STATE OF MINNESOTA

MINNESOTA POLLUTION CONTROL AGENCY

INDUSTRIAL DIVISION

FACT SHEET
for
State Disposal System (SDS) Permit MNG300000
Ballast Water Discharge General Permit

Public Comment Period Begins: **June 30, 2008**

Public Comment Period Ends: **July 30, 2008**

Name and Address of Permittee:
Vessels specifically identified in the Notice of Coverage.

Facility Name and Location:
Any vessel in Minnesota meeting the applicability requirements of this permit.

Receiving Water: Minnesota State waters of Lake Superior – surface waters of Lake Superior and waters that discharge, flow, or otherwise are transferred into Lake Superior that are under the jurisdiction of the State of Minnesota.

This Fact Sheet has been prepared according to Minn. R. 7001.0100, subp. 3 regarding a draft SDS permit for vessels, meeting the applicability criteria in the permit, which transit through and discharge ballast water to Minnesota State waters of Lake Superior. This Fact Sheet outlines the principle issues related to the preparation of this draft permit, and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

The Minnesota Pollution Control Agency (MPCA) Commissioner's determination that the permit should be issued is preliminary. During the comment period, any person may submit written comments and/or a petition for a public informational meeting and/or a petition for a contested case hearing on the proposed permit action. The comment period begins and ends as indicated above. Any comments, requests, or petitions received no later than 4:30 p.m. on the last day of the comment period will be considered in the formulation of final determinations.

You may submit written comments on the terms of the draft permit or on the Commissioner's preliminary determinations. Your written comments must include the following:

1. A statement of your interest in the permit application or the draft permit.
2. A statement of the action you wish the MPCA to take, including specific references to sections of the draft permit that you believe should be changed; and
3. The reasons supporting your position, stated with sufficient specificity as to allow the Commissioner to investigate the merits of your position.

If you previously provided written input during the informal phase of permit development, you must submit written comment as directed in this fact sheet for additional consideration by the MPCA.

You also may request that the MPCA Commissioner hold a public informational meeting. A public informational meeting is an informal meeting which the MPCA may hold to help clarify and resolve issues.

In accordance with Minn. R. 7000.0650 and Minn. R. 7001.0110, your petition requesting a public informational meeting must identify the matter of concern and must include the following: items 1 through 3 identified above; a statement of the reasons the MPCA should hold the meeting; and the issues you would like the MPCA to address at the meeting.

In addition, you may submit a petition for a contested case hearing. A contested case hearing is a formal hearing before an administrative law judge. Your petition requesting a contested case hearing must include a statement of reasons or proposed findings supporting the MPCA's decision to hold a contested case hearing pursuant to the criteria identified in Minn. R. 7000.1900, subp. 1 and a statement of the issues proposed to be addressed by a contested case hearing and the specific relief requested. To the extent known, your petition also should include a proposed list of witnesses to be presented at the hearing, a proposed list of publications, references or studies to be introduced at the hearing and an estimate of time required for you to present the matter at hearing.

You must submit all comments, requests and petitions during the public comment period identified on page 1 of this notice. All written comments, requests, and petitions received during the public comment period will be considered in the final decisions regarding the permit. The draft permit will be presented to the MPCA Citizens' Board (Board) for final decision. You may participate in the activities of the Board as provided in Minn. R. 7000.0650.

Comments, petitions, and/or requests must be submitted by the last day of the public comment period to:

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Minnesota Pollution Control Agency
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The permit will be issued if the MPCA determines that the proposed Permittee or Permittees will, with respect to the vessel activity to be permitted, comply or undertake a schedule of compliance to achieve compliance with all applicable state pollution control statutes and rules administered by the MPCA and the conditions of the permit, and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

I. INTRODUCTION

Minn. R. 7001.0210 provides authority to the Minnesota Pollution Control Agency (MPCA) to issue a single permit to a category of permittees whose activities are the same or substantially similar. This single SDS permit that can apply to numerous vessels is referred to as a general permit. Minn. R. 7001.0210 states that a general permit can be issued if the MPCA determines that:

i. there are several permit applicants or potential permit applicants who have the same or substantially similar operations, emissions, activities, discharges, or facilities;
ii. the permit applicants or potential permit applicants discharge, emit, process, handle, or dispose of the same types of waste;
iii. the operations, emissions, activities, discharges, or facilities are subject to the same or substantially similar standards, limitations, and operating requirements; and
iv. the operations, emissions, activities, discharges, or facilities are subject to the same or substantially similar monitoring requirements.

As required by Minn. R. 7001.0100, subp. 3(C), MPCA shall publish a notice of intent to issue a general permit in the *State Register*.

The MPCA has reviewed data to determine if a category, or categories, of vessels which transit through or discharge ballast water to Minnesota State waters of Lake Superior met the stipulated criteria for development of a general permit for ballast water activities. The MPCA found that larger vessels, defined as vessels with a ballast water capacity of 8 cubic meters or more and at least 50 meters in length, meet the stipulated criteria. These vessels have similar operations and volumes of ballast water to manage. The MPCA has determined that a general permit is an appropriate permitting mechanism for these vessels to minimize the threat of aquatic invasive species (AIS) into the Minnesota State waters of Lake Superior. This general permit is issued under the SDS permit program defined in Minn. Stat. 115.07 and Minn. R. 7001.0020, subp. D.

In May 2008, the Minnesota Legislature passed S.F. 3056 which contains language related to ballast water management. The legislation becomes effective on July 1, 2008. The legislation specifies requirements related to ballast water management and ballast water record books for vessel owners and operators. Specifically, S.F. 3056 details what a ballast water management plan and ballast water record book should contain, and provides for the MPCA's approval of the management plan. The draft general permit reflects the requirements in the legislation.

The requirements of this draft general permit are in addition to any federal requirements and are not intended to exclude any federal requirements.

II. GENERAL DESCRIPTION OF BALLAST WATER DISCHARGE

Ballast water is typically ambient water taken onboard a vessel to assist with vessel draft, buoyancy, and stability. Large vessels (e.g. container ships, bulk carriers, other cargo vessels, tankers, and passenger vessels) normally have dedicated ballast water tanks. The discharge rate and chemical and biological nature of the ballast water varies by vessel type, ballast tank capacity, deballasting equipment, and the source of the ballast water. The volume of ballast water discharged to Lake Superior is significant. In 2005, more ballast water was discharged to

Minnesota Lake Superior harbors than any other Great Lakes port. The Duluth-Superior harbor received approximately 5,387,000,000 gallons of ballast water and the Two Harbors port received approximately 1,876,000,000 gallons (Wiley Presentation, January 2008).* Minnesota's Lake Superior harbors receive ballast water discharges from both oceangoing vessels (Salties) and Great Lakes-only vessels (Lakers). The Duluth Seaway Port Authority estimates that approximately 5 percent of the ballast water discharged to Lake Superior is from Salties and 95 percent is from Lakers.

