Trust Fund 2009 Work Program

Date of Report: May 8, 2009, Revised May 28, 2009
Date of Next Progress Report: January 31, 2010
Date of Work Program Approval: <TBD>
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Ballast Water Technology Testing and Sampling in Freshwater

Project Manager: Mary Jean Fenske, Principal Investigator: Allegra Cangelosi (NEWMI)
Affiliation: Minnesota Pollution Control Agency
Mailing Address: 520 Lafayette Road North
City / State / Zip: St. Paul, MN 55155
Telephone Number: 651-757-2354
E-mail Address: maryjean.fenske@pca.state.mn.us
Fax Number: 651-297-8676
Web Site Address: www.pca.state.mn.us

Location: Northeast Region; St. Louis, Lake, Cook Counties; City of Duluth and others

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**300,000**
	Great Lakes Protection Acct	$	66,000
	Minus Amount Spent:	**$**	**0**
	Equal Balance:	**$**	**366,000**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 6a

Appropriation Language:
$300,000 is from the trust fund and $66,000 is from the Great Lakes protection account to the commissioner of the Pollution Control Agency in cooperation with the Department of Natural Resources to conduct monitoring for aquatic invasive species in ballast water discharges to Minnesota waters of Lake Superior and to test the effectiveness of ballast water treatment systems.

II. PROJECT SUMMARY AND RESULTS:

Safe and effective shipboard treatment of ballast water is regarded as the best solution to address ballast water as a pathway for the introduction of invasive species. Three ballast treatment systems have received International Maritime Organization (IMO) approval relative to effectiveness and environmental soundness, however, these systems remain largely untested relative to fresh water performance. Moreover, the best technical means of monitoring the effect of treatments installed on ships relative to a given benchmark has yet to be fully developed, trialed and customized to Great Lakes ships. In addition to assessing treatment effectiveness

onboard ships, credible monitoring information is essential to understanding the relative contributions of vessel fleets to the introduction and spread of invasive species. This project will advance protection of Minnesota's water resources with respect to ship-mediated introductions of invasive species through: a) fresh water testing in Lake Superior of at least two ballast treatment systems that have received International Maritime Organization approval, and 2) developing, to the extent necessary, and trialing scientifically credible and operationally feasible ballast water monitoring/sampling mechanisms and procedures for purposes of measuring discharge quality against a treatment performance benchmark. The work will also result in the collection and analysis of information on the contents of ballast discharge associated with a range of ships to assist in further developing the state's environmental and natural resources policies. The project will contribute to environmental protection in the state and region by fully outfitting twelve ships that visit Duluth Harbor for effective and efficient discharge monitoring.

III. PROGRESS SUMMARY AS OF January 31, 2010

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Install and trial inline sampling devices on twelve ships, develop a methods guidebook for effective ship discharge monitoring, and categorical data on ballast biological constituents of subject ships.

Description: Results from this part of this study will build the state's capacity to monitor ships' discharges into Minnesota ports (Duluth, Two Harbors, Taconite Harbor, Silver Bay) for invasive species. By leveraging existing funds, benefit will be afforded to this specifically Minnesota-based purpose for the funds required by creating the capacity for the state to monitor ballast discharges from ships traveling its waters. These funds will provide for the development of guidebook-like protocols for use by shipping companies and potential state regulators.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$ 156,000**
	Amount Spent:	**$ 0**
	Balance:	**$ 156,000**

Deliverable	Completion Date	Budget
1. In-line sampling apparatus design and installation plans for 12 ships from three different classes of vessels consistent with domestic and international guidelines	Oct. 2009	$ 35,000
2. Outfitting of 12 ships in the fleet of ships that travel to Duluth/Superior with in-line sampling devices	May 2010	$ 96,000
3. Protocol for ballast discharge sampling and analysis for Minnesota	April 1, 2011	$ 25,000

Result Completion Date: June 30, 2011

Result Status as of January 31, 2010:

Result Status as of October 31, 2010:

Result Status as of March 31, 2011:

Result Status as of June 30, 2011:

Final Report Summary: No later than August 1, 2011

Result 2: Evaluation of ballast water treatment systems performance in fresh water

Description: The Great Ships Initiative (GSI) has the only fresh water testing facility in the world, located in the Duluth/Superior Harbor. To expedite implementation of treatment systems that are effective and safe in fresh water and to establish the degree to which other testing facilities may be providing findings predictive under the circumstances of Minnesota waters, the project will contract with Northeast Midwest Institute (NEMWI), lead organization for managing the GSI testing facility, to test at least two and up to three treatment systems that have received final approval under international guidelines and agree to be tested at the GSI facility.

Summary Budget Information for Result 2:

Trust Fund Budget:	**$ 210,000**
Amount Spent:	**$ 0**
Balance:	**$ 210,000**

Deliverable	Completion Date	Budget
1. Participation agreements with at least two treatment technology vendors and submittal of applications for discharge permits, if needed	Sept. 2009	$ 10,000
2. Biological sampling and testing protocols consistent with international and domestic guidelines	May 2010	$ 10,000
3. Conduct treatment tests on two and up to three treatment systems at GSI facility	August 2010	$ 135,000
4. Report detailing treatment test procedures, biological results of samples collected and analyzed, and results analysis	Dec. 2010	$ 55,000

Result Completion Date: June 30, 2011

Result Status as of January 31, 2010:

Result Status as of October 31, 2010:

Result Status as of March 31, 2011:

Result Status as of June 30, 2011:

Final Report Summary: No later than August 1, 2011

V. TOTAL TRUST FUND PROJECT BUDGET:

Contracts: $ 366,000 for Northeast Midwest Institute (lead for Great Ships Initiative)

TOTAL TRUST FUND PROJECT BUDGET: $ 366,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. PROJECT STRATEGY:

A. Project Partners:

Mary Jean Fenske, Minnesota Pollution Control Agency – No money received

Jay Rendall, Minnesota Department of Natural Resources – No money received

Allegra Cangelosi, Northeast Midwest Institute - $ 366,000 for project oversight and payment for work by AMI Engineering, University of Minnesota- Duluth, and Lake Superior Research Institute

B. Project Impact and Long-term Strategy:

This project will provide necessary research to help prepare for the MPCA's implementation of its new ballast water discharge permit by providing information on sampling methods that is currently lacking. New information gained on treatment technology performance in fresh water will assist the MPCA in approving technologies between 2011 and 2016. In addition, this project will likely influence federal and other Great Lakes states efforts to prevent the introduction and spread of invasive species.

C. Other Funds Proposed to be Spent during the Project Period:

Attachment B contains a list of the additional money and in-kind resources that will be spent on the project.

The Trust funds will be combined with $350,000 of US DOT Maritime Administration (MARAD) money to make it possible to include as many different kinds of ships that ply the Great Lakes as possible in the analysis for Result 1 of this Project. In so doing, the GSI will generate information that will prepare the full range of ships that ply the Great Lakes for effective ballast discharge monitoring, and assure that Coast Guard guidelines are applicable to the entire range. For Result 1, the MARAD funds will go to the sampling demonstration, drafting of biological design and sampling protocols, results and interpretation of biological ballast water sampling analyses, evaluation and write up (UWS, NEMWI and other scientific expertise).

NEMWI funds will be used for securing the participation of ships, developing a participation agreement contract, assuring all parties have adequate insurance, oversight and management of engineering design and analysis and sampling apparatus installation, peer review of results, and posting of results. The Trust funds also will support a Great Lakes-based engineering firm knowledgeable in Great Lakes fleets and ballast sampling to adapt the USCG proposed design and criteria to detail and implement an installation plan for each test ship.

D. Spending History:

Prior to July 1, approximately $25,000 of the $350,000 MARAD funds will be expended to begin the project.

