

Discussion Draft

Bridging ballast water treatment technology gaps: Moving from proof of concept to full implementation of Great Lakes Ballast Water skid mounted treatment systems within 24 to 36 months!

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Introduction:

This document was created for the Great Lakes Ballast Water Collaborative (GLBWC) to further the development of collaborative solutions designed to prevent new aquatic invasive species introductions or their spread within the Great Lakes. The authors offer the document as a step for further discussion and refinement in our common quest to protect the Great Lakes.

The ultimate solution for preventing new invasive species introductions from ballast discharges is to have all vessels equipped with effective, approved and regulated ballast treatment systems per the International Maritime (IMO) and United States standards. However, we are years away from full implementation as numerous obstacles exist. Shipboard ballast treatment systems are expensive to install and regulations may not be developed for years, especially for Lakers. Although industry has made improvements in risk reduction through both voluntary actions, and recently with enhanced exchange compliance procedures mandated by the Seaway and USCG, additional efforts could further reduce risk for an interim period, while facilitating the development of new long-term ballast treatment solutions.

The Great Lakes Ballast Water Collaborative (GLBWC) convened to determine what can be done to enhance the protection of the Great Lakes from aquatic invasive species. Many international, national and state governments are evaluating, ratifying or implementing ballast water management programs. A variety of ballast water discharge standards are being debated with no clear consensus among stakeholders. Methods for accurately evaluating the effectiveness of ballast treatment systems are being evaluated and developed with significant technical problems to overcome, especially for the more stringent standards. Ballast water treatment technology vendors will not have a significant market for

their products until laws are passed and treatment is mandated. The installation of on-board treatment systems will need to be phased-in to allow treatment vendors time to build production capacity and vessel operator's time for installation.

It has become clear that complete ballast water treatment in the Great Lakes could take 7 to 10 years for full implementation. Canadian and United States laker ships do not treat at all, and salt water vessels currently undertake only ballast exchange or flushing operations prior to discharge. Research has demonstrated that ballast exchange can reduce freshwater species survival in ballast, and that ballast treatment provides a significantly greater reduction with more consistent results. Consequently, there is room for improvement beyond exchange. Developing interim treatment will allow us to take a step towards moving beyond exchange and to begin to solve operational and implementation issues that will be required to fully implement both the IMO and United States Coast Guard (USCG) standards. It can also provide a back up for when future shipboard systems fail, and may produce a cost-effective treatment design suitable for long-term use.

We need not wait for all of the regulatory and technical hurdles associated with ship based treatment to be solved before making more strides toward preventing new introduction. Environmental Protection Agency (EPA) has identified 58 new species that are capable of being introduced into the Great Lakes (EPA, 2008). An effective interim program could reduce the risk of new introductions by treating the ballast of selected vessels determined to contain high-risk ballast. The envisioned interim treatment system will require the development of a:

- Risk assessment to determine which vessels carry ballast that warrant interim treatment.
- Skid mounted biocide treatment system designed to treat ballast discharges from the vessels selected through the risk assessment.

A significant number of ships will not have effective ballast water treatment systems installed until after 2016 or possibly as late as 2021. Until that time, regulators face the possibility that vessels carrying high risk ballast will arrive in ports ready to discharge with no tools to reduce the risk. New interim treatment methods could further reduce risk by making ballast treatment available sooner for certain vessels that need to carry ballast between port waters that are considered to have a high-risk of producing new invasions. This interim treatment system may also be adapted for use in emergency ship grounding situations. The risk of discharging suspect ballast water in an environmentally sensitive area may be mitigated by directing a salvor to treat the casualty's ballast tanks using the interim treatment system prior to discharge.

Section 1 of this paper will describe a collaborative project between the National Park Service and United States Geological Survey (USGS) to develop a skid mounted interim treatment system through proof of concept and practicality review. The agencies have leveraged their own funding with Fish and Wildlife Service, GLRI money and support from nonprofits to accomplish the tasks in section 1. Section 2 covers a series of additional proposed actions from State and GLRI proposals that, if funded concurrently

and centralized through a coordinating entity, would address the broader issues that affect implementation of a skid mounted interim treatment system.