Oceangoing vessels enter the Minnesota State waters of Lake Superior through the Great Lakes system and are typically classified as No Ballast On Board (NOBOB) vessels. The Great Lakes NOBOB Assessment Project (NOBOB-A) concluded that ballast tank residuals in NOBOB vessels contain live biota and resting eggs and are a potential source for introduction of new phytoplankton, invertebrates, and pathogens to the Great Lakes. It also was found that while NOBOB vessels do not conduct ballasting operations on a regular basis, various conditions often lead to ballast exchange while in the Great Lakes. Thus even the ballast tanks which are listed as "empty" upon entering the Great Lakes contain live biota in the residuals at the bottom of the tank and can be an important ship-related vector for new invading species to the Minnesota State waters of Lake Superior (NOAA, NOBOB-B, Northeast-Midwest Senate Coalition Great Lakes Task Force).

Ballast water from oceangoing vessels can carry, and potentially introduce, thousands of species within their tanks from foreign ports. Vessels that are restricted to the Great Lakes system are not immune. Due to the large volume of ballast water that Laker vessels transport around the Great Lakes annually, the U.S. and Canadian Laker fleets may play a role in spreading and dispersing species already introduced and established in the Great Lakes (Cangelosi and Mays, 2006). Therefore, an untreated discharge of ballast water from any of these vessels represents a significant risk to the Lake Superior ecosystem and Minnesota's inland waters. Viable species discharged with ballast water from Salties and Lakers have the potential to establish new populations in water bodies to which they are not native. According to the National Center for Research on Aquatic Invasive Species' Great Lakes Aquatic Non-Indigenous Species Information System, at least 125 non-native aquatic species have been identified in the Great Lakes. Of those species, 43 are known to inhabit Lake Superior. Ballast water discharges from commercial vessels have been identified as the primary source of unintentional introductions of aquatic invasive organisms into the waters of the United States, including Lake Superior (Cangelosi Testimony, March 25, 2004 and NOAA Technical Memorandum, 2007). Sea Grant Minnesota estimates that ballast water discharges acted as the mechanism for introduction for approximately 48 percent of those non-native species into Lake Superior. The large volume of ballast water discharged to Minnesota waters of Lake Superior from Salties and Lakers each year, and the identification of AIS in other foreign and Great Lakes ports, highlights the need for regulatory action on ballast water. The intent of this general permit is to protect the water quality of the Minnesota waters of Lake Superior by reducing the threat of AIS from ballast water, while supporting a viable shipping industry in Minnesota and throughout the Great Lakes.

* It should be noted that these numbers only include the vessels that were in the study, so the actual volumes discharged may be considerably higher.

III. CRITERIA FOR COVERAGE UNDER THE GENERAL PERMIT

The draft general permit applies to all vessels 50 meters in length or more and having a ballast water capacity of 8 cubic meters or more that transit through or discharge ballast water to Minnesota State waters of Lake Superior. The applicability for vessel length and ballast water capacity is consistent with various sections of the International Maritime Organization (IMO) International Convention for the Control and Management of Ships' Ballast Water and Sediments (Convention), the Ballast Water Management Provisions in the U.S. Coast Guard Authorization Act of 2008 (H.R. 2830), and the Ballast Water Control and Management Regulation SOR/2006-129 dated June 8, 2006, in the Canadian Shipping Act of 2001.[*]

The applicability criterion for ballast water capacity has been a subject of debate and was established for two reasons. First, the greater the number of viable organisms released into Lake Superior, the greater the propagule pressure. Propagule pressure is a composite measure of the number of individuals of a species released into a region to which they are not native and the risk of invasion from a potentially harmful exotic species. Most U.S. and international efforts to regulate ballast water have done so under the assumption that the volume of water discharged likely correlates to the number of organisms discharged. Therefore, lower volumes of water should contain fewer organisms which can successfully establish themselves. According to this logic, a vessel that carries and discharges 3,000 cubic meters of ballast water poses a greater risk to receiving waters than the vessel that carries 5 cubic meters. The greater the volume of ballast water discharged means a greater likelihood of creating enough propagule pressure to result in an enhanced risk of the spread of AIS. Second, the applicability is consistent with the standards set forth by the IMO Convention requiring ballast water treatment performance standards. Therefore, it is recognized internationally as a standard among mariners.

This general permit potentially covers approximately 55 to 65 U.S. Flagged Lakers, 60-65 Canadian Flagged Lakers, and 100-200 foreign flagged vessels. The number of vessel meeting the applicability criteria entering Minnesota State waters of Lake Superior varies from year to year.

IV. VESSELS NOT REQUIRED TO OBTAIN PERMIT COVERAGE

The following vessels are not required to obtain coverage under this general permit:

1. Vessels that carry ballast in permanently sealed ballast water tanks that are not able to discharge.
2. Vessels which only operate within the Duluth Captain of the Port (COTP) Zone established by the U.S. Coast Guard.
3. Vessels which only discharge ballast water directly to, or to a transport vessel which discharges directly to, an on-shore treatment facility.
4. Vessels implementing flow-through or "flush" ballast water management techniques approved by the MPCA.
5. Vessels of the Armed Forces as defined in Part 312(a)(14) of the Clean Water Act are excluded from coverage under this general permit.

[*] The vessel exemptions for length and ballast capacity in the Canadian Shipping Act of 2001 are specifically for ships used in search and rescue operations or pleasure craft.

Vessels listed above either present no or limited risk of introducing or spreading AIS through ballast water, or are managed under other programs. For example, vessels which do not discharge ballast water to Minnesota State waters of Lake Superior, either because of ship construction or because they discharge to an on-shore treatment system, present zero risk of AIS transport via ballast. Vessels which operate exclusively in the Duluth COTP Zone, which includes the western half of Lake Superior only, presents limited risk of spreading AIS. The threat of AIS to Minnesota State waters of Lake Superior comes from outside of this COTP Zone. Vessels which implement flow-through or "flush" ballast water management techniques eliminates the risk of AIS transport since these vessels continually exchange the water in the ballast tanks during transit with ambient water in the vicinity of the vessel. Vessels of the U.S. Armed Forces are required to follow the Uniform National Discharge Standards under the authority of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Defense.

Vessels that fail or have failed to comply with a regulation, permit schedule, or compliance order issued by the MPCA may be excluded from coverage under the general permit and required to apply for coverage under an individual permit.

Discharges from an on-shore ballast water treatment facility, including sediment management facilities, are not covered by this general permit. These systems, if constructed, would be required to apply for an individual National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) permit.

V. HOW TO OBTAIN COVERAGE UNDER THE GENERAL PERMIT

The procedure for obtaining authorization to transit through or discharge ballast water to Minnesota State waters of Lake Superior is as follows:

1. The eligible vessel owner or operator submits the necessary application forms, including a ballast water and sediment management plan.
2. The MPCA reviews the application for completeness.
3. If the application is considered complete and the MPCA determines that the vessel is eligible for coverage under the general permit, the MPCA will send the vessel owner or operator a written Notice of Coverage (NOC) and a copy of the general permit. Authorization to conduct activities under the general permit does not begin until the permittee receives a written NOC from the MPCA. If the MPCA determines that the vessel is not eligible for coverage under the general permit, coverage under the general permit will be denied and, if appropriate, the owner/operator will be directed to submit an application for an individual permit.
4. If a permit applicant who is eligible to be covered by the general permit requests an individual permit, the MPCA shall process the application as an application for an individual permit. If the MPCA finds that the operations, activities, or discharges of a permit applicant or a Permittee covered by the general permit would be more appropriately controlled by an individual permit, the MPCA shall issue an individual permit to the applicant or the Permittee. Upon issuance of the individual permit, a general permit previously applicable to the permittee no longer applies to that Permittee. In

considering whether it is appropriate to issue an individual permit, the MPCA shall consider:

a. Whether the ballast water operations, activities, or discharges of the permit applicant or Permittee have characteristics creating the potential for significant environmental effects.
b. Whether the Permittee has been in compliance with the terms of the general permit and applicable statutes and rules.
c. Whether the ballast water operations, activities, or discharges have been altered such that they no longer fit within a category of vessels covered by the general permit.