VII. DISSEMINATION:
In addition to submittal of the research findings for publication in a peer-reviewed journal for Result 1, findings of the research from this project will be disseminated by the organizations involved in this effort. The MPCA will share the findings to the more than 300 parties on its ballast water program e-mail distribution list and make it available on its vessel discharge program webpage (http://www.pca.state.mn.us/programs/ballastwater.html). The MPCA also intends to share project progress and findings with the Great Lakes Panel on Aquatic Nuisance Species at future meetings and request electronic distribution by that group to its members. The Great Ships Initiative webpage (http://www.nemw.org/GSI/index.htm) will post research findings and its Board members will be asked to distribute results as well. The audience for this project includes vessel owners and operators, shipping industry association representatives, port authorities, natural resource experts, other Great Lakes states, the US Coast Guard, U.S. Environmental Protection Agency, Transport Canada, Fisheries and Oceans Canada, and other private individuals and organizations interested in addressing the ship-mediated introduction of invasive species via ballast water.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than January 2010, October 2010, and March 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

A Research Addendum for this project dated April 3, 2009 is attached.

Attachment A: Budget Detail for 2009 Projects								
Project Title: Ballast Water Technology Testing and Sampling in Freshwater								
Project Manager Name: Mary Jean Fenske.								
Trust Fund Appropriation: $ *366,000 ($300,000 from Trust fund/ $60,000 from Great Lakes Protection Account)*								
2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**Result 2 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Identify and trial inline sampling devices and methods on ships			**Evaluation of ballast water treatment systems performance in fresh water**				
BUDGET ITEM								
Contracts								
Professional/technical contract with Northeast Midwest Institute for project management and subcontracts*	156,000	0	156,000	210,000	0	210,000	366,000	366,000
COLUMN TOTAL	**$156,000**	**$0**	**$156,000**	**$210,000**	**$0**	**$210,000**	**$366,000**	**$366,000**
DETAILS OF CONTRACT								
***Result 1 Contract with NEMWI:**								
1. In-line sampling apparatus design and installation plans for 12 ships from three different classes of vessels consistent with domestic and international guidelines	NEMWI subcontract to AMI Engrg	$35,000						
2. Outfitting of 12 ships in the fleet of ships that travel to Duluth/Superior with in-line sampling devices	NEMWI subcontract to AMI Engrg	$96,000						
3. Protocol for ballast discharge sampling and analysis for Minnesota	NEMWI	$25,000						
COLUMN TOTAL		**$156,000**						
***Result 2 Contract with NEMWI:**								
1. Participation agreements with at least two treatment technology vendors and submittal of applications for discharge permits, if needed	NEMWI	$10,000						
2. Biological sampling and testing protocols consistent with international and domestic guidelines	NEMWI	$10,000						
3. Conduct treatment tests on two and up to three treatment systems at GSI facility	NEMWI Subcontract for biological sampling, analysis and results write-up: UW-Superior: $90,000; UM-Duluth: $45,000	$135,000						
4. Report detailing treatment test procedures, biological results of samples collected and analyzed, and results analysis. Includes budget of $1000 for Travel/ Meetings by NEMWI staff.	NEMWI	$55,000						
COLUMN TOTAL		**$210,000**						

Attachment B: Other Funds Budget Detail for 2009 Projects

SOURCE OF OTHER FUNDS	AMOUNT	Status
Other Non-State $ Being Leveraged During Project Period: Maritime Administration (Federal Funding). For purchase and installation of ship sampling devices, data analysis and write-up	$ 350,000	*Secured (federal funding)*
In-kind Services During Project Period:		
NEMWI/City of Superior for use of land-based test facility site and equipment for treatment testing	$ 75,000	*Secured*
UMD and UWS for use of laboratory space and equipment	$ 5,000	*Secured*
Duluth Port Authority for marine engineering advice	$ 25,000	*Secured*
Carrier companies for access and support during design and implementation of sampling exercises (verbal agreements made)	$ 25,000	*Pending*
Treatment system developers for access to prototype systems for testing*	To be determined	*Pending*
GSI expert advisors from USGS, Cornell University, Old Dominion U, Maritime Environmental Research Center	$ 10,000	*Secured*
MPCA for expertise/coordination supplied by Jeff Udd, Mary Jean Fenske	$ 10,000	*Secured*
MN DNR for expertise supplied by Jay Rendall's time	$ 5,000	*Secured*
TOTAL: Other Funds/ In-Kind Service Value	$ 505,000	

*One vendor (Hammon) has committed verbally to date.

Environment and Natural Resources Trust Fund

Research Addendum

Project Manager Name: Ms. Mary Jean Fenske, Principal Investigator: Ms. Allegra Cangelosi

Project Manager Email Address: maryjean.fenske@state.mn.us; acangelo@nemw.org

Project Title*:* Ballast Water Technology Testing and Sampling in Freshwater

Project number: 074-C1

1. Abstract

Ballast water discharges from ships are responsible for the arrival of zebra mussels, spiny water fleas and round gobies into the Great Lakes, including Duluth harbor of Lake Superior. Left unchecked the ballast water vector will continue to introduce and spread more invasive species. Safe and effective shipboard treatment of ballast water is regarded as the best solution to this problem, and three ballast treatment systems have received International Maritime Organization approval relative to effectiveness and environmental soundness. However, these IMO approved systems remain largely untested relative to fresh water performance. Moreover, the best technical means of monitoring the effect of treatments installed on ships relative to a given benchmark—one that assures replicable, credible and representative information on ballast discharge quality—has yet to be fully developed and customized to ships that ply the Great Lakes. Monitoring guidelines are under development domestically and at the International Maritime Organization and the International Standards Organization. In addition to assessing treatment effectiveness on board ships, credible monitoring information is essential to understanding the relative contributions of vessel fleets (U.S. laker, salty, Canadian laker) to the problem of introduction and spread of invasive species into the Duluth Harbor and other harbors of Lake Superior. This project will advance protection of Minnesota's water resources with respect to ship-mediated introductions of invasive species through: a) fresh water testing in Lake Superior of ballast treatment systems that have received International Maritime Organization approval, and 2) developing, to the extent necessary, and trialing scientifically credible and operationally feasible ballast water monitoring/sampling mechanisms and procedures for purposes of measuring discharge quality against a treatment performance benchmark. The work will also result in the collection and analysis of information on the

contents of ballast discharge associated with a range of ships to assist in further developing the state's environmental and natural resources policies. The project will contribute to environmental protection in the state and region by fully outfitting twelve ships that visit Duluth Harbor for effective and efficient discharge monitoring.

2. Background

Ballast water discharges from ships have introduced aquatic invasive species, such as zebra mussels, spiny waterfleas and round gobies into Lake Superior and the Duluth Harbor and continue to introduce and spread more invasive species. More ballast water is discharged to the shared port in Duluth, Minnesota and Superior, Wisconsin (Duluth/Superior) than any other Great Lakes port. Once established in Lake Superior, these species can be moved via boaters to inland waters. It is virtually impossible to eliminate these species once established and management tools are costly to develop and implement.

The overall long-term objective of the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Natural Resources (DNR) is to have shipboard treatment in place as quickly as possible and to have reliable tools to measure invasive species in ballast discharges to know whether treatment is effective.

Two main categories of ships discharge ballast water to Minnesota's ports:

- Lakers - About 100-130 lakers (both U.S. and Canadian) transit only the Great Lakes and St. Lawrence Seaway system. The majority of discharges to Minnesota waters are from ships traveling the western portion of the Great Lakes system.
- Oceangoing - About 100-200 oceangoing ships annually come to the Duluth/Superior harbor from a foreign port. The vast majority visit a lower Great Lakes port first and thus have ballast tanks containing primarily freshwater.

