 58 net tons per one-way trip, and over the course of the year burned about 8,120 net tons of coal. *See* Attachment DD.[25] Using the same methodology outlined above, but assuming the higher ash content allowed for coal under the current VGP (9.5%), the total ash generated and discharged in 2011 would not have exceeded about 772 tons. For purposes of determining the concentration of coal ash in the effluent, this is the total ash figure that LMC used.

LMC used a third calculation as well. In 2011, LMC assumed an ash content of 6.72% based on certain coal analytical data from prior years. Attachment DD at LMCF00023. This level was used for purposes of testing performed in 2011 and 2012 using the EPA methods noted above.

In sum, all calculations done for purposes of this application were done using three different ash content assumptions: 6.72% (based on coal specifications); 8.94% (based on physical weight of ash); and 9.5% (maximum permitted under VGP permit). NPDES analytical

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[25] The Badger operated for only 132 days in 2011, rather than 157 days as was the case in 2008.

testing was done in 2011 and 2012, while the vessel was still in operation during the 2011 season, and before LMC's petition to seek the permit was granted by Region 5 in 2012.

We have also estimated that the volumetric ratio of bottom ash to economizer ash to fly ash is approximately 50% to 35% to 15%. This may vary by a percentage point or two. This was determined by visual observation and approximate measurement of the volume of ash in each location, over a six-week period in 2011. Attachment S contains a summary of the volumetric observations made at each location over this period of time, and Attachment R contains one example of the real-time notes made of these observations. Adjusting these figures based on ash density gives a mass ratio of 58/28/14. *See* Attachment CC, at CC-1.

Assuming the 58/28/14% mass ratios of bottom ash/economizer ash/collector (fly) ash as described above, and the total maximum ash allowed under the current permit, the Badger's theoretical maximum amount of ash discharged in 2011 contained no more than 6,397 pounds of bottom ash, 3,053 pounds of economizer ash, and 1,570 pounds of collector (fly) ash per day during the 2011 season.[26] The basic assumptions underlying all analytical results are set forth in Attachment CC at CC-1. These figures are used for purposes of the concentration calculations in the analytical tests that accompany the permit application forms. In addition, as explained above, ash is not discharged continuously. Actual discharges from the boiler, economizer, and collectors occur for approximately 110 minutes at intervals described above during the four-hour trip across Lake Michigan.[27]

[26] As noted above, we know the real figures are lower based on actual measurements.

[27] *See* note 14 above.

Based on the actual figures derived from 2008 and the maximum potential figures calculated for 2011, and assuming a 9.5% ash generation rate (which we know is high), the ash content of the effluent at the time it is discharged is in the range of 1,960 mg/l (collector ash) to 5,323 mg/l (bottom ash). This is all set forth in Attachment CC at CC-1.

In sum, we believe the following statistical summaries are appropriate:

- Coal burned per season: About 8,120 tons in 2011;
- Bottom ash generated per season: About 895,580 pounds;[28] *see* Attachment CC at CC-1;
- Collector ash generated per season: About 427,420 pounds; *see* Attachment CC at CC-1;
- Economizer ash generated per season: About 219,800 pounds; *see* Attachment CC at CC-1;
- Total time of actual ash discharges per trip: 110 minutes;
- Gallons of water (effluent) used during 110 minute discharge period:

  132,000 gallons;
- Concentration of coal ash during discharge: 1,960 mg/l to 5,323 mg/l based on several factors (this is not a continuous range); *see* Attachment CC at CC-1;
- Coal type, fuel province and source: *See* Attachment DD;
- Discharge conditions (GPS location start and end of each discharge period for each boiler, economizer, and dust collector, distance from shore, water depth, air & water temp, weather conditions, % relative humidity, average barometric pressure, and vessel speed at time of discharge) - for both discharge and range of values for typical voyages:

  GPS location chart: At least 6 miles from Michigan shore; at least 4.5 miles from Wisconsin shore; *see* discharge map attached to NPDES Form 1;

  Water depth: 100-520 feet;

[28] Coal ash generated per season based on mass discharged per day (lbs) as calculated in Attachment CC at CC-1 assuming 140 days of operation.

Weather conditions: Varies; vessel operates late May through early October only;

Vessel speed at time of discharge: About 14-15 knots;

- Vessel characteristics (ship width, draft, range of ship speed during discharge events):

  Ship width: 59 feet; 410 feet long; height is 106 feet (seven stories); weight is 6,650 displaced;

  Draft: Approximately 16-17 feet;

  Range of speed during discharge events: about 14-15 knots, but no less than 6;

- Discharge Port Characteristics (port diameter, elevation, vertical & horizontal angle, number of ports, port spacing, port depth, effluent flow, effluent temperature and concentration):

  Port diameter: 6 inches;

  Port elevation: About 4 feet from surface of water;

  Vertical and horizontal angle: N/A;

  Number of Ports: 2;

  Port spacing: N/A. One on port side and one on starboard side of vessel;

  Port depth: N/A;

  Effluent flow: *See* Attachment CC at CC-1;

  Effluent temperature: Not recordable; probably slightly above ambient lake temperature;

  Effluent concentration: *See* Attachment CC at CC-1.