VI. PROPOSED PERMIT LIMITS AND CONDITIONS

This draft general permit establishes permit limits and conditions for vessels which transit through or discharge to Minnesota State waters of Lake Superior. The control of AIS from ballast water discharges to Minnesota State waters of Lake Superior is accomplished through the implementation of Best Management Practices (BMPs), ballast water treatment, effluent monitoring and limitations and other conditions for vessels meeting the applicability criteria.

A. Best Management Practices

The vessel owner or operator shall implement Best Management Practices for the management of ballast water as required by the Ballast Water and Sediment Management Plan. BMPs include operating procedures and practices to control the discharge of AIS and shall be implemented immediately upon issuance of the Notice of Coverage to the vessel owner or operator. The Ballast Water and Sediment Management Plan shall be submitted with the application for permit coverage, and shall be maintained and revised as necessary to minimize the discharge of AIS. The Ballast Water and Sediment Management Plan must include, at a minimum, the following:

a. Operation and maintenance procedures for the vessel and crew associated with ballast water management;
b. Actions for implementing ballast water management requirements and practices in accordance with this permit;
c. Detailed ballast system fouling maintenance and sediment removal practices;
d. The disposal method for non-suspended sediment and other residual solids associated with ballast tank operation that will not result in unlawful pollution of Minnesota's air, surface water or ground water, or create nuisance conditions;
e. The designated position or officer on board the vessel in charge of ensuring the plan is properly implemented;
f. Detailed reporting requirements for ports the vessel may visit, specifically ports in Minnesota waters of Lake Superior; and
g. A translation of the Plan into English if the vessel's working language is another language.

The prohibition of new discharges to specific areas of Lake Superior is found in Minn. R. 7050.0180, subp. 3.

The prohibition of discharges of non-suspended sediment is due to the concerns with AIS in ballast water sediment. "Non-suspended sediment" means those solids that remain in the ballast tank after normal vessel operations. Sediment that is re-suspended during ballast tank cleaning operations is considered "non-suspended sediment." Common practice is to re-suspend these solids during routine cleaning operations and discharge the wash water during transit in open water. The MPCA is concerned this practice has the potential to result in the introduction and spread of AIS in Minnesota waters of Lake Superior.

The draft general permit prohibits discharges of ballast water to Minnesota harbors of Lake Superior from vessels fully ballasted with sea water unless the vessel can demonstrate to the satisfaction of the MPCA that the discharge will comply with Minn. R. 7050.0211 and Minn. R. 7052.0210. Since sea water has the potential to be toxic to freshwater organisms, this provision ensures that a discharge of ballast water to Minnesota harbors of Lake Superior will not jeopardize the continued existence of the harbor aquatic ecosystem.

B. Treatment Requirements

The draft general permit requires vessels that discharge ballast water to Minnesota State waters of Lake Superior to install ballast water treatment capable of meeting the biological performance standards discussed below. Treatment is in addition to the BMP requirements discussed above. The general permit requires the vessel owner or operator to submit a Ballast Water Treatment Plan, for MPCA review and approval, at least 180 days prior to the installation of ballast water treatment. The Ballast Water Treatment Plan shall include, at minimum:

a. The type of treatment technology or technologies to be implemented, including manufacturer name and contact information;
b. The design summary used for equipment sizing and selection;
c. Drawings showing the proposed location on the vessel for the treatment system;
d. Documentation that shows the treatment technology is capable of meeting the performance standards in Table A;
e. Appropriate operating procedures to ensure the treatment technology is performing properly;
f. A sampling plan, including analytical methodologies, laboratory controls, and reporting schedule, necessary to comply with the applicable effluent limits in Tables A and B;
g. Plans and specifications for the treatment system and associated piping, including any necessary vessel modifications to accommodate the treatment system;
h. Sample port location and design, consistent with the U.S. Coat Guard Research and Development Center's "Development Methods for Biological Injection and Sampling from Fluid Lines" dated August 2005, or equivalent, to ensure a representative sample of treated ballast water can be obtained; and
i. The proposed schedule for implementation of the treatment technology.

The general permit does not prescribe specific treatment technologies, but rather includes biological performance standards that technologies need to meet prior to implementation on board a vessel.

State Performance Standards
As stated previously, this draft general permit is issued under the State Disposal System (SDS) permit program defined in Minn. Stat. § 115.07 and Minn. R. 7001.0020, subp. D. The specific requirements of an SDS permit are not explicitly defined in state rules. Therefore, the process to develop discharge standards for ballast water technologies was similar to the procedures defined in 40 CFR § 125.3. MPCA staff determined that the procedures for developing discharge standards based on Best Professional Judgment (BPJ) are the appropriate guidance for this general permit. BPJ is defined as the highest quality technical opinion developed after consideration of all reasonably available and pertinent data or information that forms the basis for the terms and conditions of a permit. While the cost of attainability must be considered, it is not a requirement to balance cost against the benefit of effluent reduction.

Through the SDS permit development process, MPCA staff determined that the following biological performance standards (Table A in general permit) should apply to any ballast water treatment technology implemented onboard a vessel, according to the dates discussed in Item E:

Parameter	Limit	Limit Type	Sample Type
Organisms > 50 µm in minimum dimension	< 10 viable organisms per m^3	Daily Average	Composite
Organisms 10 – 50 µm in minimum dimension	< 10 viable organisms per mL	Daily Average	Composite
Escherichia coli	< 250 cfu/100 mL	Daily Average	Composite
Intestinal enterococci	< 100 cfu/100 mL	Daily Average	Composite

The discharge standards are based on the Performance Standards contained in Section D-2 of the IMO Convention, with the exception of the standard for vibrio cholerae. The general permit does not include a limit on vibrio cholera because analytical methods to enumerate that organism in ballast water have not been validated.

The IMO Convention D-2 Performance Standards are included in the general permit for several reasons:

1. MPCA staff recognizes the need to protect the water resources of the state and the need for uniformity in discharge standards and believes the IMO standards are appropriate at this time;
2. The IMO standards are generally recognized throughout the international shipping community;
3. Treatment technologies are currently being developed to meet the IMO performance standards; and
4. The technologies designed to meet the IMO performance standards are expected to be commercially available within the term of the implementation schedule described in the general permit.