Consequently, ballast water treatment that can effectively remove fresh water organisms is important. In addition, the MPCA's recently issued ballast water discharge permit requires that treatment system performance relative to the IMO D-2 standard be confirmed according to U.S. EPA's Environmental Technology Verification Program protocols, or equivalent, at a fresh water research, development and technology evaluation facility prior to implementation onboard a vessel. All vessels required to obtain the permit and discharging to Minnesota waters must have treatment systems installed that meet the performance standards by January 1, 2016.

Nearly 30 different types of ballast water treatment systems are being developed by companies worldwide, primarily for seawater application. These treatment systems use a variety of mechanisms to kill organisms, e.g. ultraviolet light, chlorination, and deoxygenation. The effectiveness of a particular treatment method may differ in fresh water and with freshwater organisms. None of the treatments in development or those that are IMO approved have been validated in the United States or in fresh water, and near-term incentives for vendors are lacking to test treatment performance in fresh water. Treatment manufacturers have a global market and, to date, have focused on sea water applications where the majority of their market exists. A subset of these systems are attaining IMO and type approval. A subset of these will be promising for use in fresh water. Without empiricial evaluation of these systems in fresh water, however, their capacity to deliver effectiveness remains in question.

Not only does freshwater treatment system development need a boost, but widely accepted sampling methods are lacking for the kinds of ships that transit Lake Superior. Conventional methods of sampling large water masses for plankton (i.e. using nets, hoses or whole water grab samples) while valid for some kinds of qualitative analysis of biota, simply cannot produce quantitatively accurate results necessary to determine inoculation pressure or consistency of a ballast discharge to a numeric standard. Sampling and measurement methods that can provide a representative sample of organisms in ballast water are critical to a valid regulatory structure. Sampling guidelines are under development internationally and domestically, and design and engineering studies are underway through the Naval Research Laboratory in Key West, FL. However, it is also unclear when the design exercises will be completed, and even if they were completed soon, there would still be a need for practical demonstration and evaluation of the methods in the real world, particularly for ships that ply the Great Lakes. The NRL looks forward to a trial phase involving ships. This project would directly complement their efforts, assuring that some of the demonstration work involves Great Lakes ships. In 2008, the NEMWI and GSI project team, ran first-time empirical studies to gauge the extent to which various in-line sampling methods produce similar results, and to compare in-line with in-tank sampling procedures. This work, conducted at the GSI land-based facility, built on Computational Fluid Dynamics studies undertaken in Key West by the Naval Research Laboratory. This work is complete and in the write up stage. It will provide an important foundation for the shipboard work proposed here.

3. Hypotheses [Purpose]

***Part 1*:** The primary purpose of this project part is to first design, if needed, and detail the installation and use plan for credible, quantitative and operationally feasible sampling methods for vessel types used on Lake Superior, building upon existing international—IMO's Uniform Guidance for Sampling (G2) contained in Resolution MEPC.173(58)—and federal guidelines. Second, this project will trial the method on multiple ships in each major fleet of vessels that ply the Great Lakes (salties, Canadian lakers, US lakers), and review against a range of criteria the method in consultation with mariners and scientists, proposing improvements as needed. This work will help speed broad scale implementation of ballast treatment discharge monitoring in the Great Lakes that is workable for the industry and the regulators by designing and trialing methods. The secondary purpose of this project part is to design and further populate a database to document levels of invasive species carried in ballast water by ships discharging to Minnesota's ports. This work will help prepare states and federal agencies to effectively carry out monitoring once routine sampling for regulatory purposes gets underway. The project will contract with the Great Ships Initiative (GSI) to carry out this work.

***Part 2*:** The purpose of part 2 of the project is to a) expedite implementation of treatment systems that are effective and safe in fresh water through generating information on their performance in fresh water in a manner that is scientifically credible, and if available, consistent with domestic guidelines; and b) help build an information base which will establish the degree to which other testing facilities may be providing findings predictive under the circumstances of Minnesota waters. These purposes will be accomplished by conducting land-based testing at the GSI facility of at least two and up to three treatment systems that have received final approval under international guidelines. The system performance relative to the IMO discharge standards at a land-based fresh water testing facility will be determined. Results will be compared to those generated by the land-based testing undertaken in support of IMO-approval. Differing results will indicate the need to investigate the source of difference, but that investigation is outside the scope of this project.

4. Methodology

***Part 1 Methods*:** Part 1 of this project will draw on several sources of information to identify and implement a method of monitoring ships ballast discharge quality that is consistent with domestic and international guidelines and which will optimize scientific credibility and

operational practicability. Sources of information that will provide a starting point for the sampling method to be trialed include a) prior shipboard research efforts, b) engineering studies underway at the Naval Research Laboratory in Key West Florida, c) empirical work on in-line and in-tank sampling scenarios undertaken at the Great Ships Initiative in 2007 and 2008, and d) the best professional judgment of engineering and biological science experts regionally and internationally.

The objective of the sampling method to be detailed and trialed is to support routine monitoring of treatment performance on ships that ply the Great Lakes. As such, it is intended to provide representative quantitative samples of the life status and types of zooplankton, phytoplankton and microbial organisms that may be entrained in ballast water discharge. If available, the project will incorporate draft federal guidelines or protocols in this method. These organism types will be grouped by size class consistent with the IMO ballast discharge standard, as well as taxonomically.

Live/dead analysis will be undertaken on plankton using GSI protocols (see www.greatshipsinitiative.org) in addition to quantitative and taxonomic diversity assessments using standard methods. Microbial analysis will be undertaken using conventional methods as well as more novel PCR-based and high throughput DNA analysis.

Four ships in each of three vessel fleets (US lakers, Canadian lakers, salties) that ply into Duluth-Superior harbor will be identified for participation. While the specific ships cannot be identified at this point in the effort, there is little likelihood of any problem procuring interested participants since a) all three fleets are involved with GSI; b) the project will result in a free installation of the sampling apparatus; and c) participation in the project will provide participant the opportunity to have direct input. The results of the biological analyses will not be linked to a specific vessel, as this is a condition needed to ensure participation by some shipping interests.

The sampling method will be analyzed for a number of parameters relevant to effective and replicable sampling. These include:

a. Replicability will be assessed by measuring the degree of variation of results from one tank to the next on a given ship for which ballasting history across tanks is the same. A percent similarity analysis will be employed for this purpose.
b. Resources (time, personnel, equipment, etc.) required for sampling and analysis will be analyzed across ships, water quality, and organism density conditions, among others.
c. Cost required for installation of sampling apparatus will be analyzed across types of ships/trades.

d. Relationship of statistical power (i.e. precision) relative to sampling effort will be analyzed.
e. Cost of individual aspects of the sampling method will be assessed.

***Part 2 Methods*:**

Part 2 of this project will verify in fresh water the performance of at least two and up to three ballast treatment technologies that have received IMO approval based on testing in seawater at facilities in Europe. This testing will help to corroborate these findings and assure that they apply to freshwater circumstances.

Treatment systems will be selected based upon 1) their having received IMO approval and type approval from some member of IMO; and 2) independent reviews that predict probable effectiveness and environmental soundness in fresh water. The review approach will be the standard GSI approach detailed on its website (www.greatshipsinitiative.org). Currently there are 4 systems with the necessary approvals and more are on the horizon. Since freshwater performance will be an important marketing advantage (i.e. flexibility to perform wherever the ship may ply), most serious treatment prospects will seek to address fresh water. Moreover, testing capacity in fresh water will drive system designers to find a way to make their systems perform effectively, because product claims can be confirmed. It is, however, impossible to predict in advance precisely how many qualifying systems will be available. One such vendor (Hamman) has already committed to testing.