D. Sampling Schedule and Number of Samples - Actual Samples

Attachment CC at CC-9 through CC-97 contains test results for all ash tests conducted by LMC. For 2011 and 2012 test results, the following process was used.

Representative ash slurry samples were prepared using ash saved from the Badger's final voyage of the 2011 season, which occurred on October 9, 2011. Near the end of each voyage, ash is generated after the discharge ceases, such as when the Badger is no longer in waters where discharge is permitted. This ash is normally retained on the vessel and discharged during the next voyage. At the end of the season, any remaining ash remnants are usually removed and sent to a landfill. After the final voyage of the 2011 season, LMC personnel collected approximately 0.5 cubic yards of each type of ash (boiler ash, economizer ash, and collector (fly) ash). These bulk ash samples were collected on approximately October 10, 2011 in large (30-35 gallon) plastic tubs, covered, and stored aboard the vessel. ASI Environmental Technologies, Inc. ("ASI Environmental") collected samples from the bulk ash samples in these tubs using standard sampling procedures, and provided them to Merit Laboratories for analysis.

Two sets of slurries were prepared. The first set represents the estimated ash concentrations based on the Badger making four crossings of Lake Michigan (two round-trip voyages) per day. The second set represents the estimated ash concentrations on days when the vessel makes only two crossings (one round-trip) per day. Because the boilers continue to operate while the vessel is in port, reducing the number of crossings does not substantially reduce the total mass of ash produced; rather, a larger mass of ash must be discharged during the subsequent voyage. This larger quantity of ash, entrained into the same volume of water, yields a more concentrated ash slurry. Representative samples of both the less concentrated (4-crossing) and more concentrated (2-crossing) slurries were analyzed to provide characterization of the vessel's discharges under the full range of operating conditions. Attachment CC at CC-99.

Table 3. Ash slurry concentrations based on four crossings per day (6.72% ash concentration)

Ash Source	Ash density (lb/ft^3)	% of total by volume	Ash source contribution (lb/ft^3)	% of mass	Mass Discharged per Crossing (lbs)	Discharge Duration (min)	Water Pumping Rate (gal/min)	Ash Concentration (lb/gal)	Slurry Concen-tration (mg/l)
Boiler	22	50%	11	58.0%	1,103	60	1,200	0.0153	1,836
Economizer	15	35%	5.25	27.7%	526	30	1,200	0.0146	1,752
Collector	18	15%	2.7	14.2%	271	20	1,200	0.0113	1,352

Table 4. Ash slurry concentrations based on two crossings per day (6.72% ash concentration)

Ash Source	Ash density (lb/ft^3)	% of total by volume	Ash source contribution (lb/ft^3)	% of mass	Mass Discharged per Crossing (lbs)	Discharge Duration (min)	Water Pumping Rate (gal/min)	Ash Concentration (lb/gal)	Slurry Concen-tration (mg/l)
Boiler	22	50%	11	58.0%	2,206	60	1,200	0.0306	3,671
Economizer	15	35%	5.25	27.7%	1,053	30	1,200	0.0292	3,504
Collector	18	15%	2.7	14.2%	541	20	1,200	0.0226	2,703

Lake Michigan water was collected by ASI Environmental staff using standard sampling procedures. Samples were collected on February 21, 2012 from the north side of the north breakwater in Ludington. Samples were collected outside of the breakwater to minimize Pere Marquette river water influences and be representative of Lake Michigan water. A stainless steel container was repeatedly lowered into the lake using a string, and sample bottles were filled with the retrieved lake water. Water and ash samples were provided to Merit Laboratories for preparation of the slurries and subsequent analysis.

Merit Laboratories prepared the ash slurry samples as follows:

1) Lake water was received in one liter amber bottles. To avoid contamination of the water, the lab assumed each amber bottle

contained one liter of the Lake water without removing the water to measure the exact volume.

2) Then, using an analytical balance, the lab weighed into a new, tared, plastic weighing dish (*i.e.* 3.1g, 1.665g, etc.) the number of grams of ash to be mixed into each bottle of the Lake water.

3) After weighing, the lab transferred the ash into the amber bottles of Lake water quantitatively and reweighed the weighing dish to subtract any residual ash remaining in the weighing dish.

4) With the transfer completed, the bottles were capped and agitated by inversion and shaking.

5) The bottles were allowed to equilibrate for at least 24 hours. After this time, the lab poured undisturbed sample into the appropriate bottles for the analyses requested and submitted them for testing using standard laboratory procedures and the analytical methods listed in Table 5.

These samples were analyzed for the pollutants listed in Form 2C of the NPDES permit application that were believed to be potentially present. Previous sampling of a composite ash slurry sample consisting of all three types of ash (results provided in Attachment CC at CC-9 through CC-97) indicated that all organic chemicals were below the limit of detection. For this reason, the individual ash slurry samples were not analyzed for organic pollutants. Table 5 lists the analytes and associated analytical methods employed.