The BPJ determination for the biological effluent limits included in this permit is based on MPCA staff evaluation of the numerous treatment technologies currently being developed for the treatment of ballast water (Appendix 1). This evaluation was not completed to "pre-approve" treatment technologies or specific treatment systems. The evaluation was done to: (1) gather and assess the information available on ballast water treatment technologies; (2) make a determination on whether technologies will be available for implementation to meet the performance standards included in the general permit; and (3) estimate potential costs per vessel for implementing and operating treatment technology. While MPCA staff acknowledges that ballast water treatment technologies are in the development stage, it seems reasonable to assess the current status of a wide variety of technologies with the underlying assumption that further development will continue in a rather short period of time. It is the intent of the MPCA to keep abreast of new developments and technological breakthroughs in the area of ballast water treatment. If peer-reviewed data is made available demonstrating the effectiveness of available ballast water treatment systems to meet more stringent biological standards, MPCA staff will consider amending the standards included in the draft permit. The MPCA is required to review the appropriateness of any discharge standard prior to future permit reissuances.

C. Additional Effluent Limits Based on Treatment Technology

Additional effluent limits to protect water quality (e.g.: aquatic life, human health, wildlife) may apply depending on the type or method of treatment technology implemented onboard a vessel. The appropriate effluent limits shall be determined upon approval of the ballast water treatment plan. The most common treatment methods to control AIS include the addition of oxidants (such as chlorine), deoxygenation, or heat. Each of these treatment methods will require additional monitoring and limits found in Table B of the general permit and discussed below. Additional effluent limits not specifically discussed below may be applicable to alternative treatment methods and will be determined by the MPCA as appropriate.

Total Residual Oxidants

The draft permit requires vessels to monitor for total residual oxidants (TRO) if they install ballast water treatment technology that includes the use of oxidants, such as chlorine or bromine. The draft permit includes applicable total residual oxidant limits, reported as total residual chlorine (TRC). The limit would apply to vessels that chose to install ballast water treatment technology that included the use of oxidants. The water quality standard for TRC is 0.038 mg/L for all Class 2 waters, based on the Final Acute Value (FAV). The water quality standard is found in Minn. R. 7050.0220.

Dissolved Oxygen

The draft permit requires vessels to monitor for dissolved oxygen if they install ballast water treatment technology using deoxygenation. The water quality standard is found in Minn. R. 7050.0220.

Temperature
The draft permit requires vessels to monitor for temperature if they install ballast water treatment technology using heat. The water quality standard is found in Minn. R. 7050.0220.

D. Discharge Monitoring and Frequency
Monitoring of the ballast water discharge for compliance with the biological performance standards is not required under this permit. Verification that a ballast water treatment technology can comply with the performance standards is required prior to implementation onboard a vessel. The verification shall be confirmed according to EPA's Environmental Technology Verification Program protocols, or equivalent, at a freshwater research, development and technology evaluation facility prior to implementation onboard a vessel. The concept is "up front" verification. If this study determines that compliance with the performance standards can be achieved, the technology can be installed onboard a vessel.

There are several reasons for "up front" verification:

- The vast majority of ballast water treatment technologies currently being developed and tested under IMO are designed for saltwater or brackish water conditions. These technologies may perform differently under freshwater conditions.
- The sampling and analysis protocols for each organism are currently being established or validated.
- Due to the size and number of ballast water tanks on board each vessel, it is difficult to obtain a representative sample of the water being discharged.
- This is similar to the process identified in the IMO Convention, which again, is regarded as the international standard.

The draft permit does require the vessel owner or operator to locate and design sample ports consistent with the U.S. Coast Guard Research and Development Center's "Development Methods for Biological Injection and Sampling from Fluid Lines" dated August 2005, or equivalent, to ensure a representative sample of treated ballast water can be obtained. The MPCA reserves the right to sample for biological parameters from any vessel discharging ballast water to Minnesota State waters of Lake Superior.

Monitoring for total residual oxidants and dissolved oxygen, if applicable, is required on a quarterly basis. Monitoring for temperature shall be done continuously during discharge, with the maximum temperature recorded during the monitoring period being reported.

E. Implementation Schedule for Ballast Water Treatment
For existing vessels meeting the applicability criteria, compliance with the biological performance standards shall occur no later than January 1, 2016. For new vessels constructed after January 1, 2012, and meeting the applicability criteria, compliance with the biological performance standards shall occur prior to commencement of vessel operation in Minnesota State waters of Lake Superior.

While the final date for implementation of ballast water treatment has been the subject of considerable debate, several factors have been considered in the development of this implementation schedule included in the general permit. The most influential considerations are described below:

Treatment Technology Development
While numerous treatment technologies are in various stages of development and some may be considered commercially available, the technology development for ballast water is an emerging field and changing rapidly. While three technologies are expecting final IMO approval in 2008, none have received that status to date. Consideration must be given to the lack of "proven" treatment technologies currently available, specifically in freshwater applications. It will take some time to complete the land-based freshwater validation studies prior to any onboard implementation.

Dry Dock Schedule
A major impact on the shipping industries timeline for meeting specific discharge standards is the availability of dry docking slips available in the Great Lakes for the Laker vessels. As the approximate number of Laker vessels increased until the 1980's and has remained constant the last twenty years, the number of dry dock slips have evolved to handle just those ships. Laker vessels are usually sent to dry dock on a schedule of every five to six years in order that engines can be overhauled and the other necessary maintenance performed. Most dry docking is done in the period of January through March, when the Great Lakes are at least partially frozen. This leads to virtually no availability of dry dock facilities on a more accelerated schedule. For the vessels to go into dry dock during their shipping season is a greater possibility, but that would mean the vessel would not be in use during that time, which could be up to two months, and would result in significant lost revenues for the company. Laker vessels are also worked to some extent, such as engines can be overhauled, in a wet dock situation. The availability of wet dock slips is much more prevalent, but no modifications to the ballast water intake ports and associated piping would be able to be done. This would limit the amount of work which could be done in retrofitting a vessel for ballast water treatment. According to the Duluth Seaway Port Authority, there are only two dry dock slips in the Great Lakes which can accommodate the 1000 foot Laker vessels. For Salties vessels, the usual dry dock schedule is every three years. The vessels are in constant use except when in a dry dock situation, so any significant modifications to the piping systems would have to be done only during that time.

Maintenance System Development
An issue in regards to the new treatment technologies is that the installed technologies will need system support as well as commercial availability. Such support will have to come from the system suppliers or companies formed to be on demand to troubleshoot and fix problems that arise in system operations, as the vessel's crew probably would not have the expertise to do such work. Such support systems are being considered by some suppliers, but are not currently available in the numbers which would be needed for the hundreds of vessels that would be impacted.

VII. NONDEGRADATION CONSIDERATIONS

Minn. R. chs. 7050 and 7052 establish the nondegradation standards and implementation procedures for surface waters of the state in the Lake Superior Basin. The beneficial uses inherent in water resources are valuable public resources. It is the policy of the state to protect all waters from significant degradation from point and nonpoint sources and wetland alterations and to maintain existing water uses and aquatic and wetland habitats. Existing beneficial uses and the water quality necessary to protect the existing uses must be maintained and protected from point and nonpoint sources of pollution.

It is the policy of the MPCA that water quality conditions that are better than applicable water quality standards and are better than levels necessary to support existing beneficial uses must be maintained and protected unless the commissioner finds that, after full satisfaction of this part, a lowering of water quality is acceptable per Minn. R. 7050.0185.