Testing activities will take place at the GSI's Research, Development, Testing and Evaluation (RDTE) facility in Superior, Wisconsin (see figure 1 for photos). Key features of the facility include:

- A freshwater estuary with plentiful aquatic life as the water/organism source;
- Capacity to run experiments on treatment systems at flow rates of up to 341 m^3/hour;
- A common intake stream that is split into control and treatment tracks for simultaneous and comparable filling of treatment and control retention tanks;
- Capacity to retain water in two pairs of matched control and treatment retention tanks, each roughly 200 m^3 in volume;
- Ability to treat water upon intake and discharge, and to retain following discharge treatment;
- The option to conduct either in-line or in-tank sampling and/or spiking; and

- Ability to discharge to a tanker truck for transport to a water treatment facility, if required.

Water traveling through the facility (i.e. on intake, pre- and post-treatment, pre- and post-tank retention and at discharge) is sampled at designated in-line sample points. There are 14 sample points in total; figure 2 provides a simplified schematic of the RDTE facility indicating the location of each sample point. Sample points consist of three sample ports each with a center-located elbow-shaped pitot tube (figure 3). Intake sampling uses sample ports at the paired intake sample points of SP#2 and SP#3 on the control and treatment tracks for concurrent sample water collection (figure 4). Discharge sampling uses sample ports at the discharge sampling points of SP#9 and SP#10, with sequential collection of control and treatment water (figure 4). Samples are collected continuously throughout intake and discharge processes using automated diaphragm valves to control flow. Sample water is carried from the sample ports to one of six 3.8 m3 centrally located collection tubs via a PVC transfer pipe (see figure 5 for a photo of the collection tubs). During intake, each sample port has a set destination sample tub (figure 4). During recirculation and discharge, sample ports can supply either of two destination sample tubs (figure 4). In practice, three sets of sample ports are active for a given trial: sample ports located on the intake lines for the control and treatment tracks, and discharge sample ports, used for both control and treatment discharge.

A mobile field laboratory provides bench-scale facilities to support time-sensitive assays associated with the RDTE facility tests (figure 6). The laboratory is climate-controlled, and has enough desk and counter space to allow for simultaneous microscopic and analytical analysis of zooplankton, phytoplankton and bacteria samples. In addition, laboratories of the Lake Superior Research Institute of the University of Wisconsin-Superior and the Natural Resources Research Institute of the University of Minnesota-Duluth both provide non-time sensitive analysis of samples from the land-based tests. Since both facilities are only a few miles from the RDTE facility, samples can be easily transported for rapid analysis.

Figure 1. The GSI-RDTE Land-Based Facility, Superior, Wisconsin.

Figure 2. Simplified Schematic of the GSI RDTE Facility.

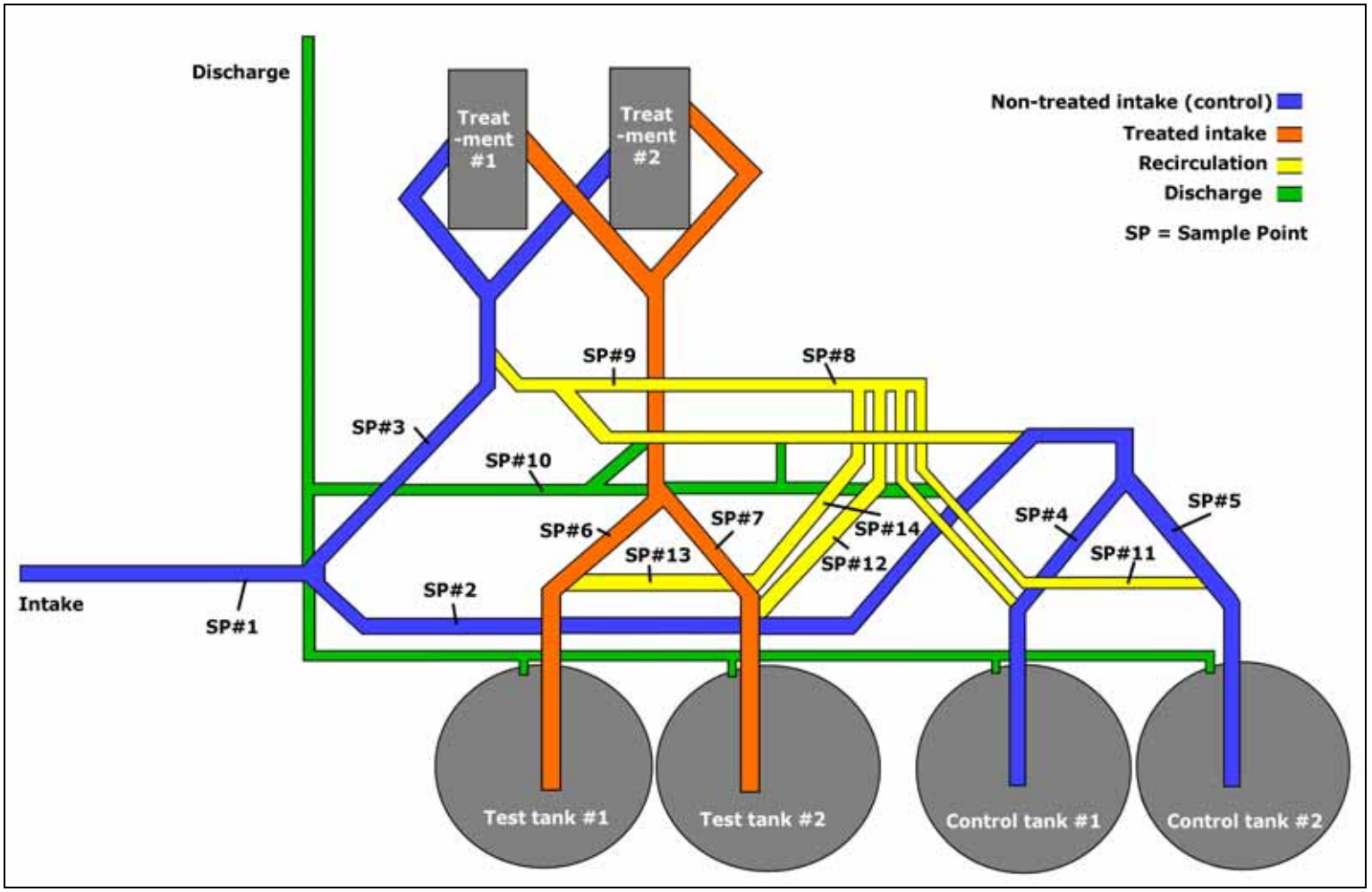

Figure 3. Simplified Schematic of a Sample Point, Showing the Three Sample Ports.

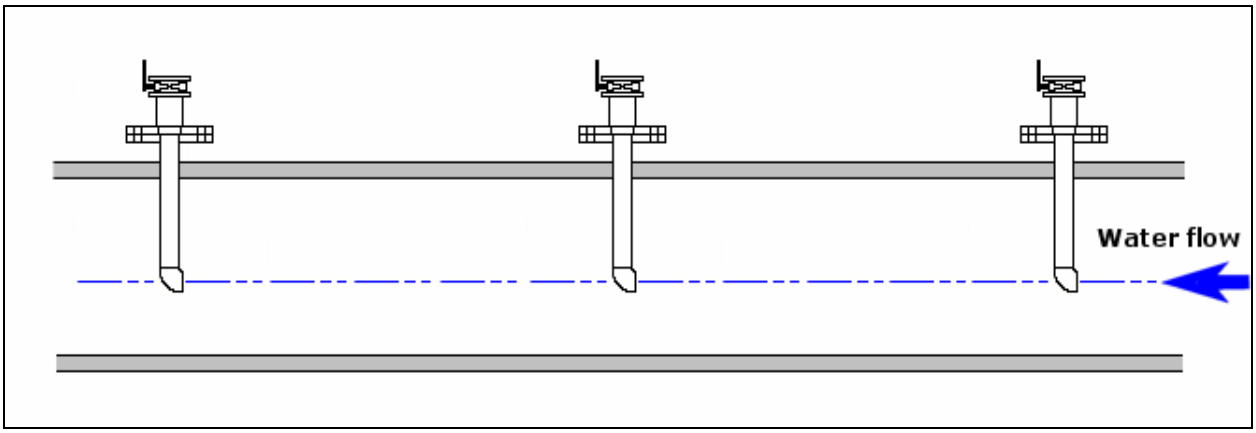

Figure 4. Simplified Schematic of the GSI RDTE Facility Showing Location of the Intake and Discharge Sample Points, Sample Ports, and Corresponding Sample Collection Tubs.