Table 5. Analytical Methods

Parameter	Method
Ammonia-N	4500-NH3 D
COD	410.4
Cyanide	335.4/4500-CN-E
Nitrate-N	300.0
Nitrite-N	300.0
Organic Nitrogen	Calculation
pH	4500-H+B
Sulfate	300
Sulfide	4500-S2 D
Sulfite	4500-SO3 2-B
TBOD5	10360
TOC	EPA 415.1
Total Kjeldahl Nitrogen	4500-N(org)/NH3

Parameter	Method
Total Phosphorus	4500-PE
Total Suspended Solids	2540D
Aluminum	200.8
Antimony	200.8
Arsenic	200.8
Barium	200.8
Beryllium	200.8
Boron	200.8
Cadmium	200.8
Chromium	200.8
Cobalt	200.8
Copper	200.8
Iron	200.8
Lead	200.8
Magnesium	200.8
Manganese	200.8
Molybdenum	200.8
Nickel	200.8
Selenium	200.8
Silver	200.8
Thallium	200.8
Tin	200.8
Titanium	200.8
Zinc	200.8
Mercury, Low Level	1631E

V. ADDITIONAL INFORMATION RELEVANT TO PERMIT APPLICATION

When the coal ash effluent discharge was authorized by the VGP in 2008, LMC demonstrated what it believed to be BAT, and EPA agreed. We have continued to apply that technology, and seek alternatives, and to date the currently-authorized conditions remain BAT.

As we understand it, EPA is required to conduct another BAT analysis as part of its review of LMC's individual permit application. That is, EPA must set technology-based effluent limitations ("TBELs") in the Badger's permit based upon its evaluation of the factors listed at § 304(b)(2)(B) of the CWA, 33 U.S.C. § 1314(b)(2)(B), and 40 C.F.R. §§ 125.3(c) and (d). This multi-factor BAT analysis indicates that the Badger is currently using BAT with regard to coal ash discharges, just as it was in 2008. Therefore, EPA should approve an NPDES permit that includes TBELs based upon the Badger's current technology, and not based on LMC's ability to demonstrate the viability of alternative systems that are not currently available or feasible.

A. Standards for Setting Effluent Limits Based on Best Available Technology

The CWA prohibits the discharge of pollutants by any persons from any point source into the navigable waters of the United States except when authorized by an NPDES permit. *See* 33 U.S.C. §§ 1311(a) ("§ 301(a)"), 1342 ("§ 402"). The legal standard governing the issuance of NPDES permits begins with § 402 of the CWA. This section authorizes issuance of NPDES permits in two circumstances. First, a permit may be issued when a proposed discharge will comply with all applicable requirements of the Act, including effluent limitation guidelines ("ELGs") promulgated under § 301 and 33 U.S.C. § 1314 ("§ 304") of the Act. CWA § 402(a)(1)(A). Second, if ELGs have not been implemented, a permit may be issued based upon "such conditions as the Administrator determines are necessary to carry out the provisions of this chapter." CWA § 402(a)(1)(B).

EPA has interpreted this second prong of its permitting authority in its regulations at 40 C.F.R. § 125.3. *See* NPDES Permit Writer's Manual, Chapter 5.2.3.1 at 45 (Sept. 2010). When EPA has not promulgated ELGs for a particular discharge stream, EPA must use its best professional judgment ("BPJ") in setting TBELs on a case-by-case basis in NPDES permits. 40 C.F.R. § 125.3(c)(2); NPDES Permit Writer's Manual at § 5.2.3.1 at 45. In *NRDC v. EPA*, 863 F.2d 1420 (9th Cir. 1988), the court described the nature of the process that must be undertaken in writing an NPDES permit when there are no ELGs on point:

> [I]n issuing permits on a case-by-case basis using its [BPJ], EPA does not have unlimited discretion in establishing permit effluent limitations. EPA's own regulations implementing this section [§ 402(a)(1)(B)] enumerate the statutory factors that must be considered in writing permits. *See* 40 C.F.R. § 125.3(c), (d) (1987). *See also* 51 Fed. Reg. at 24915 ("In developing the BPJ permit conditions, [the EPA] Regions are required to consider a number of factors, enumerated in [33 U.S.C. § 1314(b)] . . . ."). In addition, courts reviewing permits issued on a BPJ basis hold EPA to the same factors that must be considered in establishing the national effluent limitations. *See, e.g.*, *Trustees for Alaska v. EPA*, 749 F.2d

> 549, 553 (9th Cir. 1984) (EPA must consider statutorily enumerated factors in its BPJ determination of effluent limitations); *API*, 787 F.2d [965] at 972, 976 (applying statutory factors in reviewing effluent limitations in a BPJ permit).

Id. at 1425.

We understand the inquiry is the same whether EPA is evaluating an application for an individual or a general permit. *See* 40 C.F.R. § 125.3(c)(2) (drawing no distinction between general and individual permits when setting case-by-case effluent limitations); *Trs. for Alaska v. EPA*, 749 F.2d 549, 553 (9th Cir. 1984) (stating that the EPA Administrator must consider the factors listed at § 304(b)(1)(B) when making case-by-case determinations under § 402(a)(1), in a case involving an individual NPDES permit). For all case-by-case permitting exercises, "[t]he permit writer shall apply the appropriate factors listed in § 125.3(d) and shall consider: (i) [t]he appropriate technology for the category or class of point sources of which the applicant is a member, based upon all available information; and (ii) [a]ny unique factors relating to the applicant." 40 C.F.R. §§ 125.3(c)(2)(i) and (ii).