In addition, the MPCA recognizes that the maintenance of existing high quality in some waters of outstanding resource value to the state is essential to their function as exceptional recreational, cultural, aesthetic, or scientific resources. To preserve the value of these special waters, the MPCA will prohibit or stringently control new or expanded discharges from either point or nonpoint sources to outstanding resource value waters per Minn. R. 7050.0180.

Finally, bioaccumulative substances of immediate concern (BSICs), which include mercury and polychlorinated biphenyls (PCBs), are specifically addressed under the Great Lakes Initiative (GLI) in Minn. R. ch. 7052. BSIC discharges to Lake Superior and most surface waters within the watershed are subject to additional nondegradation standards (Minn. R 7052.0300 subp. 3). Existing water uses and the level of water quality necessary to protect existing uses in the Lake Superior Basin must be maintained and protected. Where designated uses of the waterbody are impaired, there must be no lowering of the water quality with respect to the GLI pollutants causing the impairment. (Minn. R. 7052.0300 subp. 3). These nondegradation requirements are found at Minn. R. 7052.0300 to 7052.0330.

General Permit Requirements

The purpose of the permit is to prevent the introduction and spread of AIS in Minnesota Waters of Lake Superior. As states previously, the permit does not mandate a certain technology for control of AIS. Rather the permit allows vessels to elect to install any treatment that has been confirmed according to EPA's Environmental Technology Verification Program protocols, or an equivalent verification protocol, at a freshwater technology evaluation facility, prior to implementation onboard a vessel. A number of different approaches to control AIS have been proposed including chlorination, heating, ozonization, filtration, and ultra-violet irradiation of ballast water. Depending upon the approach taken by an individual ship, the general permit will require the vessel to monitor for parameters such as total residual oxidants, dissolved oxygen, or temperature.

Nondegradation Demonstration Triggers - New or Expanding Pollutant Discharges

Nondegradation review is required for new and expanding discharges as defined in Minn. R. 7050.0180. New discharges to Lake Superior are those that were not in existence on November 5, 1984, the date on which Lake Superior was designated as an outstanding resource value water. Consistent with this regulation, MPCA staff is required to complete nondegradation

reviews for ships discharging ballast water into Minnesota waters of Lake Superior that were not in service and discharging ballast water to Lake Superior on or before November 5, 1984, and ships that have expanded ballast water discharges since November 5, 1984. An expanded discharge is a discharge that changes in volume, quality, location, or any other manner after the effective date the outstanding resource value water was designated (which in the case of Lake Superior is November 5, 1984) such that an increased loading of one or more pollutants results.

The MPCA does not believe that expanded discharges of ballast water flow are likely to occur. The size and number of ballast tanks is fixed when a ship is constructed. The only way that an expanded discharge of ballast water from a ship could occur is if more ballast tanks were added to a ship. The environmental threat posed by the pollutants carried in ballast water and addressed in this nondegradation review – aquatic invasive species (AIS), mercury, PCBs, and salinity- have remained relatively unchanged since the opening of the St. Lawrence Seaway in 1959. Therefore, nondegradation review applies exclusively to vessels not in existence on November 5, 1984.

Nondegradation Review for New Discharges
With regards to nondegradation for new ballast water discharges the pollutants of concern are mercury, polychlorinated biphenyls (PCBs), and total residual oxidants for vessels that choose to treat ballast water with oxidizing chemicals prior to discharge. Additional nondegradation consideration is required for vessels coming from ocean ports in terms of potential toxicity from a discharge of sea water.

Aquatic Invasive Species (AIS)
Minnesota's general SDS permit for ballast water discharges requires all ships at least 50 meters in length designed to carry a minimum of 8 cubic meters of ballast water with the potential to discharge ballast water to Lake Superior, to install and operate ballast water treatment systems and comply with the effluent limits developed by the International Maritime Organization (IMO). These limits, intended to minimize the spread of AIS, are shown in the following table.

Parameter	**Limit**
Organisms > 50 μm in minimum dimension	< 1 living organisms per ml
Organisms 10 – 50 μm in minimum dimension	< 1 living organisms per ml
Escherichia coli	< 126 cfu/100 ml
Intestinal enterococci	< 33cfu/100 ml

The permit, which requires ballast water treatment and other best management practices, such as alternatives to the discharge of non-suspended ballast tank residual sediments to Minnesota waters, to prevent the spread of AIS, is much more protective than the former practice of allowing untreated ballast water discharges to Lake Superior. The permit requires treatment of ballast water discharged from all vessels meeting the size criteria, regardless of their in service date. The general permit will result in a decrease in the potential for discharge of AIS and will prohibit expanded discharges of untreated ballast water.

Mercury and PCBs

The fish in Lake Superior like all lakes and rivers in Minnesota, are contaminated with mercury to some degree. Lake Superior is included on the Minnesota inventory of impaired lakes for mercury fish consumption. As part of the Minnesota Pollution Control Agency's 1999 Lake Superior/Duluth Superior Harbor Toxics Loading Study mercury data was collected in the Duluth shipping channel near the Duluth Harbor. Samples from this location had a mercury concentration of 0.42 – 4.0 nanograms per liter (ng/L). Comparable data from the Superior shipping channel near the Superior Harbor ranged from 0.32 – 5.3 ng/L. The Great Lakes Initiative (GLI) water quality standard for mercury in Lake Superior is 1.3 ng/L. It is estimated that 99 percent of the mercury load to Minnesota's lakes and streams is from atmospheric deposition. Mercury is transported via the atmosphere and deposited to surface water. The nature of ballast water operations are such that the vast majority of ballast water discharged to the Lake Superior harbors originates elsewhere in the Great Lakes or in the ocean ports. Ballast water discharges do not introduce new mercury into the waters of the Great Lakes System. Minnesota's Statewide Mercury TMDL emphasizes control of air emissions of mercury to meet the safe fish consumption goal. A reduction in atmospheric deposition of mercury will reduce the mercury found in surface waters. The statewide TMDL also requires point sources to implement mercury minimization activities to reduce loads to surface waters. Since vessels do not add chemicals to ballast water tanks and mercury is not used in ballast operations, mercury in ballast water discharges is already minimized.

While the statewide TMDL covers mercury-impaired waters throughout Minnesota, it does not include Lake Superior. MPCA staff estimate that the TMDL to address the Lake Superior mercury impairment will be completed in 2011. It is likely that similar assumptions to those used in the development of the statewide mercury TMDL will be used to develop the mercury TMDL for the Lake Superior basin. Consideration of point source discharges of mercury to Lake Superior will be one component of the yet-to-be-completed TMDL. Point source specific requirements in that TMDL that are applicable to ballast water discharges will be included in next issuance of the general permit.

As is the case for mercury, Lake Superior is included on the Minnesota inventory of impaired waters for a fish consumption advisory due to polychlorinated biphenyls (PCBs). PCBs were primarily used as coolants and insulating fluids for transformers and capacitors, stabilizing additives in flexible PVC coatings of electrical wiring and electronic components. PCB production was banned in the 1970s due to the high toxicity of most PCB congeners and mixtures. PCBs are classified as persistent organic pollutants which bioaccumulate in animals. The Lake Superior/Duluth Superior Harbor Toxics Loading study found PCBs in the shipping channel near Duluth Harbor at an average concentration of 0.37 -1.59 ng/L. In the Superior shipping channel total PCBs averaged 0.4 – 2.8 ng/L. Based upon measured water column and fish tissue concentrations of PCBs collected in Lake Superior, it is anticipated the ballast water from other ports that is ultimately discharged to Lake Superior may include low levels of PCBs. The MPCA is drafting a TMDL for PCBs that is schedule for completion in 2011. As is the case with the mercury TMDL, it is likely that the main focus of the PCB TMDL will be control of air emissions sources containing PCBs. TMDL requirements and reductions that are applicable to ballast water discharges will be incorporated into the next draft of the general permit.