Current members of the Collaborative were part of five independent proposals submitted to EPA for Great Lakes Restoration Initiative (GLRI) funding in FY 2010. If the Great Lakes Ballast Water Collaborative members can support critical steps to determine proof of concept through pilot tests, along with supporting GSI as a regional “service center” for developing needed scientific and technical information, enhanced protection of the Great Lakes could occur by the middle of 2013.

Though the GLRI proposals came from various sources they are complementary, and along with other efforts underway in the region (like GSI) and outside it, they represent a comprehensive approach to the problem. All five actions listed below would need to be initiated in calendar year 2011 to make a significant difference by 2013. The GLRI proposals included:

- 1) Establishing two pilot case studies for interim treatment in the lower Great Lakes: one directed for salt water vessels and one for freshwater (partially funded);
- 2) Determining the protocols for risk assessment to determine when to treat;
- 3) Generating a database for ambient water quality parameters that affect biocide demand and neutralization;
- 4) Creating a grant program for ships to install treatment and sampling ports (could be modified to include low cost loans); and
- 5) Developing financial support for industry/government/non-governmental organization forums for developing a system wide protection plan for the Great Lakes.

Copies of the original proposals for all of these actions are available upon request. The following outlines the process to develop and test the skid mounted treatment system.

Section 1: Developing skid mounted delivery systems at strategic shore stations

The concept of a Skid mounted ballast treatment technology was developed from preliminary work on emergency treatment of ballast by the National Park Service with USGS scientists, which dealt with identifying effective means of 1) accurately delivering biocides with minimal equipment; and 2) mixing biocides or a subsequent neutralizer. The Guidelines for the Emergency treatment of ballast (www.nps.gov/isro) will be updated with May 2010 shipboard test results by the fall of 2010. The studies have dealt with technology gaps in delivery mechanisms and mixing and as a result are ready to proceed cautiously to active biocide testing. In order for biocide testing to occur, compliance with the Federal Insecticide, Fungicide, and Rodenticide Act, United States Coast Guard and the Environmental Protection Agency rules needs to be met, and efficacy testing needs to proceed.

Skid mounted biocide delivery systems will enable a rapid response to treat identified high-risk ballast discharges. Developing a dependable interim treatment system is linked to many high priority needs identified within the Great Lakes by lead organizations concerned with the health of the freshwater ecosystems.

The goal of the skid mounted pilot project is to further reduce the risk of invasive species spread through ballast discharges, and to create an effective, efficient, and environmentally sound program of integrated pest management for priority Aquatic Invasive Species. The objectives are:

1. By July 30, 2011, skid mounted technology will be developed, piloted and refined; and
2. By 2012, with broad-based partnerships and funding, expanded pilot projects will be implemented at critical interdiction locations within the Great Lakes that demonstrate innovative prevention, and containment measures.

The success of the program will be defined by: The implementation of an interim ballast treatment program, coupled with voluntary and mandated actions that further reduce the risk of introduction for any of the next 58 potential invaders into the Great Lakes via ballast, and a reduction in the movement of AIS between the Lakes basins.

This timeline assumes that the tasks outlined in section 2 will occur. For example, responsible agencies with subject matter experts would convene during the winter of 2010-2011 to determine how to quarantine locations with new arrivals, and slow transfers of problematic fish diseases and aquatic invasive species (AIS) using man-made and natural separations between the basins of the Great Lakes.

Preliminary approvals and coordination for shipboard testing a skid mounted system using Sodium hydroxide and sodium hypochlorite:

FIFRA registration: Clorox Company is willing to provide a letter of sponsorship and has stated they will move towards product registration for ballast use under FIFRA once additional tests are conducted. An academic sponsor for NaOH has been found which meets EPA requirements for proceeding with experimental use permits. Once FIFRA approval is established for a chemical compound it becomes easier for other manufacturers of the same chemical to register parallel products.