As we understand it, which factors are appropriate for consideration turns on the type of pollutant to be discharged. With regard to non-conventional pollutants (like coal ash), limitations must reflect the "best available technology economically achievable." CWA § 301(2)(A). BAT is technology that is both (1) technologically available and (2) economically achievable. *BP Exploration & Oil, Inc. v. EPA*, 66 F.3d 784, 790 (6th Cir. 1995); *NRDC v. EPA*, 863 F.2d at 1426 (accepting EPA's determination that a particular technology was not BAT, despite its technological feasibility); Attachment U. While EPA may treat technology that is not presently in use by a given industry as available, there must be some indication in the administrative record of the reasons for concluding that such technology will be feasible and economically achievable if mandated. *Hooker Chem. & Plastics Corp. v. Train*, 537 F.2d 620, 636 (2d Cir. 1976).

In determining what is economically achievable, consideration must be given to the impact on profitability and loss of jobs. *BP Exploration & Oil*, 66 F.3d at 796-98 (court upheld EPA's determination that an available industry practice was not BAT due to unreasonably high costs); *Waterkeeper Alliance, Inc. v. EPA*, 399 F.3d 486, 515-18 (2d Cir. 2005) (EPA acted reasonably in rejecting technologies that although available would have resulted in 11% facility closures industry-wide). In developing TBELs based on BAT, the following factors must be considered: (1) the age of the equipment and facilities involved, (2) the process employed, (3) the engineering aspects of the application of various types of control techniques, (4) process changes, (5) the cost of achieving such effluent reduction, and (6) non-water quality environmental impact (including energy requirements). CWA § 304(b)(2)(B); 40 C.F.R. § 125.3(d)(3). This is precisely the BAT analysis that was followed in setting the case-by-case effluent limitations for discharges covered by the VGP, including coal ash discharges, and must be the process used for an individual permit application as well. Attachment U at 41-49. The same standard should be applied to the current individual permit application.

B. As Applied to the Badger, BAT Is the Currently Installed Coal Ash Discharge System

Despite LMC's best efforts, the BAT for the discharge of coal ash remains the system currently installed on the Badger and authorized in the current VGP. The possibility that the Badger would be unable to create a zero discharge system by the end of 2012 was raised by LMC in its public comments to the VGP, and was addressed by EPA in its response to LMC. *See* Attachment L at 6-558. EPA said that LMC might have to seek individual permit coverage after the expiration of the coal ash authorizations in the VGP. *Id.* This is exactly what is happening. LMC requests that EPA follow its standard process for setting effluent limitations via an individual NPDES permit. LMC's continued efforts to seek out and create a novel technology to eliminate coal ash discharge should not count against it in its individual NPDES permit application.

In the 2008 VGP, a similar case-by-case permitting exercise, EPA settled on a mix of numeric and narrative effluent limitations for coal ash discharges from large ferries; it was information from LMC that formed the basis for this determination. *See* VGP at § 5.3.2.3 (requiring large ferries to minimize coal ash effluent discharge, to use low sulfur content coal, and to discharge coal ash only when more than 5 nautical miles ("nm") from any shore and in waters of 100 feet deep).[29] As noted, it is believed the Badger is the only vessel that falls in this category. EPA imposed these TBELs because it determined that "there is currently not a feasible, available, or economically practicable and achievable means to eliminate the discharge," i.e., the Badger's then-existing technology represented BAT. Attachment L at 6-558. *See also* Attachment U at 44 ("Technology-based limits in the permit represent the . . . BAT (for toxic and non-conventional pollutants) level of control for the applicable pollutants.").

The December 19, 2012 expiration date on the coal ash discharge authorization is not a mandatory effluent limitation based on BAT, as evidenced by its placement outside the VGP section that sets forth coal ash effluent limits, and EPA's acknowledgment that LMC could seek individual permit coverage for the discharge in the future if necessary. *See* VGP at §§ 5.3.1.1 and 5.3.2.3; Attachment L at 6-558. Instead, this expiration date reflected EPA's expectation (and

[29] As is reflected in the materials provided, LMC goes to extraordinary efforts to operate its boilers as efficiently as possible so as to reduce how much coal it uses, and how much ash is generated. *See* Section III.A.3 above.

ours) that the Badger would no longer need to obtain authorization under the VGP, because LMC hoped to eliminate the discharge of coal ash by 2012. As explained below, the multi-factor analysis mandated by 40 C.F.R. § 125.3 confirms that the BAT for the discharge of coal ash remains the system currently installed on the Badger.