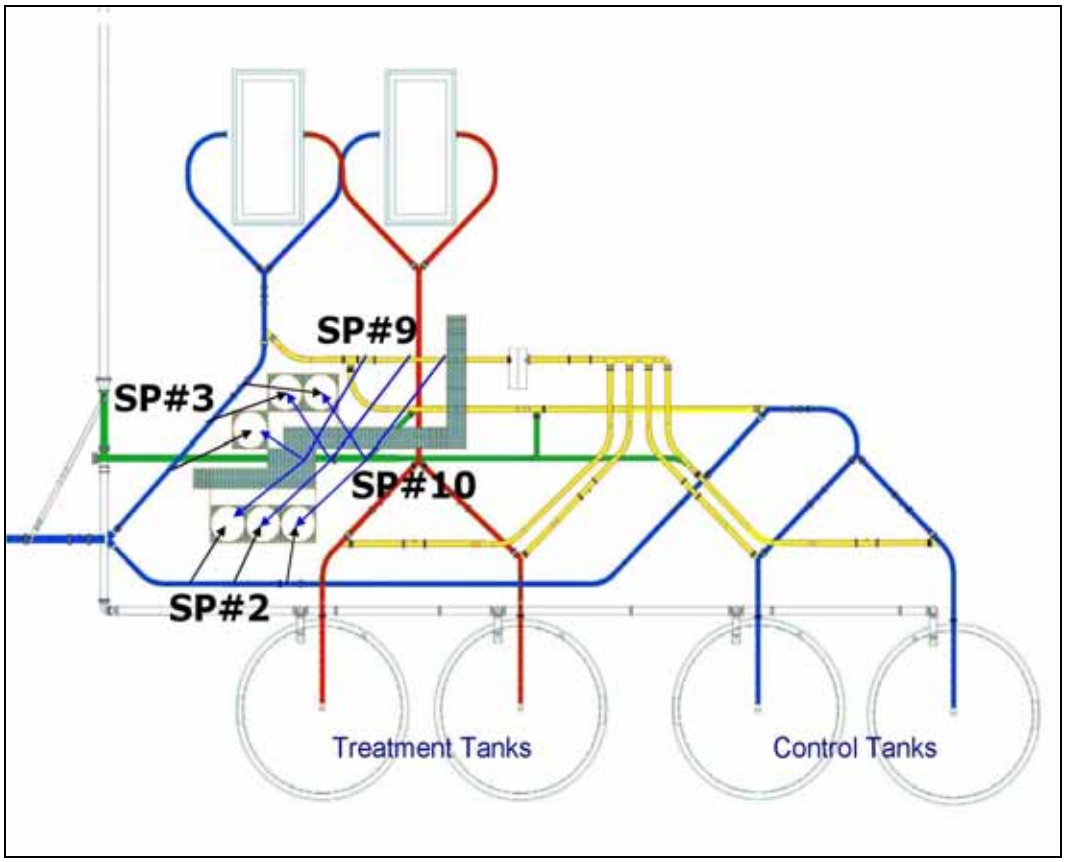

Figure 5. Photo Showing the Six Sample Collection Tubs.

Figure 6. The GSI Mobile Field Laboratory.

GSI land-based tests fall under four scenarios or Standard Experimental Designs (SEDs)—alpha, beta, delta and gamma—which are summarized in table 1. Beta, and delta testing relate to treatment processes which are implemented upon uptake, and upon both uptake and discharge, respectively, For a given IMO approved treatment process, the SED most similar to the proposed operational scenario in a ship will be selected as a basis for testing. To assure consistent conformance to technical and quality system requirements and to support data quality, each SED utilizes the same set of Standard Operating Procedures (SOPs) to test its objective. The SOPs, outlined in table 2, cover all aspects of the GSI land-based testing activities including programmatic and technical processes and procedures such as operation of the GSI RDTE facility; sample collection, labeling, analysis and custody; and safety.

Key international and national testing parameters proposed for land-based facilities engaged in ballast treatment technology evaluations using freshwater (i.e. < 3 PSU) are outlined in table 3. The same table also compares these test parameters with those proposed at the GSI RDTE Land-Based Facility. In addition, table 4 lists current and proposed international and federal ballast treatment performance standards relevant to GSI RDTE land-based ballast treatment technology testing activities. GSI is consistent with most IMO-guidelines. A key difference between IMO approval guidelines for land-based testing and those to be applied through GSI pursuant to this project is in the holding time. IMO guidelines stipulate a five day holding time post treatment prior to discharge sampling. GSI holds water 18-24 hours for these tests,

consistent with the draft ETV protocol domestically. The shorter holding time allows more systems to be tested in a given period of time, and is more conservative due to a longer holding time in which natural attrition contributes to die-off. This project will hold water for the shorter time period initially; since the IMO-approval has already been issued for eligible systems, there is no requirement to hold water five-days. If the system fails using this abbreviated method of testing, a five day holding test could be run to determine if retention time was a factor. However, as a practical matter, if the system fails the shorter retention time test by a large margin, the system might not warrant further testing.

The same rules governing whether or not a trial is valid for the European facilities will be used in the GSI tests. These requirements tend to control for natural and seasonal variation, so that only one set of tests is necessary. Note, however, that each facility and each national administration is exercising some judgment in this regard. The bottom line for a valid test within this project plan is the presence of live organisms in the discharge of the control line in densities of at least 10 times the IMO standard.

Each system will receive 5 successful trials or 6 trials, whichever comes first. As provided in the IMO guidelines, instances in which treatment systems yield 5 trials in which the mean discharge levels are estimated to be below the IMO standard (meeting it) will be considered consistent with the IMO standard. The results will be compared to results from European facilities on the basis of whether or not GSI's results show the system meets the standard as it did for the European facility. If the results are different, these tests will not be adequate to delineate the cause of the difference. That is, it could be circumstantial (salt versus fresh water) or methodological. But it will provide important insight into the comparability of the tests at the two sites for that particular system. More testing may be warranted to determine cause.

Table 1. Standard Experimental Designs for GSI Ballast Treatment Technology Testing Activities at the RDTE Land-Based Facility.

Standard Experimental Designs (SEDs)	Objective	Assessment Metrics
Alpha Test: Scale Effects (GSI/SED/LB/T/1).	Determine the extent to which organism response to treatment is equivalent to results received in bench-scale tests.	Live and total zooplankton densities, taxonomy and size measurements; live and total phytoplankton densities, taxonomy and size measurements; heterotrophic bacteria counts, *Enterococci*, *E. coli*, MS-2 bacteriophage.
Alpha Test: Efficiency Duration Study (GSI/SED/LB/T/2).	Determine the extent to which biological efficacy is altered by the duration of operation of the treatment system.	Live and total zooplankton densities, taxonomy and size measurements; live and total phytoplankton densities, taxonomy and size measurements; heterotrophic bacteria counts.
Beta Test: Treatment Plus Retention Effects (GSI/SED/LB/T/3).	Determine the extent to which treatment followed by tank retention reduces live organisms in water relative to controls.	Live and total zooplankton densities, taxonomy and size measurements; live and total phytoplankton densities, taxonomy and size measurements; heterotrophic bacteria counts.
Gamma Test: Treatment Plus Retention Plus a Second Treatment Prior to Discharge (GSI/SED/LB/T/4).	Determine the extent to which treatment followed by tank retention and a second treatment pass reduces live organisms in water relative to controls.	Live and total zooplankton densities, taxonomy and size measurements; live and total phytoplankton densities, taxonomy and size measurements; heterotrophic bacteria counts.
Delta Test: Treatment Plus Retention Plus a Second Treatment and Retention Prior to Discharge (GSI/SED/LB/T/5).	Determine the extent to which treatment followed by tank retention and a second treatment pass reduces live organisms in water relative to controls following a post-discharge holding period of 18 hours.	Live and total zooplankton densities, taxonomy and size measurements; live and total phytoplankton densities, taxonomy and size measurements; heterotrophic bacteria counts.