Discharge standards: Standards have been established for two biocides--sodium hydroxide and sodium hypochlorite.

Engineering design and construction: One pilot system is funded through GLRI via the National Parks of Lake Superior Foundation, which is in the process of selecting an engineering firm(s). The system will be tested on a million gallon pond at a US Geological Survey research facility prior to a shipboard test as soon as practical this fall. The system will be designed to deliver NaOH as a biocide and CO₂ as a neutralization agent to reduce the pH to acceptable levels for discharge. The system may be capable of being adapted to deliver other biocides and neutralization agents in a liquid form, but this will require further evaluation.

Industry support: The American Steamship Company is continuing with their generous support by providing the *M/V Indiana Harbor* as a test platform for NaOH treatment system development. National Park Service has solicited support from two saltwater shipping companies and they are awaiting more details of support, needs and testing impacts prior to committing ships as a test platform. Provided pilot testing proves the pilot systems have a broad application for interim treatment, shippers

could proceed with the next step of implementation by agreeing to install in-line metering systems and sampling ports to determine that target doses have been achieved and neutralization standards met.

Regulatory support for testing: Jeff Stollenwerk of MNPCA has agreed to work with the project team to secure needed approvals in States where testing is to occur. The project team has mapped out all State and Federal permits and compliance check points needed to proceed and the National Park Service representative will work to secure them.

Independent Laboratory testing: The Great Ships Initiative is funded to conduct biological testing of the shipboard trials to evaluate the efficacy of the treatment procedures.

Funding: The first skid mounted system is part of a stepwise approach to developing a NaOH shipboard mounted treatment system or a shore-based system capable of serving the treatment needs of multiple vessels. The USDI Fish and Wildlife Program ballast water grant within the EPA's GLRI program is supporting the NaOH development as a treatment for freshwater application. Funding is available to conduct a proof of concept test this fall by using a skid mounted system to test biocide application and neutralization process. In addition, the National Park Service has incorporated funding for a second shipboard test using a second biocide for spring of 2011 into the agency requests for GLRI appropriations.

Initial efforts to develop interim ballast treatment methods were funded by the National Oceanographic and Atmospheric Administration, the Legislative-Citizens Commission on Minnesota Resources, the Great Lakes Fisheries Trust, the National Parks of Lake Superior Foundation, United States Geological Survey and the National Park Service. The National Aquatic Nuisance Species Task Force has established a sub-committee of federal stakeholders to further emergency treatment methods to reduce risk. The American Steamship Company installed all the sampling tubes and supports the research team during shipboard trials. These initial efforts resulted in the publication of a document describing a suite of methods to dose and mix ballast tanks on a variety of vessel types with either full or empty tanks and the work serves as a platform for developing interim treatment.

Ship Trial Overview:

The proposed effort includes 2 ship trials using a shore station skid mounted delivery system to dose 1, and perhaps 2 biocides (and subsequent neutralizer) into full and NOBOB ballast tanks under real time conditions to confirm the practicality of the method and efficacy of the treatment. Results will be used to update the NPS emergency responders' field guide for ballast treatment.



Figure 1 – 1,000 Foot Sister Ship of testing platform, *M/V Indiana Harbor*, during Winter Lay-Up

Previous testing demonstrated that complete mixing can occur with basic mixing techniques but the timelines for mixing make them less practical for an emergency response. Another research project tested enhanced mixing techniques using two different mixing systems (air-lift and eductor) and replicated the most promising techniques from previous tests.

The next research trial using the skid mounted unit is proposed for the *M/V Indiana Harbor*. The trial will utilize four to six highly instrumented ballast tanks, each of which is typically filled with 800,000 gallons of ballast water. A chemical metering system will be designed and built to support trials, and be suitable for future emergency response work. The system may be suitable for more than one biocide, but further testing is required for validation. Efficacy testing will be performed on a standard assay of organisms in accordance with the protocols of the Great Ships Initiative. The focus of this testing is to evaluate the engineering and practicality of the skid mounted unit and to validate that the biocide and neutralization agents were well distributed, and kill rates were within acceptable ranges.