1. Water quality impacts of coal ash discharge

The water quality impacts posed by the Badger's continued short-term discharge of coal ash effluent do not pose a threat to human health or the environment. We have provided extensive testing results that reflect representative samples of the coal ash discharge.[30]

In analyzing the coal ash discharged from the Badger, only 18 of the 110 constituents analyzed were present, and of those, the levels were far below those allowed by applicable Michigan, Wisconsin, and federal law, procedure and guidance. *See* Attachment CC at CC-2 through CC-7. ***Analytical testing demonstrates that the ash discharge does not exceed the applicable water quality wasteload allocations, including those for acute toxicity and human health.***[31] *See* Attachment CC at CC-2 through CC-8. For example, the highest calculated arsenic

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[30] This testing distinguishes between bottom ash, economizer ash and collector ash as EPA requested. As noted above, by volume, about 50% of the ash discharged is bottom ash, 35% is collector ash and 15% is economizer ash. On a mass basis, the ratios are 58/28/14%. *See* Table 1 on page 45. This is described at pages 52-53 above. Each type of ash is discharged separately. In addition, our analyses assumed three different levels of ash content including one that assumes the highest possible ash content based on the current permit, one that uses actual ash generated, and one that is based on coal specifications.

[31] We understand that the acute wasteload allocation is the effluent quality that is necessary to meet the acute water quality standards of the receiving water, based on ambient criteria and the exposure of the resident aquatic community. "Technical Support Document for Water Quality-based Toxics Control," EPA/505/2-90-001 (May 1991), *available at*: http://www.epa.gov/npdes/pubs/owm0264.pdf (*last accessed on* May 15, 2012). The acute ambient criterion represents the highest concentration of a material in the ambient water column to which an aquatic community can be exposed briefly without resulting in unacceptable effects. MICH. ADMIN. CODE r. 323.1043 (2006), *available at*: http://www7.dleg.state.mi.us/orr/Files/AdminCode/102_80_AdminCode.pdf (*last accessed on* May 15, 2012).

We understand the human health wasteload allocation is the concentration of a pollutant in the effluent that is necessary to meet human health water quality standards, based on ambient criteria and the exposure of humans to potentially toxic conditions. While other water quality criteria exist, they do not apply to the Badger. For example, drinking water limits do not apply, due to the distance of Badger discharges from shore and drinking water sources concentration (0.1 mg/l in the collector ash sample) is still more than 52,000 times **less than the applicable Wisconsin acute** wasteload allocation of 5,241 mg/l. Lead was present in collector ash (which represents less than a fifth of all the ash) at .073 mg/l. That is **40,150 *times below the Michigan human health wasteload limit*** of **2,931 mg/l**.[32] *See, e.g.*, Attachment CC at CC-6.

These levels are not only below applicable wasteload allocations protective of water quality standards, but are also well below the annual load levels that other permittees are allowed to discharge. For example, the Milwaukee Metropolitan Sewerage District's reported annual lead load (425 lbs/year) is over 70 times more than the Badger's lead load (6.0 lbs/year). The Wisconsin Power and Light Company ("WPL") Edgewater, Sheboygan facility's annual arsenic load level is more than five times (5.3) that of the Badger's assuming the highest (and most environmentally protective) ash generation rate of 9.5%.

Apart from these analytes, we specifically address two issues raised by EPA: mercury and Total Suspended Solids.

a) Mercury

Because mercury is regulated differently from the other analytes, and is measured differently,[33] we address it separately and as requested by EPA, address it in relation to the bottom ash, economizer ash and collector ash separately as well. Results of mercury testing are

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and the immediate dilution of the discharge in Lake Michigan; any pollutants present in the discharge will be undetectable well before reaching any drinking water intakes. Chronic values are not applicable because the duration of the Badger's discharges is under 30 minutes; chronic criteria are based on a four-day duration of exposure. "Technical Support Document for Water Quality-based Toxics Control," EPA/505/2-90-001 (May 1991), *available at*: http://www.epa.gov/npdes/pubs/owm0264.pdf (*last accessed on* May 15, 2012).

32 The lead present in the remaining 83% of the ash was at lower levels and would be even further below the wastewater allocation.

33 Mercury is measured in ng/l rather than mg/l, a far lower standard. In addition, since most discharges cannot meet this standard, there is a statewide variance in place. Also, because mercury is a persistent material that does not 'break down' in the environment, there are total load considerations for mercury regardless of concentration, which do not apply to other analytes.

found at Attachment CC at CC-8. The bottom and economizer discharges (over 80% of all the ash discharged) are well below the all applicable standards under both Michigan and Wisconsin law, even using the theoretical highest ash concentrations possible. In terms of overall amount of mercury discharged, over the course of a year, the effluent contains approximately 0.0013 pounds (0.02 ounces) of mercury. According to one report, the average daily mercury load from the 146 NPDES permitted municipal and industrial point sources that discharge into Lake Michigan is approximately ***36 times*** higher than the amount discharged by the Badger.[34] *See also* Attachment CC at CC-8.

Most point source discharges are unable to meet the stringent wildlife water quality criterion for mercury of 1.3 ng/l. In fact, the Michigan Department of Environmental Quality (2010) reports that 80% of NPDES permitted discharges in Michigan do not meet this criterion. Unlike them, the Badger does meet this standard for over 80% of the ash discharged.