Table 2. GSI Land-Based Standard Operating Procedures (SOPs).

SOP Category	Subcategory	SOP Title	SOP Code
General	Operation	Procedure for Operating the GSI Land-Based RDTE Facility	GSI/SOP/LB/G/O/1
General	Operation	Procedure for Cleaning Sampling Equipment at the GSI Land-Based RDTE Facility	GSI/SOP/LB/G/O/3
General	Operation	Procedure for Cleaning the Retention Tanks	GSI/SOP/LB/G/O/4

		at the GSI Land-Based RDTE Facility	
General	Safety	Procedure for Worker Safety at the GSI Land-Based RDTE Facility	GSI/SOP/LB/G/S/1
General	Sample Custody	Procedure for Sample Custody	GSI/SOP/G/RA/SC/1
General	Sample Custody	Procedure for Labeling Samples Collected at the Land-Based RDTE Facility	GSI/SOP/G/RA/SC/2
Research Activities	Sample Collection	Procedure for Collecting Biological Samples Via In-Line Sample Ports	GSI/SOP/LB/RA/SC/1
Research Activities	Sample Collection	Procedure for Algae/Small Protozoa Sample Collection	GSI/SOP/LB/RA/SC/3
Research Activities	Sample Collection	Procedure for Microbial Sample Collection	GSI/SOP/LB/RA/SC/4
Research Activities	Sample Collection	Procedure for Zooplankton Sample Collection	GSI/SOP/LB/RA/SC/6
Research Activities	Sample Collection	Procedure for Preparing Lugol's Solution	GSI/SOP/LB/RA/SC/7
Research Activities	Sample Analysis	Procedure for Algae/Small Protozoan Sample Analysis	GSI/SOP/LB/RA/SA/1
Research Activities	Sample Analysis	Procedure for Microbial Analysis using the Heterotrophic Plate Count Method	GSI/SOP/LB/RA/SA/2
Research Activities	Sample Analysis	Procedure for the Detection and Enumeration of *Enterococci* by Membrane Filtration	GSI/SOP/LB/RA/SA/3
Research Activities	Sample Analysis	Procedure for the Detection and Enumeration of E. coli by Membrane Filtration	GSI/SOP/LB/RA/SA/4
Research Activities	Sample Analysis	Procedure for the Detection and Enumeration of MS-2 Bacteriophage	GSI/SOP/LB/RA/SA/5
Research Activities	Sample Analysis	Procedure for Zooplankton Sample Analysis	GSI/SOP/LB/RA/SA/6
Research Activities	Sample Analysis	Procedure for Analyzing the Concentration of Ozone in Test Water	GSI/SOP/LB/RA/C/1
Research Activities	Sample Analysis	Procedure for Determining Total Residual Oxidants (TRO) in Water	GSI/SOP/LB/RA/C/2
Research Activities	Sample Analysis	Procedure for Analyzing Non-Purgeable Total Organic Carbon (NPTOC) and Non-Purgeable Dissolved Organic Carbon (NPDOC) in Water	GSI/SOP/LB/RA/C/3
Research Activities	Sample Analysis	Determination of Percent Transmittance (%T) at 254 nm in Water	GSI/SOP/LB/RA/C/4

Table 3. Comparison of Key Test Parameters Proposed for Land-Based Facilities Engaged in Ballast Treatment Technology Evaluations Using Freshwater1, including Tests Proposed at the GSI RDTE Land-Based Facility.

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
Organisms To Be Evaluated	Zooplankton	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage supplemented by the addition of standard test organisms.	Naturally occurring (i.e. ambient assemblage of Duluth-Superior Harbor), or cultured species that may be added to the test water.
	Phytoplankton	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage supplemented by the addition of standard test organisms.	Naturally occurring (i.e. ambient assemblage of Duluth-Superior Harbor), or cultured species that may be added to the test water.
	Microbes	Naturally occurring, or cultured species that may be added to the test water.	Ambient assemblage.	Naturally occurring (i.e. ambient assemblage of Duluth-Superior Harbor), or cultured species that may be added to the test water.
Intake Organism Diversity & Density	Zooplankton	Organisms ≥50 mm in minimum dimension should be present in a total density of preferably 10^6 individuals but not less than 10^5 individuals per m^3, and should consist of at least 5 species from at least 3 different phyla/divisions.	Organisms in the > 50 µm size class must be present in minimum concentrations of 10^5 organisms/m^3 with at least 5 species across 3 phyla.	Organisms ≥50 mm in minimum dimension should be present in a total density of not less than 10^4 individuals per m^3, and should consist of at least 5 species from at least 3 different phyla/divisions.

[1] Comparison is limited to freshwater aspects of the IMO and ETV guidelines only.

[2] IMO MEPC 57, Annex 3: Revised Guidelines for Approval of Ballast Water Management Systems (G8). April 4, 2008.

[3] Generic Protocol for the Verification of Ballast Water Treatment Technologies. Version 3.0. Revision by: Naval Research Laboratory, Washington D.C. August 2008.

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
	Phytoplankton	Organisms ≥10 mm and less than 50 mm in minimum dimension should be present in a total density of preferably 10^4 individuals but not less than 10^3 individuals per mL, and should consist of at least 5 species from at least 3 different phyla/divisions.	Organisms in the > 10 µm and < 50 µm size class must be present in minimum concentrations of 10^3 organisms/mL with at least 5 species across 3 phyla.	Organisms ≥10 mm and less than 50 mm in minimum dimension should be present in a total density of not less than 10^3 individuals per mL, and should consist of at least 5 species from at least 3 different phyla/divisions.
	Microbes	Heterotrophic bacteria should be present in a density of at least 10^4 living bacteria per mL.	Organisms in the < 10 µm size class must be present in minimum concentrations of 10^3 culturable aerobic heterotrophic bacteria/mL.	Heterotrophic bacteria should be present in a density of at least 10^4 living bacteria per mL.
Water Quality of Intake/Source Water	N/A	Salinity: <3 PSU; Dissolved Organic Carbon (DOC): >5 mg/L; Particulate Organic Carbon (POC): >5 mg/L; Total Suspended Solids (TSS): >50 mg/L.	Salinity: <1 PSU; Dissolved Organic Matter (DOM): 4-8 mg/L as DOC; Particulate Organic Matter (DOM): 1-2 mg/L; Mineral Matter (MM): 16-22 mg/L; Total Suspended Solids (TSS): = POM + MM: 17-24 mg/L; Temperature: 4 – 35 °C.	Salinity: <1 PSU; Dissolved Organic Carbon (DOC): >10 mg/L; Particulate Organic Carbon (POC): >1-2 mg/L; Total Suspended Solids (TSS): >6 mg/L; Temperature: 4 – 20 °C.
Sample Volume	Zooplankton	At least 20 L of intake water and 1 m^3 of treated water.	Minimum of 3 m^3 concentrated to 1000 mL per sample.	Between 1 and 10 m^3 concentrated to 1000 mL per sample.
	Phytoplankton	At least 1 L of intake water and 10 L of treated water.	Minimum of 3 m^3 concentrated to 1000 mL per sample.	At least 1 L of intake water and 10 L of treated water.
	Microbes	At least 500 mL of intake water and 500 mL of treated water.	1000 mL per sample.	At least 500 mL of intake water and 500 mL of treated water.