Figure 2: Sampling Arrangement in Conveyor Tunnel on *M/V Indiana Harbor* (Typical Six Tanks)

In addition to the freshwater NaOH test, with industry cooperation, a salt water ship trial will be conducted. Current funding will allow data to be collected on one of two situations: 1) skid mounted application of a biocide and subsequent neutralizer into full ballast tanks (Provided that the NAOH shid mounted unit can be adapted for a salt water application); or 2) mixing a biocide into empty ballast tanks, NOBOB. NPS would like to secure a matching grant to enable both tests and will discuss with the Collaborative which has the most potential to further AIS interdiction if only one can be conducted. Program sub-tasks include: deployment of inline chemical dosing equipment, efficacy testing, updates to the field Response Guide,



and a final report. This trial will be performed on a ship of opportunity, to establish the practicality of the emergency response method on a salt water vessel.

Project Plan and Milestones

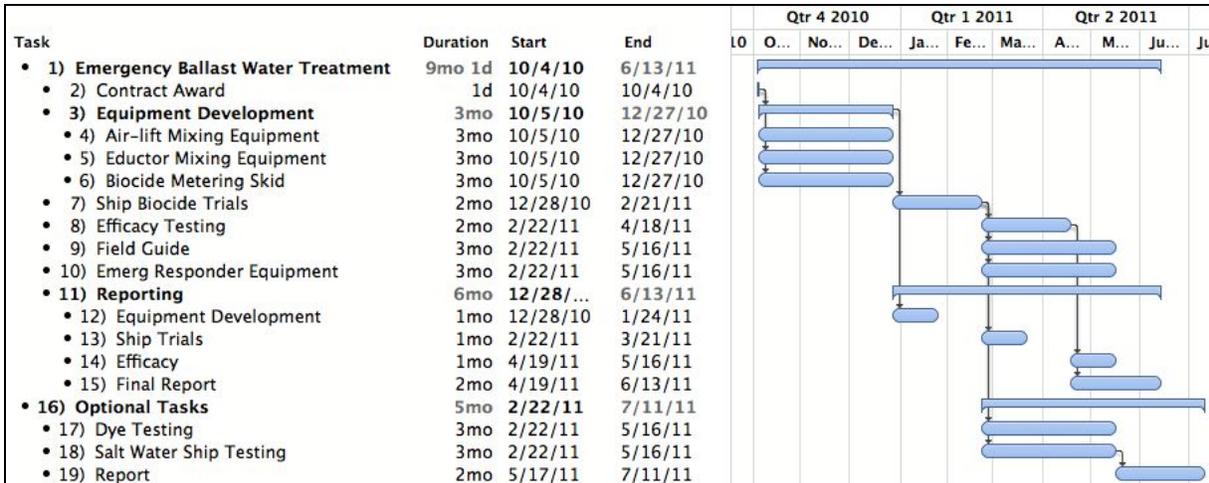


Figure 3 – Project Schedule and Milestones

Partners include: USGS scientists, naval architects and marine engineers, ship owner and operators, maritime salvage community, regulatory agencies, and the National Park Service. This project has built these relationships in a manner to result in fast and cost effective execution, and minimized project risk. The project timeline and milestones reflect a very aggressive schedule that could only be executed based on these relationships (Figure 3).

Section 2: Framework for addressing broader implementation concerns:

A broader analysis of how to address risk assessment needs to occur prior to the full implementation of the above described skid mounted pilot project. Risk assessment work is a critical component of protecting the Great Lakes with the least amount of chemicals and impact to vessel operators in the interim. To develop the assessment, responsible agencies with subject matter experts would convene during the winter of 2010-2011 to determine how to quarantine locations with isolated AIS populations, and slow transfers of problematic fish diseases and aquatic invasive species (AIS) using man-made and natural separations between the basins of the Great Lakes. It would include representation from all 8 States and Canada. The team would use a new report from EPA characterizing the next potential 58 problematic species for the Great Lakes and review the influence of wild vectors for potential transmission (EPA, 2008).