Because virtually no one is able to meet this limit since technology does not exist to do so, a variance policy has been implemented in each state, and approved by EPA. We understand that implementation of this general mercury variance is intended to prevent substantial and widespread social and economic impacts. Attachment CC at CC-100; WIS. ADMIN. CODE NR § 106.145 (2005). *Available at* http://dnr.wi.gov/org/water/wm/wqs/codes/nr106.pdf (*last accessed on* May 15, 2012). It was determined that the average cost to remove mercury below 12 ng/l

[34] Veil, JA and D Elcock, 2010. Comparative Analysis of Discharges to Lake Michigan. Phase II - The Entire Lake. Environmental Science Division, Argonne National Laboratory. Prepared for Purdue University, June 2010. *Available at* http://www.es.anl.gov/Energy_Systems/Research/process_technology/PDFs/final-ANL_EVS_R-09-3.pdf at page 28, 42 (*last accessed* May 9, 2012).

through end-of-pipe treatment is in excess of ten million dollars per pound of mercury removed.[35]

All the Great Lakes states have adopted this approach. Michigan, for example, has reviewed the available information regarding end-of-pipe treatment for mercury, including the effectiveness of the treatment and associated costs, most of which was contained in Ohio's 1997 assessment of economic impacts for mercury treatment strategies. Like Ohio, Michigan concluded that end-of-pipe treatment to meet the 1.3 ng/l Water Quality Standard ("WQS") would cause widespread social and economic impacts without guaranteeing removal sufficient to achieve the mercury WQS, and that a general (*e.g.*, statewide) mercury variance was appropriate. The MDEQ Mercury Strategy Workgroup Report (MDEQ, 2008b) includes a discussion of mercury removal from municipal wastewater treatment plant effluent, and current practices and technologies available for separation of mercury-containing dental amalgam from sanitary wastewater. Attachment CC at CC-100. Here, the cost for the Badger to eliminate 0.0013 pounds of mercury would be no less than $ 33,900,000 per ounce per year.[36]

As noted above, the Badger's entire coal ash discharge contains 36 times less mercury than is in the average discharges of 146 other permittees. Over the life of this permit, a total of *one tenth* of an ounce would be contained in the ash discharge entering Lake Michigan.

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[35] Studies performed by Foster Wheeler Environmental Corporation, DRI / McGraw Hill, and the Ohio EPA support this. Ohio Environmental Protection Agency, Mercury Variance Guidance 10, ORC 6111.03, 1 (June 23, 2000). *Available at* http://www.epa.ohio.gov/portals/35/guidance/permit10.pdf (*last accessed on* May 16, 2012) The general mercury variance has been included in Ohio's rules to offer NPDES permittees an opportunity for relief from installing costly end-of-pipe treatment in order to comply with very low average water quality-based mercury limits.

[36] 0.0013 lb = 0.0208 ounces; Attachment Y demonstrates that the least costly ash retention option that would eliminate the discharge of mercury entirely costs $705,225.60 per year. Eliminating 2 ounces of mercury would translate to an annual cost of $67,810,153.85 per year, or over $33,900,000.00 per ounce.

Based on this information, it is fair to conclude that the trace levels of mercury contained in the Badger's effluent discharge presents **no risk** to human health or the environment because it meets two of the three applicable standards, and meets the variance policy applicable to the third.

b) Turbidity

EPA has in the past expressed concern regarding turbidity from the discharge, given that the character of the discharge essentially resembles dust and fine particulates. Attachment L at 6-558. LMC had a separate analysis of this done by the Great Lakes Environmental Center ("GLEC"). The GLEC report on coal ash effluent discharge from the Badger found **no indication that the turbidity and total suspended solids resulting from the discharge of coal ash from the Badger's operations in the manner set forth in the VGP would be harmful to the aquatic life or the environment of Lake Michigan**. GLEC Evaluation of the Potential Ecological Impacts of Coal Ash Slurry Discharges from the Badger to the Open Waters of Lake Michigan, (June 3, 2011) (Attachment W at W-28.). The GLEC assumed an 8.94% ash rate. Extending this calculation to a "worst-case" ash rate of 9.5% does not change the conclusions. The GLEC report indicated that the Badger discharges could increase total suspended solids ("TSS") in the immediate vicinity of the vessel by 0.20 mg/l, and could increase turbidity by 0.08 nephelometric turbidity units ("NTU"). Using the higher (9.5%) ash rate and based on 2011 coal usage, the Badger discharges might increase local TSS concentrations by 0.33 mg/l, and turbidity by 0.13 NTU. The resulting upper-bound TSS concentration in the vicinity of the Badger would be **1.86 mg/l, and the upper-bound turbidity would be 0.88 NTU. Both of these values are well below levels that would have adverse effects on water quality, as discussed in the GLEC report**. *See* Attachment W at W-7.