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
Number of Intake Samples	Zooplankton	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample prior to treatment and 1 sample prior to entry into control tank.	1--3 samples collected from the treatment track and 1- 3 samples collected from the control track.
	Phytoplankton	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample prior to treatment and 1 sample prior to entry into control tank.	1- 3 samples collected from the treatment track and 1-3 samples collected from the control track.
	Microbes	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample prior to treatment and 1 sample prior to entry into control tank.	1- 3 samples collected from the treatment track and 1-3 samples collected from the control track.
Number of Discharge Samples	Zooplankton	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample from the discharge of the control tank, and 1 sample from the discharge (following any treatments) of the treated water.	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.
	Phytoplankton	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample from the discharge of the control tank, and 1 sample from the discharge (following any treatments) of the treated water.	1- 3 samples collected from the treatment track and 1-3 samples collected from the control track.
	Microbes	Minimum of 3 samples collected from the treatment track and 3 samples collected from the control track.	1 sample from the discharge of the control tank, and 1 sample from the discharge (following any treatments) of the treated water.	1- 3 samples collected from the treatment track and 1-3 samples collected from the control track.
Analytic Endpoints: Discharge Density	Zooplankton	Less than 10 viable organisms per m^3 greater than or equal to 50 mm in minimum dimension for treated water; more than 100 viable organisms per m^3 greater than or equal to 50 mm in minimum dimension for control water.	Treatment efficacy will be determined by measurement of living ambient organism concentrations in the treatment discharge; densities of organisms in the control discharge must be no less than 50% of the treated densities after 1 day.	Less than 10 viable organisms per m^3 greater than or equal to 50 mm in minimum dimension for treated water; more than 100 viable organisms per m^3 greater than or equal to 50 mm in minimum dimension for control water.

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
	Phytoplankton	Less than 10 viable organisms per mL less than 50 mm in minimum dimension and greater than or equal to 10 mm in minimum dimension for treated water; more than 100 viable organisms per mL less than 50 mm in minimum dimension and greater than or equal to 10 mm in minimum dimension for control water.	Treatment efficacy will be determined by measurement of living ambient organism concentrations in the treatment discharge; densities of organisms in the control discharge must be no less than 50% of the treated densities after 1 day.	Less than 10 viable organisms per mL less than 50 mm in minimum dimension and greater than or equal to 10 mm in minimum dimension for treated water; more than 100 viable organisms per mL less than 50 mm in minimum dimension and greater than or equal to 10 mm in minimum dimension for control water.
	Microbes	Less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu per 1 g (wet weight) zooplankton of Toxicogenic *Vibrio cholerae* (O1 and O139), less than 250 cfu per 100 mL of *E. coli*, and less than 100 cfu per 100 mL of intestinal *Enterococci* for treated water; more than 10 cfu per 100 mL or more than 10 cfu per 1 g (wet weight) zooplankton of Toxicogenic *Vibrio cholerae* (O1 and O139), more than 2500 cfu per 100 mL of *E. coli*, and more than 1000 cfu per 100 mL of intestinal *Enterococci* for control water.	Treatment efficacy will be determined by measurement of living ambient organism concentrations in the treatment discharge; densities of organisms in the control discharge must be no less than 50% of the treated densities after 1 day.	Less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu per 1 g (wet weight) zooplankton of Toxicogenic *Vibrio cholerae* (O1 and O139), less than 250 cfu per 100 mL of *E. coli*, and less than 100 cfu per 100 mL of intestinal *Enterococci* for treated water; more than 10 cfu per 100 mL or more than 10 cfu per 1 g (wet weight) zooplankton of Toxicogenic *Vibrio cholerae* (O1 and O139), more than 2500 cfu per 100 mL of *E. coli*, and more than 1000 cfu per 100 mL of intestinal *Enterococci* for control water.
Water Quality Measurements	N/A	pH, temperature, salinity, dissolved oxygen, TSS, DOC, POC and turbidity (NTU) should be measured at the same time that the samples are collected.	Temperature, salinity, TSS, POC, DOM, dissolved oxygen, pH, chlorophyll *a*.	pH, temperature, salinity, dissolved oxygen, TSS, DOC, POC and turbidity (NTU).

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
Toxicity	N/A	Separate samples should be collected for toxicity testing of treated water, from the discharge, for systems that make use of Active Substances and also for those which could reasonably be expected to result in changes to the chemical composition of the treated water such that adverse impacts to receiving waters might occur upon discharge. Tests should conducted in accordance with paragraphs 5.2.3 to 5.2.7 of the Procedure for Approval of Ballast Water Management Systems That Make Use of Active Substances (resolution MEPC.126(53)) as amended.	Toxicity tests will be conducted for treatments involving biocides. Tests will be selected from a short list of U.S. EPA standard tests.	Toxicity tests using standard methods will be conducted for treatments involving active substances at the bench-scale ahead of land-based tests.
Sample Analysis	N/A	Samples should be analyzed as soon as possible after sampling, and analyzed live within 6 hour or treated in such a way as to ensure that proper analysis can be performed. Widely accepted standard methods for the collection, handling, storage, and analysis of samples should be used.	Direct counts (number of dead and total) for organisms in the > 50 µm size class; grow out plus one enumeration method for organisms in the in the > 10 µm and < 50 µm size class; incubation/grow out experiments of heterotrophic bacteria for organisms in the < 10 µm size class.	Direct counts (number of dead and total) for organisms in the > 50 µm size class; grow out plus one enumeration method for organisms in the in the > 10 µm and < 50 µm size class; incubation/grow out experiments of heterotrophic bacteria for organisms in the < 10 µm size class.
Flow Rate	N/A	At least 200 m^3/hr.	Up to 300 m^3/hr.	200 m^3/hr.
Number and Capacity of Retention Tanks	N/A	At least 1 control and 1 treatment tank with a minimum capacity of 200 m^3 each.	At least 1 control and 1 treatment tank with a minimum capacity of 200 m^3 each.	2 control and 2 treatment tanks each with a capacity of 200 m^3.
Control/Treatment Cycle Sequence	N/A	Control and treatment cycles may be run simultaneously or sequentially.	Control and treatment cycles may be run simultaneously or sequentially.	Control and treatment cycles may be run simultaneously or sequentially.

Parameter	Sub-Category	IMO G8[2]	Draft U.S. EPA ETV[3]	GSI Land-Based Tests
Retention Time	N/A	At least 5 days.	24 hours ±6 hours.	24 hours ±6 hours.
Number of Trials	N/A	At least 5 successes.	At least 3.	At least 5 successes out of 6 trials.
Statistical Analysis	N/A	Statistical analysis should consist of t-tests, or similar statistical tests, comparing control and treated water.	TBD.	Statistical analysis consisting of t-tests, or similar statistical tests, comparing control and treated water.
QAQC	N/A	Quality Management Plan (QMP) addressing the quality control management structure and policies of the testing body, including subcontractors and outside laboratories; Quality Assurance Project Plan (QAPP) addressing the specifics of the ballast treatment technology to be tested, the test facility, and other conditions affecting the actual design and implementation of the required experiments.	A Quality Assurance Project Plan (QAPP) will be prepared by the Testing Organization and included as part of the Test Plan.	Quality Management Plan (QMP) addressing the quality control management structure and policies of the GSI; Quality Assurance Project Plan (QAPP) addressing the specifics of the GSI's ballast treatment tests, its facilities, and other conditions affecting the actual design and implementation of the required experiments.

5. Results and Deliverables

Part 1: Results from Part 1 of this study will build the state's capacity to monitor ships' discharges into Minnesota ports (Duluth, Two Harbors, Taconite Harbor, Silver Bay) for invasive species. By leveraging existing funds, benefit will be afforded to this specifically Minnesota-based purpose for the funds required by creating the capacity for the state to monitor ballast discharges from ships traveling its waters. These funds will provide for the development of guide-book like protocols for use by shipping companies and potential state regulators.
Budget: $ 156,000.