In addition, barriers to implementing an interim (or any) ballast treatment include: no approved independent testing labs; no approved regulatory standard to measure effectiveness; no approved compliance testing protocols; complex and inconsistent regulatory environment; safety and material handling issues; and no approved cost effective shipboard treatments. The following potential options are offered as a start for further review and refinement.

Independent testing laboratory: The eight great lakes states and St. Lawrence Seaway Corporation approve the Great Ship Initiative testing facility (at a minimum) as the official independent test facility to provide independent testing for treatment options to be used in the Great Lakes. GSI would provide the service function of data collection to support regulatory oversight in all aspects of certifying the systems and documenting the skid mounted system efficacy. The Collaborative would work with Canada to determine if GSI could provide for their needs, as well. Efficacy results from GSI bench scale tests would be used as a basis for chemical vendors who may wish to use the skid mounted system. It is assumed GSI would continue to pursue USCG and EPA test facility certification and this work on Great Lakes issues would provide additional documentation for their approval in the future.

Standards to measure the biological effectiveness of treatment systems: Use a technology standard with a known biological base. For example, Michigan established a 10mg/liter chlorine standard for dosage in order to accommodate a wide range of ambient demand for chlorine and have enough residual toxicity to kill all AIS. Michigan also established one of the toughest discharge standards for residual chlorine in the country at .038mg/l.

We would suggest that states adopt a technology standard as follows: Any biocide using a shore station delivery station must have the equivalent kill rate of 5mg/l of chlorine (above ambient demand) for a set exposure rate as proven by bench scale and land based testing and confirmed by the GSI facility. GSI would provide the information to the regulators for rulemaking in support of this effort when needed. Ships using skid mounted treatment will have the procedures to test for ambient demand or use data tables when developed from the proposed ambient demand study (see Hand Appendix A). This provides a bench mark for chemicals like NaOH or others from vendors. Chemicals must have a discharge standard already established or proceed through the EPA approval process to establish one.

Compliance testing protocols: Compliance checks for regulatory oversight will measure whether the biocide dose was achieved, and whether the discharge standard was met. A random sample of ships participating in the program would have additional biological samples pulled in order to start to correlate technology standards and coarse compliance test techniques with biological sampling to determine the effectiveness of treatments.

Regulatory consistency: Most great lakes states have adopted ballast water discharge standards ranging from IMO D-2 to 1000 times IMO with implementation dates ranging from 2012 to 2016. Wisconsin is conducting a practicality review to determine whether it is appropriate to implement a 100 times IMO standard versus the IMO standards. Michigan, which used a technology based standard, will be reviewing their standards within two years. The St. Lawrence Seaway Corporation established mandatory saltwater exchange practices, which established consistency on vessels entering the Great Lakes. The St. Lawrence Seaway Corporation could play a role in establishing interim consistency in treatment by requiring treatment at certain dose levels based on a risk assessment and the skid mounted systems would be provided at their sites for dosing and neutralizing as a start point in preventing new introductions. This will allow greater protection of the Great Lakes while the EPA and USCG promulgate regulation and certify systems. Standards for interim treatment, both for discharge and efficacy need to be developed and could create a common ground for States and the laker industry to agree on in concert with EPA and the USCG.

Safety and material handling issues: The research team will lay the ground work for FIFRA compliance and have American Bureau of Shipping and USCG reviews of two biocides as pilot tests. Any ship participating in the program (whether as part of compliance with state regulations or voluntarily) would conduct a review of all current seals and piping, and tanks, in the line of treatment for compatibility with the biocide they would be using. The research team would develop standard operating procedures for the chemical handling and crew safety information that are subject to regulatory review for the two biocides that are part of the test program. Vendors of other chemicals would have to provide that support.