Minn. R. 7052.0350 lists the chemicals classified as bioaccumulative substance of immediate concern (BSICs) and bioaccumulative chemicals of concern (BCCs). Mercury and PCBs are listed as both BSICs and BCCs. Minn. R. 7052.0320 subp. 2 includes the nondegradation requirements that must be met for new and expanded discharges of BCCs to Lake Superior. If the BCC is also a BSIC, then the requirements of Subpart 3 must be met as well. In accordance with Minn. R. 7052.0310 subp. 4, a nondegradation review is required for discharged-induced actions or activities that, based on the information available, could be reasonably expected to result in an increased loading of a bioaccumulative chemical of concern (BCC) to the Lake Superior Basin. The following addresses each of these subparts for new discharges of ballast water to Lake Superior. As stated previously expanded discharges of ballast water are not considered due to the nature of ship construction and ballast water tanks.

Minnesota Rules 7052.0320 subp. 2 requires dischargers subject to a nondegradation demonstration to take the following action:

- Identify the available cost-effective pollution prevention alternatives and techniques that would eliminate or reduce the load from the discharge.

- Identify available cost-effective alternative or enhanced treatment techniques, beyond best available technology economically achievable that would reduce the load from the discharge and the costs to the shipper relative to the cost of treatment necessary to achieve compliance with the effluent limitations.

- Identify the economic or social development and the benefits to the area in Lake Superior that will not occur if the discharge is not allowed.

With regards to mercury and PCBs, pollution prevention activities are ongoing as mandated by the statewide mercury TMDL and the ban on PCB production. MPCA staff have been unable to identify cost effective treatment technologies for mercury and PCBs in ballast water, moreover MPCA staff does not believe that treatment technologies for these constituents is required because ballast water is not a reliable source of these contaminants. The permit does not consider ballast water treatment for mercury and PCBs due to the emphasis on controlling mercury through air source emissions reductions and the ban on PCBs. Furthermore, it is not possible to evaluate the cost-effectiveness of technologies because there are no ballast water treatment technologies designed to remove mercury and PCBs. The discharge of ballast water is integral to the shipping industry and the Great Lakes water transportation industry is vitally important to Minnesota's economy. According to the May 2006 Great Ships Initiative Report *Great Ships for Great Lakes* the Great Lakes shipping industry directly employs more than 44,000 people and provides $6 billion each year to the U.S. and Canadian economies. Using data from the Bureau of Economic Analysis and the Duluth Seaway Port Authority, MPCA staff estimate that the combined value of earning and profits from shipping business in Minnesota and business activity that results from spending by shipping firms, owners and employees is between $210 million and $363 annually. Without proven identifiable treatment technologies for the low levels of mercury and PCBs potentially in ballast water discharges, it is not possible to estimate the cost of treatment in comparison to the social and economic benefit from the industry. However, an outright ban on ballast water discharges to Minnesota State waters of Lake Superior would likely represent the end of the shipping industry in Minnesota.

Minnesota Rule 7050.0320 subp. 3 requires discharges subject to a nondegradation demonstration to complete an analysis of the best technology in process and treatment (BTPT) to eliminate or reduce discharge load consistent with the following:

- The BTPT analysis must evaluate the opportunities and technologies the discharger has to reduce loadings and minimize the generation of BSICs including pollution prevention, minimization and toxics reduction, and state-of-the-art or advanced process technologies. The preferred opportunity or technology choice to reduce the generation and loadings of BSICs is pollution prevention, minimization, and toxics reduction.

- The BTPT analysis must evaluate the effects of the transfer of pollutants to other media in addition to water as a result of the implementation of a process technology, pollution prevention technique, or treatment technology used to implement BTPT.

- If a multiple BSIC discharge exists, the BTPT analysis must identify BTPT for each BSIC in the discharge. If the identified BTPT technologies are not compatible and, if implemented together, cannot minimize or treat each BSIC to levels that would be achieved if the individual BTPT technology was implemented alone, a GLI pollutant minimization program must be implemented according to part 7052.0250, subpart 4.

- BSICs subject to a BTPT analysis must be assumed to be present in the discharge if there is evidence of their presence at the facility in internal processes or internal waste streams, even if the effluent concentration is below analytical detection levels.

- The BTPT proposed must be the most advanced technology available, viable in the marketplace, and compatible with existing processes where facility modifications or process technology changes are proposed.

Since vessels do not add mercury or PCBs to their ballast water, there are few or no opportunities for them to reduce or minimize the loading of these pollutants in Lake Superior. This is especially true considering that the majority of these pollutants are deposited to surface water from the atmosphere. With regards to the transfer of mercury or PCBs in ballast water to other media, there is potential for a transfer of these contaminants to sediment. However, the draft permit requires vessels to properly dispose of non-suspended sediments and residual solids associated with ballast water operations in Minnesota waters of Lake Superior. It is likely that some of the ballast water treatment technologies designed to reduce AIS may reduce concentrations of mercury and PCBs in ballast water. This would be particularly probable on vessels that install treatment that relies on filtration or physical removal of solids. As mercury and PCBs tend to associate with solid particles, removal of solids would arguably remove the majority of these contaminates from ballast water. However, without data on the potential concentrations of mercury and PCBs in ballast water uptake locations and on the efficacy of solids removal of proposed technologies, it is not possible to determine if any treatment meets the BTPT criteria.

Minnesota Rules 7072.0310 subp. 4 requires nondegradation review for discharged-induced actions or activities that, based on the information available, could be reasonably expected to result in an increased loading of a bioaccumulative chemical of concern (BCC) to the Lake Superior Basin.

As stated previously, it is possible that ballast water discharged to Lake Superior that originated in other ports may contain low levels of mercury and PCBs. However, without reliable data it is not possible to identify new ballast water discharges as a source of increased mercury and PCB loading to Lake Superior. The vast majority of mercury in Lake Superior comes from deposition of mercury emitted into the air. PCBs are no longer in production and therefore the potential for new discharges of PCBs is very small. Given that vessels do not add mercury or PCBs to ballast water, it is not reasonable to expect vessels to install ballast water treatment technologies for these parameters.

Total Residual Oxidants
Many of the proposed ballast water treatment technologies currently being considered for validation in the U.S. and internationally rely on chemical disinfection using oxidants for control of AIS. Total residual oxidants are not covered by Minn. R. ch. 7052. Minn. R. 7050.0180 defines how a nondegradation analysis must be done for total residual oxidants discharged to Lake Superior. Minn. R. 7050.0180 subp. 6 restricts new or expanded discharges to Lake Superior unless there is a no prudent or feasible alternative.