2. Age of the equipment and facilities involved

The ash removal system consists of a vacuum conveyor system and associated intricate piping that was built into the vessel structure, and is the original design that was in place when the Badger went the Badger went into service in 1953. Attachment J at 4. This is explained in Sections III.A and III.B above. The vessel was designed and built to use coal to create steam. While it is possible that some coal fired steam ferries may have been retrofitted to use heavy diesel as fuel 50 years or more ago, LMC is not aware of any that were retrofitted and operate today. Moreover, as noted above, EPA is currently in the process of prohibiting use of heavy diesel fuel. LMC is aware of one vessel, the S.S. Crapo, which may have been retrofitted in the mid-1990s to operate on heavy oil instead of coal, but it is LMC's understanding that this vessel was unable to operate economically and ceased operating after about a year.

As explained above, it is neither technologically feasible nor economically achievable (or both) to redesign the equipment. Further, while pursuit of an alternative is extremely challenging, LMC continues to utilize expert engineers to try and resolve these issues.

3. The process employed

The Badger, like all other coal-fired vessels, was designed and built to burn coal as fuel and discharge the coal ash generated by this system. Steam is used to power the vessel and all of its equipment, including water pumps and equipment necessary for passenger safety and health. Coal combustion generates heat. Heat generates steam. Thus, steam is generated from the burning of coal. Steam is used to provide power to all vessel functions including heat and electricity. It is largely a unified single operation that today cannot be disassembled as explained and illustrated in Sections III.A and III.B above.

The boilers need to be operating continuously for the vessel systems to operate; they cannot be taken off-line. To accommodate the need to keep the boilers operating continuously, a system is built into the Badger's infrastructure to allow for the collection and removal of coal ash in its solid, dry form from the boilers, without shutting them down. This system relies on a vacuum created by water pressure that is pumped from a system powered by the boilers. The vacuum system draws out the dry ash, carries it in its dry state through the conveyor via the vacuum, and ultimately combines it with water in a 24 inch combining pipe so that it can then be ejected as effluent through a 36 inch overboard pipe. The system is built to direct the ash to one location on each side of the Badger, in a fixed piping system constructed as part of the vessel's infrastructure when it was built. This is explained in great detail in Section III.B above.

4. Engineering aspects of various control techniques

No coal-fired vessel operated in the past employed technology that eliminated ash effluent discharge. As discussed above in Section III.C, there are no demonstrated control technologies currently being used in the vessel industry to control ash effluent discharges. Technology transfer is not available in this case, since there is no other higher level of performance being achieved within the industry. Even assuming that an undemonstrated technology (*e.g.*, holding coal ash onboard) is technologically available to achieve zero discharge, such a technology could not be BAT because it is not economically achievable. In the proposed VGP, EPA discussed the costs of retaining particular discharges on board and then discharging them to an appropriate facility on land when the vessel reaches a port. As explained above, this potential option for the coal ash, where BAT would be zero discharge and require the manual removal of ash, was tested during the October 12 trial. Attachment J at 8. Under that scenario, for each round-trip taken by the Badger, three days of no operation would be required to remove the ash. We previously indicated that this would result in a 54% reduction in trips and a concomitant 54% reduction in gross revenues. There is no question that this would put LMC out of business. On reflection, however, it appears we vastly underestimated the impact of using this method to eliminate discharge of the ash. We assumed in our October 27 submission that the Badger would be out of service 2-3 days per week of operation. In fact, based on our October 12 experiment, a 2-3 day shutdown period would be needed to remove ash from 12 hours of operation (with one round-trip voyage). This would essentially reduce the Badger to 1 or 2 round-trips **per week,** instead of 2 **per day – an 86% reduction in business.** This is unquestionably a completely unviable option economically. As explained below, the Badger would be shut down.

To our knowledge, no coal-fired vessel has ever employed technology that eliminated coal ash effluent discharge by storing the ash on board and disposing of it landside. When the VGP was written in 2008, LMC thought that the Badger could be fitted with a system for coal ash storage that would result in zero discharge into Lake Michigan. LMC spent about $250,000 attempting to design a system for ash retention that would result in zero discharge. Unfortunately, the original ash retention system envisioned by LMC in 2008 was, after two years of effort, determined to be both technologically infeasible and economically unachievable for the reasons discussed in Section III.C.1 and III.D above. Similarly, the other methods of coal storage and discharge discussed in Sections III.C.1 and III.D have not yet proven to be either technically feasible or economically achievable. As stated above, while pursuit of an ash retention alternative is extremely challenging, LMC continues to utilize expert engineers to try and resolve these issues.

Moreover, installation of new equipment must first receive Coast Guard and American Bureau of Shipping authorization. Finally, as a form of public and commercial transportation, the Badger provides ferry services to thousands of cars and trucks each year and saves an estimated 1.1 million gallons of gasoline and diesel fuel. In sum, the costs of obtaining zero discharge immediately render a zero discharge BAT economically infeasible and unachievable at this time. Although BAT is not currently zero discharge, the possibility exists for BAT to be developed over the next several years that could potentially achieve zero discharge. LMC is committed to trying to do this as explained in our prior submissions. Based on EPA precedent, the agency could establish a phased or rolling BAT as control technology develops over time, as we have suggested in our prior comments.