Deliverables:

1. Protocol for Ballast Discharge Sampling and Analysis in Minnesota no later than April 1, 2011.

2. Initial baseline data entries from at least four vessels within each of the three classes of ships that comprise the majority of saltwater and laker visits to Minnesota ports by July 1, 2011.

3. Outfitting of 12 ships in the fleet of ships that travel to Duluth/Superior with in-line sampling devices by May 2010 precluding the need for installation of sampling apparatus at a later date.

***Part 2*:** Results from Part 2 of this study will accelerate verification of ballast water treatment systems for fresh water application. Budget: $ 210,000.

The Great Ships Initiative (GSI) has the only fresh water testing facility in the world, located in the Duluth/Superior Harbor. To expedite implementation of treatment systems that are effective and safe in fresh water and to establish the degree to which other testing facilities may be providing findings predictive under the circumstances of Minnesota waters, the project will contract with GSI to test at least two and up to three treatment systems that have received final approval under international guidelines and agree to be tested at the GSI facility.

Deliverable:

1. Evaluation of at least two ballast water treatment technologies by July 1, 2011.

6. Timetable - Layout the proposed times for completing the proposed research including proposed dates for individual results and deliverables.

***Part 1 Timetable*:**

Please note that there are two primary sources of funding for Part 1 of the project: US DOT Maritime Administration (MARAD) funding and the Minnesota Environment and Natural Resources Trust Fund. MARAD funding is already secured and some of the work described

below related to that funding source may begin prior to July 1, 2009.

1. Organizational Stage (July 2009):
    a. Convene USCG/MARAD/CDN Coast Guard/EPA to assess work to date internationally and domestically on credible and replicable ballast discharge sampling;
    b. Convene relevant carrier companies and classification societies to scope project activities relevant to ships and identify ships to host sampling tests in each category of vessel.
2. Design stage (August-October 2009):
    a. Convene AMI engineers along with Jim Sharrow of the Duluth Seaway Port Authority and fleet engineers of relevant carrier companies to custom-design sampling methods for the relevant fleets that are consistent with domestic and international guidelines or proposed approaches.
    b. Convene biologists to design sampling/analysis protocols consistent with international and domestic guidelines or proposed approaches.
3. Fabrication and Installation stage (November 2009 – April 2010):
    a. Procure and install sample ports consistent with the designs developed above. At least 12 ships, 4 per fleet category will be outfitted.
    b. Procure sampling and analysis equipment for biological assays.
4. Sampling Stage (April-September 2010):
    a. Sample ballast discharge of 12 ships consistent with protocols that visit Duluth Superior Harbor.
    b. Process samples
    c. Gather data on operational feasibility.
5. Data analysis and write-up phase (October-December 2010):
    a. Analyze samples
    b. Interpret data
6. Revise design (January-February 2011):
    a. Convene engineers to review and revise design of sampling apparatus based on findings;
    b. Convene biologists to review and revise design of biological sampling and analysis based on findings.
7. Write up results (March 2011)
    a. Write up and present results;
    b. Submit for publication in peer reviewed journal.

Part 2 Timetable:

1. Identifying interested vendor of IMO-approved technologies (July – September 2009).
    a. NEMWI will issue invitations to developers of applicable treatment systems for special top-off testing at GSI.
    b. NEMWI will follow-up invitations actively and develop participation agreements for interested vendors
    c. Permits will be sought for discharge to the harbor or wastewater treatment facility.
2. Testing technologies
    a. Treatment tests will be scheduled for two week periods over the course of the summer (June-August 2010).
    b. Samples will be collected and analyzed.
3. Analyzing and reporting results
    a. The GSI team will summarize results in keeping with GSI protocols (Dec. 2010).
    b. GSI will report the results publicly using the GSI website (March 2011).

7. Budget

A budget sheet is attached. In addition to in-kind services provided by participants, funding for the project will be provided by two sources:

- US DOT Maritime Administration (MARAD) - $350,000 of federal funding has been secured for the design and testing of shipboard monitoring mechanisms and procedures. Carolyn Junemann is the primary contact for MARAD.
- Minnesota Environment and Natural Resources Trust Fund/ Great Lakes Protection Account – In December, 2008, the Legislative-Citizen Commission on Minnesota Resources (LCCMR) recommended total funding of $366,000 for this project, $300,000 from the MN Environmental Trust Fund and $66,000 from the Great Lakes Protection Account. The Minnesota Legislature must still act on this recommendation in the current legislative session for funding to be secured.
- The MN Environmental Trust Fund and Great Lakes Protection Account funds (LCCMR funds) would be used as follows:

  Part I ($156,000)

  Facility and Equipment Contract (AMI Engrg): $131,000

  Project Management (NEMWI): $25,000

The LCCMR funds will be combined with MARAD money to make it possible to include as many different kinds of ships that ply the Great Lakes as possible in the analysis. NEMWI funds will be used for securing the participation of ships, developing a participation agreement contract, assuring all parties have adequate insurance, oversight and management of engineering design and analysis and sampling apparatus installation, peer review of results, and posting of results. In so doing, the GSI will generate information that will prepare the full range of ships that ply the Great Lakes for effective ballast discharge monitoring, and assure that Coast Guard guidelines are applicable to the entire range. The LCCMR funds will support a Great Lakes-based engineering firm knowledgeable in Great Lakes fleets and ballast sampling to adapt the USCG proposed design and criteria to detail and implement an installation plan for each test ship. The MARAD funds will go to the sampling demonstration, evaluation process and write up (UWS, NEMWI and other scientific expertise).

Part II ($210,000)

Project Management (NEMWI): $74,000

Research- Travel/ Meetings: $1,000

Research: UW-Superior: $90,000; UM-Duluth: $45,000

These LCCMR funds will allow 2-3 IMO approved technologies to be tested at the GSI site. NEMWI funds will be used for lining up the treatment vendors, developing the test plan, developing a participation agreement contract, assuring all parties have adequate insurance, lining up regulatory permits, oversight and management of actual testing activities, analysis of results, write up of results, peer review of results, and posting of results. Funding for UWS and UMD will go to the sampling, biological analysis, and dta management process for testing of the ballast water treatment system technologies.

8. Credentials

The biographies of the principal investigator (Allegra Cangelosi) and the primary researchers that will be conducting the analyses are attached.

9. Dissemination and Use

In addition to submittal of the research findings for publication in a peer-reviewed journal as described in section 6, findings of the research from this project will be disseminated by the organizations involved in this effort. The MPCA will share the findings to the more than 300 parties on its ballast water program e-mail distribution list and make it available on its vessel discharge program webpage (http://www.pca.state.mn.us/programs/ballastwater.html). The MPCA also intends to share project progress and findings with the Great Lakes Panel on Aquatic Nuisance Species at future meetings and request electronic distribution by that group to its members. The Great Ships Initiative webpage (http://www.nemw.org/GSI/index.htm) will post research findings and its Board members will be asked to distribute results as well. The audience for this project includes vessel owners and operators, shipping industry association representatives, port authorities, natural resource experts, other Great Lakes states, the US Coast Guard, U.S. Environmental Protection Agency, Transport Canada, Fisheries and Oceans Canada, and other private individuals and organizations interested in addressing the ship-mediated introduction of invasive species via ballast water.

This project will provide necessary research to help prepare for the MPCA's implementation of its new ballast water discharge permit by providing information on sampling methods that is currently lacking. New information gained on treatment technology performance in fresh water will assist the MPCA in approving technologies between 2011 and 2016. In addition, this project will likely influence federal and other Great Lakes states efforts to prevent the introduction and spread of invasive species.