A chemical specific nondegradation demonstration consistent with Minn. R. 7050.0180 will be completed as part of the MPCA review and approval of the Ballast Water Treatment Plan required by the permit. If vessels elect to install a ballast water treatment technology that includes the use of chemicals, specific information such as chemical dose, mixing, contact time, and other design factors needed to thoroughly evaluate the potential impacts to Lake Superior will be included in the plan. The nondegradation demonstration completed during the review of the plan will include a prudent and feasible determination.

Salt Water Toxicity
Minn. R. 7050.0211 subp.1 prohibit a discharge of toxic pollutants with the potential to cause acute toxicity or exceed the final acute value unless the effluent satisfies the whole effluent toxicity test defined in Minn. R. 7050.0218 subp. 3. Minn. R. 7052.0210 defines the mixing zone standards for acute and chronic toxic discharges to Lake Superior.

Ballast water exchange in open sea water environments has been found to be an appropriate interim means for reducing concentrations of AIS. U.S. Coast Guard Regulations 133 CFR. § 151.1510 requires oceangoing vessels to carry out an exchange of ballast water in an area more than 200 nautical miles from any shore and in waters 2,000 meters deep prior to entry into U.S. coastal areas. At the conclusion of the ballast water exchange, the ballast water shall be at a minimum salinity of 30 parts per thousand (ppt).

It is possible that ballast water discharged to Lake Superior at 30 ppt would result in a violation of Minn. R. 7050.0211. However, given the nature of the Great Lakes shipping patterns that is highly unlikely. It is rare for an oceangoing vessel to come to Minnesota fully ballasted and discharge sea water at the residual 30 ppt required by U.S. Coast Guard regulations. Usually oceangoing vessels enter the Great Lakes system with cargo designated for a lower lake ports

such as Detroit or Cleveland. While in port at one of these locations the vessels will take on ballast and dilute the residual salinity. As a result, upon arrival in Duluth the vessel will most likely have fresh water ballast onboard. It is estimated that only 5 percent of oceangoing ships that come to the Duluth Superior harbor do so fully ballasted with no cargo on board. The Duluth Seaway Port Authority estimates that overall only 5 percent of the ballast water discharged to Lake Superior is from oceangoing vessels whereas 95 percent comes from Lakers. Therefore discharges of ballast water with high residual salinity only accounts for approximately 0.25 percent of the overall discharge of ballast water to Lake Superior.

To ensure that salt water toxicity is not a concern, the draft general permit prohibits the discharge of ballast water to Minnesota harbors from vessels fully ballasted with sea water unless the vessel can demonstrate to the satisfaction of the MPCA that the discharge will comply with Minn. R. 7050.0211 and Minn. R. 7052.0210. This provision ensures that a discharge of ballast water to Minnesota harbors will not jeopardize the continued existence of the harbor aquatic ecosystem.

VIII. REFERENCES

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APPENDIX 1
Evaluation of Potential Ballast Water Treatment Technologies

MPCA staff conducted an evaluation of the treatment technologies currently being developed for the treatment of ballast water. This evaluation was not completed to "pre-approve" treatment technologies or specific treatment systems. The evaluation was done to: (1) gather and assess the information available on ballast water treatment technologies; and (2) make a determination on whether technologies will be available for implementation to meet the performance standards included in the general permit. While MPCA staff acknowledges that ballast water treatment technologies are in the development stage, it seems reasonable to assess the current status of a wide variety of technologies with the underlying assumption that further development will continue in a rather short period of time.

Ballast water treatment methods can be divided into 4 categories: mechanical, chemical, physical, and combined. Below is a brief description of each treatment method. The general outline for the evaluation of each treatment method includes a general description, advantages and disadvantages, estimated costs, and available biological performance data.

Mechanical Treatment
Mechanical treatment removes mid-size and large suspended particles from ballast water. Mechanical treatment typically occurs upon ballast water uptake to minimize the number of organisms and amount of sediment that enters the ballast tanks, and to allow the return of the removed suspended particles back to the port of origin. Mechanical treatment options available include filtration and hydrocyclonic (or centrifugal) separation. Filtration usually involves passing water through a screen, although it can include media such as sand. Typical screen mesh size for ballast water ranges from 10 to 100 microns. Hydrocyclonic separation is based on the density differences between water and the particles or organisms to be separated. Hydroclones used in ballast water treatment typically trap particles in the 50 to 100 micron size range. [California efficacy assessment, December 2007, Lloyd's Register]

The primary advantage of mechanical separation technologies is that they are proven on a wide variety of applications (from drinking water to industrial wastewater) and are relatively inexpensive to install and operate. Suspended particles/solids are removed prior to entering the ballast tanks and can be deposited at the port of origin.

The particles that can be removed are limited to a size range greater than approximately 10 microns. While in theory filtration can remove particles that are less than 1 micron in size, these processes are not viable for ballast water treatment due to the high flow rates required. Therefore, mechanical treatment is limited to use in combination with other technologies in order to comply with the performance standards.

Chemical Treatment
Chemical biocides are used to kill or inactivate organisms in ballast water. Biocides can be used during ballast uptake, vessel transit, or discharge. Biocides work by either destroying cell membranes or other organic structures, or by interfering with neural, reproductive, or metabolic processes within the cell. Biocides that can be used in ballast water treatment are similar to those typically used for disinfection at wastewater treatment facilities including chlorine, chlorine dioxide, hydrogen peroxide, sodium hypochlorite, and ozone. Other biocides, such as mendione (vitamin K3), have been or are being developed for ballast water applications.

While biocides can be effective at killing or inactivating organisms, environmental concerns do exist with chemical residuals that may be present in the water at the time of discharge. Effectively using biocides requires a balance between the amount of time required to achieve disinfection with the time needed for biocides to degrade, or treated, to acceptable levels. The effectiveness of biocides is proportional to the organic content of the water and the sediment load. Concerns related to corrosion within the ballast tanks and safety of the personnel that may come into contact with the chemicals also needs to be addressed.

Physical Treatment
Physical treatment includes non-chemical methods to kill or deactivate organisms. Physical treatment includes ultraviolet (UV) radiation, deoxygenation, ultrasonic energy, and heat. UV radiation is the most well-established and is used throughout municipal and industrial wastewater treatment. UV damages the genetic material and proteins which disrupts reproductive and physiological processes and can be highly effective against pathogens. UV relies on good transmission through the water so the removal of turbidity is critical. Deoxygenation involves the displacement of oxygen with another inert gas such as nitrogen or carbon dioxide. Deoxygenation typically takes a number of days to be effective since it takes time for the organisms to be asphyxiated. Cavitation or ultrasonic treatment ruptures the cell wall through the collapse of microbubbles. Heat can be an effective method for disinfection, but it is limited by the waste heat that is generated and can be captured on a vessel. It could be difficult to heat ballast water at the volumes required to a sufficient temperature for adequate disinfection.

Combined Treatment
The vast majority of treatment technologies currently being developed combine aspects of mechanical, chemical, or physical methods. For example, filtration (mechanical) may be used prior to chemical addition to increase the biocide effectiveness and dose requirements. Electrolytic or electrochemical oxidation processes combine electrical currents with various reactants in order to various disinfections agents. Electrolytic oxidation can produce hydroxyl radicals, capable of damaging cell membranes, or similar compounds such as ozone and sodium hypochlorite.