5. Potential process changes

As explained in Sections III.C.2 and III.C.3, LMC has considered changing the fuels that power the boilers, and changing the entire boiler system out as well. *See also* Section III.D. None is technologically feasible and/or economically achievable.

There are no other technologies currently available that could be transferred to the Badger to achieve zero discharge. In our prior submission (Attachments I at 13 and J at 6-8, 9-10; Attachment B; and photographs at Attachments C-4, C-7, C-9, and C-10), we outlined in detail one system that might work to achieve zero discharge if it can be designed and installed. Both this and other alternatives are described above and are not feasible or achievable.

6. Costs

As set forth in Section III.D above, the costs of utilizing some technology (even if it did exist) to eliminate the coal ash discharge is prohibitive. Requiring these options at this time would unquestionably require that the Badger to shut down. Additionally, the increase in highway travel that would result from shutting down the Badger would likely cause an increase in traffic fatalities. *See* Attachment G hereto. Given the fact that the coal ash discharge does not violate water quality standards and is far less problematic than many other permitted discharges, it would be reasonable and appropriate for EPA to approve this permit allowing the discharge of coal ash, subject to the conditions outlined above at page 1.

Just as in 2008, the cost of achieving zero discharge through any of the options described above is technologically infeasible and economically not achievable at this time. Any option would result in the direct loss of about 200 jobs supported by the vessel's operations and a potential loss of over 500 additional vessel-related jobs that are indirectly supported by the Badger's operations. Any option would also result in significant economic impacts to the towns of Ludington, Michigan and Manitowoc, Wisconsin, due to the tourism and ferry services provided by the Badger, which is estimated by some to reach $40 million annually. *See* discussion in Section II.B. By way of example, the cost of removing the mercury that is currently discharged, using the least expensive option, is more than $33,900,000.00[37] per ounce per year. Given the total amount of mercury discharged – less than 0.02 ounces per year – this is impractical.

7. Non-water quality environmental impacts

As discussed in Section II.C above, the Badger provides ferry service to thousands of cars and trucks each year and saves an estimated 1 million gallons of gasoline and diesel fuel. These reductions equate to annual air pollution reductions of more than 4.3 tons of total hydrocarbons, 100 tons of carbon monoxide, 20 tons of nitrogen oxide, and 1000 pounds of particulate matter.

37 See note 36.

See Attachment H. Moreover, an overall cost-benefit analysis reveals the substantially greater benefits if the Badger operates and the serious costs if it shuts down. Attachment F.

The fact that there are no technological alternatives to discharging coal ash from the Badger at this time is consistent with the situations observed by EPA for other vessels subject to the VGP. As EPA has stated in concluding that non-numeric BMPs are appropriate:

> Vessels vary widely by type and/or class, size, and activity. Furthermore, most vessel designs are unique, onboard space is highly limited, and information on the characteristics of all discharges from those vessels is limited . . . . Additionally, vessel operators cannot install equipment onboard their vessels until their equipment has been approved by the Coast Guard and, in some cases, their class societies. Hence, EPA could not require experimental equipment or technologies . . . without fully understanding the implications of these requirements.

Attachment U at 48.

As described at Section III.E above, the non-water quality environmental impacts of the current discharge practices are insignificant and essentially undetectable. The air emissions from the Badger are virtually nonexistent. When EPA considered its proposal to regulate air emissions from vessels on the Great Lakes, it understandably focused exclusively on emissions from diesel engines, even though it had extensive information about the Badger's air emissions. There are, at the same time, significant environmental benefits from the operation of the Badger, stemming largely from the significant reduction in vehicle miles travelled that the Badger provides.

Based on the foregoing, the Badger's current system remains the best and only technically feasible and economically achievable technology. Based on all available evidence, EPA should conclude today – as it did in 2008 – that the Badger's current technology is BAT and the effluent limits for coal ash set forth in the current general permit should be incorporated into the instant individual permit. LMC is unaware of any facts that suggest otherwise. This conclusion is confirmed by the multi-factor analysis mandated by 40 C.F.R. § 125.3 outlined above. These factors should be considered in light of the Badger's unique design and history and its status as a member of a class of one – the only remaining coal-fired car ferry roaming the Great Lakes. *See* 40 C.F.R. § 125.3(c)(2).

VI. CONCLUSION

In 2008, LMC provided extensive information upon which EPA relied to determine in the VGP that the current system for handing coal ash effluent discharged from the Badger constitutes BAT, and the Badger has been operating under the VGP using BAT. Despite extensive efforts, BAT remains the same. In addition, the discharge of coal ash effluent is well below concentrations associated with adverse environmental or human health effects. There is no evidence, given the nature and character of the discharge, that it presents any harm to the aquatic life in Lake Michigan, or human health and the environment. Everyone knew when the VGP was issued in 2008 that it was possible an alternative to this technology might not be available before the current authorization expires. The VGP anticipates it. It is clear that BAT for this discharge is not a no-discharge technology at this time. Therefore, we request that Region 5 issue an individual NPDES permit for LMC's coal ash discharge.

We look forward to addressing any additional questions and providing any supplemental information you may need in evaluating this permit application.