Cost effectiveness: If it was 2025, and all ships had shipboard treatment, there would still be occasional failures. If ports and regulatory agencies had access to skid mounted treatment systems it would help minimize delays and increase efficiency for industry; and insure compliance for regulators. The skid mounted unit also has potential to evolve into a shore based treatment system. Preliminary estimates for a skid mounted system indicate it should be very cost effective as the system could be used by multiple ships. Ship owners would have to install in line metering systems and sampling ports as outlined by the Lake Carriers Association in their GLRI proposal (For copies of GLRI proposals contact Phyllis Green or Jim Weakley of the Lake Carriers Association). Additionally, the delivery system may have applications in the development for a rapid response system for new outbreaks of AIS in ports (This is beyond the scope of the effort proposed in this project).

Task	Duration	Start	End
• 1) Interim Treatment Pilot Case Studies	10mo	10/5/10	7/11/11
• 1.1) Freshwater Vessels	10mo	10/5/10	7/11/11
• 1.2) Saltwater Vessels	5mo	2/22/11	7/11/11
• 2) Determine Risk Assessment Protocols for Treatment	5mo 6d	10/5/10	3/1/11
• 2.1) Plan and convene expert forum	5mo 6d	10/5/10	3/1/11
• 3) Generate Base Data for Ambient Water Quality Parameters	24mo 2d	11/1/10	9/4/12
• 3.1) Determine sampling locations and frequency	3mo 6d	11/1/10	1/31/11
• 3.2) Conduct sampling and determine parameters	7mo 13d	5/2/11	11/30/11
• 3.3) Compile info and develop database	10mo	11/30/11	9/4/12
• 4) Create Grant Program for Treatment Installation	36mo	10/5/10	7/8/13
• 4.1) Initiation and prototype construction	14mo	10/5/10	10/31/11
• 4.2) Pilot fleet implementation and reporting	22mo	11/1/11	7/8/13
• 5) Fund, Organize and Convene Forums for Great Lakes Protection Plans	36mo	10/5/10	7/8/13
• 5.1) Develop emergency response capacity	7mo	2/28/11	9/9/11
• 5.2) Forum for development and support of testing	36mo	10/5/10	7/8/13

Figure 1 – GLRI Proposal Timelines

Coordination: All of these actions would benefit from an overall coordinating entity. Independent testing and data collection for regulatory decision making by states would be well served by the GSI. They may be able to support additional oversight roles in the project. The Great Lakes Commission or the International Joint Commission also could play a role. The Collaborative will have to play an essential role in bringing disparate parties to the table to discuss policy implications of project findings and generating interest in voluntary participation for ships that are not covered by regulatory treatment until the USCG regulations are fully implemented.

Future Actions: An additional \$2.6 million is needed to fully implement the broader framework for interim treatment in the Great Lakes. Funding currently available for the skid mounted system stands at \$650K. The five actions discussed above would need to be initiated in calendar year 2011 to make a significant difference by 2013. The Collaborative could play a significant role in helping find the resources to accomplish these tasks, and keeping the various project efforts abreast of each other.

Citations:

Mearns, A., B. Benggio, and T. Waite. 1999. Ballast water treatment during emergency response: the case of the M/T Igloo Moon. Pages 1463-1468 *in* OCEANS '99 MTS/IEEE. Riding the Crest into the 21st Century. Div. of Hazardous Mater. Response, NOAA, Seattle, Washington, USA.

U.S. Environmental Protection Agency. 2008. Predicting Future Introductions of Non-indigenous Species to the Great Lakes. National Center for Environmental Assessment Office of Research and Development U.S. EPA. Washington, DC. EPA/600/R-08/066F November 2008 p.4-5

Reynolds, K.J. 2010. Emergency Response Guide for Handling Ballast Water to Control Non-Indigenous Species. Prepared for Isle Royale National Park, U.S. National Park Service, Houghton, MI.