Treatment Technologies Reviewed
MPCA staff reviewed technologies that are either commercially available now, or are expected to be commercially available in the next five years. The list of technologies to consider were based on three primary sources: (1) “Ballast Water Treatment Technology – Current Status” by Lloyd’s register dated June 2007; (2) “Assessment of Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters” by the California State Lands Commission dated December 2007; and (3) “Ballast Water Treatment Systems” prepared for the State of Washington/Puget Sound Action team by The Glosten Associates dated August 2006. While other information was included based on internet searches, the above 3 reports are the primary information sources. Treatment technologies that could not be verified by independent research are not included in the list of technologies evaluated. The table below summarizes the treatment technologies reviewed.

Table 1: Treatment Technologies Reviewed

Manufacturer	System Name	Treatment Method	Description	Current Status
Alfa Laval	PureBallast	Combined	Filtration + advanced oxidation	IMO Basic Approval IMO Final Approval (pending) Onboard Testing (in progress)
OceanSaver AS	OceanSaver	Combined	Filtration + deoxygenation + cavitation	IMO Basic Approval IMO Final Approval (pending) Onboard Testing (in progress)
Hamann AG	SEDNA	Combination	Hydroclone or Filtration + Biocide [Peraclean] (peracetic acid and hydrogen peroxide)	IMO Basic Approval (Peraclean) IMO Final Approval (pending) Onboard Testing (in progress)
Ecochlor	Ecopod	Chemical	Biocide (chlorine dioxide)	IMO Basic Approval IMO Final Approval (pending) Onboard Testing (in progress)
Electrichlor	EL 1-3B	Chemical	Filtration + Biocide (sodium hypochlorite)	
ETI	BWDTS	Combination	Ozone + ultrasound	
Greenship	BWTS	Combination	Hydroclone + electrolytic chlorination	
Hitachi	Ballast Water Purification System	Combination	Flocculation + magnetic separation + filtration	
NEI	Venturi Oxygen Stripping	Physical	Deoxygenation	STEP application pending
OptiMarin AS	OptiMar	Combination	Filtration + UV	
SeaKleen	SeaKleen	Chemical	Biocide (menadione)	
Techcross Inc.	Electro-Clean	Combined	Electrochemical oxidation	IMO Basic Approval
Severn Trent De Nora	BalPur	Combined	Electro-chlorination	Naval Research Lab testing in progress (as of 2006)
Nutech O3 Inc.	SCX 2000, Mark III	Chemical	Ozone	
Hyde Marine	BWTS	Combined	Filtration + UV	Washington state approved California state testing in progress STEP appl. pending

Treatment Technology Capacity and Estimated Costs

The capacity of treatment technologies, while variable, is generally being designed for a minimum of 10,000 cubic meters per hour (m^3/hr), or 44,000 gallons per minute (gpm). The capacity of this size will generally accommodate most vessels throughout the shipping industry, including the Great Lakes. The information available on the technologies listed indicates that the design of most treatment systems is in a "modular" style. The modular style allows multiple treatment systems to be piped in parallel to accomplish the desired flow rate. For example, a manufacturer may have treatment systems available in 500, 1000, and 2000 m^3/hr capacities. If the desired total capacity of the ballast water treatment system is 3,500 m^3/hr, then the system implemented by include (1) 500 m^3/hr system, (1) 1000 m^3/hr system, and (1) 2000 m^3/hr system piped in parallel.

It is difficult to obtain the reliable estimated costs for ballast water treatment. Due to the progress of development, manufacturers are reluctant to share capital and operating costs because the current costs are considerably higher than costs once the technologies are fully developed and produced. Available information shows that the capital cost (including installation) for a 2,000 m^3/hr system ranges from $250,000 to $1,175,000, with a median value of $500,000. Operating costs can range from $5 to $320 per 1000 m^3, with a median value of $50 per 1000 m^3.

Table 2: Capacity and Costs

Manufacturer	System Name	Capacity (m^3/hr)	Estimated Capital Cost [including installation] ($ in thousands)			Estimated Operating Cost ($/1000 m^3)
			200 m^3/hr	2,000 m^3/hr	10,000 m^3/hr	
Alfa Laval	PureBallast	250-5,000	n/a	n/a	-	15-80
OceanSaver AS	OceanSaver	10,000+	n/a	n/a	-	60
Hamann AG	SEDNA	2,000	n/a	n/a	-	200
Ecochlor	Ecopod	10,000+	260	400	-	60–80
Electrichlor	EL 1-3B	10,000+	350	n/a	-	19
ETI	BWDTS	10,000+	n/a	500	-	5
Greenship	BWTS	10,000+	147	1,175	-	n/a
Hitachi	BWPS	10,000+	n/a	n/a	-	n/a
NEI	Venturi Oxygen Stripping	10,000+	150	250	1,000	50
OptiMarin AS	OptiMar	7,000	400	n/a	n/a	n/a
SeaKleen	SeaKleen	10,000+	n/a	n/a	-	10-20
Techcross Inc.	Electro-Clean	10,000+	150	n/a	-	10-30
Severn Trent DeNora	BalPur	10,000+	350	500	-	20-30
Nutech O3 Inc.	SCX 2000, Mark III	10,000+	350	800	-	n/a
Hyde Marine	BWTS	10,000+	n/a	n/a	-	10

Treatment Technology Biological Performance Data

While biological testing of various treatment technologies is occurring throughout the shipping industry, the resulting data is difficult to obtain. When data is obtained, it is generally analyzed using differing analytical methods procedures. The data below is taken from the "Assessment of Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters" by the California State Lands Commission dated December 2007. Additional data was taken from manufacturer literature, such as the results stated for SeaKleen.

Table 3: Available Performance Data

Manufacturer	System Name	Organisms > 50 um	Organisms 10-50 um	Escherichia coli	Intestinal enterococci	Testing Type
Alfa Laval	PureBallast	0	0.407-0.943	n/a	n/a	Shipboard
OceanSaver AS	OceanSaver	n/a	n/a	n/a	n/a	
Hamann AG	SEDNA	0	0	n/a	n/a	Dockside
Ecochlor	Ecopod	0-5	0-81	0-21	n/a	Shipboard
Electrichlor	EL 1-3B	n/a	n/a	n/a	n/a	
ETI	BWDTS	n/a	1-1.5	n/a	n/a	Dockside
Greenship	BWTS	0	0-7	0-1	0	Dockside
Hitachi	BWPS	n/a	n/a	n/a	n/a	
NEI	Venturi Oxygen Stripping	0-7	443-593	<100	<10	Shipboard
OptiMarin AS	OptiMar	n/a	n/a	n/a	n/a	
SeaKleen	SeaKleen	0	0	0	0	Shipboard
Techcross Inc.	Electro-Clean	0	0	0	0	Shipboard
Severn Trent DeNora	BalPur	$4x10^5$	0.002-10	n/a	n/a	Dockside
Nutech O3 Inc.	SCX 2000, Mark III	n/a	22-190	n/a	<10	Dockside Shipboard
Hyde Marine	BWTS	3-161	n/a	0	0	Shipboard

The data above indicates that there are systems which are expected to meet the IMO D-2 performance standards, although freshwater validation is necessary.