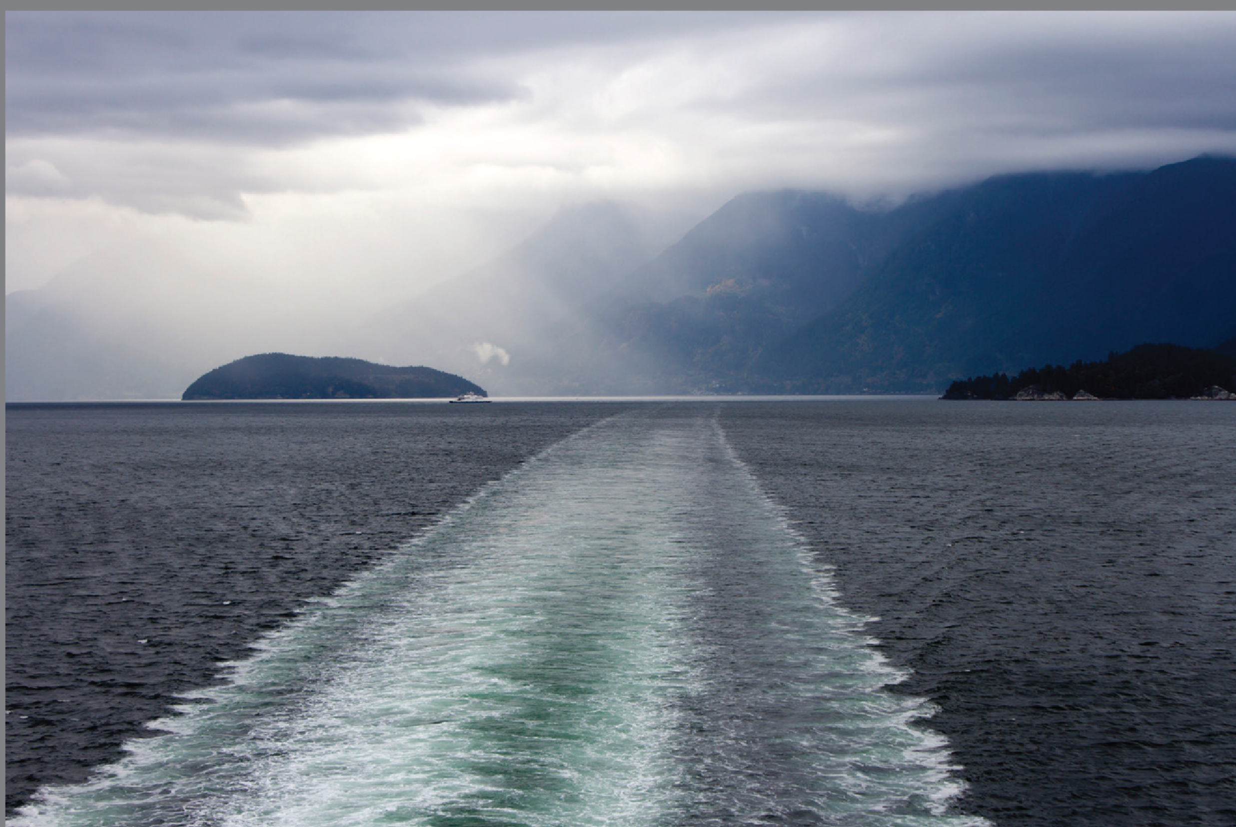
BILATERAL WORKSHOP
Grey Water Discharges from Vessels



May 1-2, 2019 | Vancouver, BC

Summary Report

Prepared by Nuka Research and Planning Group, LLC | June 2019

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1 Introduction

On May 1-2, 2019, Ocean Conservancy and WWF-Canada convened a workshop in Vancouver, British Columbia on the topic of grey water discharges from vessels. More than 30 participants brought perspectives from coastal Indigenous communities, regulators, treatment technology developers and manufacturers, cruise industry, and shippers.

This summary attempts to capture the information shared during the presentations and discussions that occurred at the workshop. This document does not present a consensus of the participants, nor was any attempt made to verify statements from presenters or participants. Instead, the workshop provided an initial opportunity to share perspectives across sectors. Finally, consensus was not a goal of the workshop due to the limited time and preliminary nature of the discussions with this group.

As was promised to the participants, individual remarks are not attributed here except when referencing presentations given.

1.1 Purpose of the workshop

The workshop aimed to:

- determine how to best address community concerns about grey water discharges and current grey water regulation;
- identify current and emerging technologies for pragmatic grey water treatment;
- exchange "lessons learned" from Alaskan grey water regulation creation and implementation to help inform practical solutions in Canada and elsewhere;
- define gaps and challenges to further progress grey water management.

1.2 Workshop organization

The first day of the workshop consisted of background information and perspectives on grey water, with an opportunity at the end of the day for all participants to offer their input. The second day focused on small group discussions of potential mitigation measures and larger group discussion on options for implementation. The agenda is provided in Appendix A.

1.3 Participants

Workshop participants are shown in Table 1. Participants brought experience and expertise from Canada and the U.S., with an emphasis within the U.S. on Alaska.

Table 1. Workshop Participants

Name	Organization
Austin Ahmasuk	Kawerak, Inc.
Bonnie Gee	B.C. Chamber of Shipping
Daniel Michaud	Transport Canada
Donna Spaulding	Cruise Lines International Association
Ed White	Alaska Department of Environmental Conservation, Water Division
Gabrielle Barnes	One Ocean Expeditions
Gayle McClelland	WWF-Canada
Gerald Inglangasuk	Environmental Impact Screening Committee, Inuvialuit Settlement Region
Hans Lennie	Inuvialuit Game Council
Jeannie Arreak-Kullualik	Nunavut Tunngavik Inc.
Jen Lam	Inuvialuit Joint Secretariat
Marc Gagnon	Fednav
Mary Turnipseed	Gordon and Betty Moore Foundation
Matthyw Thomas	VARD Marine Inc.
Megan McCann	Vancouver Fraser Port Authority
Meghan Mathieson	Clear Seas
Melissa Nacke	WWF-Canada
Melissa Parks	PEW
Mellisa Heflin	Bering Sea Elders Group
Mike Tibbles	Cruise Lines International Association
Nicole Poirier	Terragon Environmental Technologies Inc.
Ramona Pristavita	Terragon Environmental Technologies Inc.
Regina Bergner	U.S. Coast Guard
Sarah Bobbe	Ocean Conservancy
Shishir Rawat	Transport Canada
Sierra Fletcher	Nuka Research
Stephanie Hewson	West Coast Environmental Law
Troy Myers	Stand.Earth
Verner Wilson	Friends of the Earth
Wei Chen	Wärtsilä Water Systems
Zhong Xie	National Research Council of Canada

2 Grey water definition, components, and volumes

2.1 Grey water definition, components, and potential impacts

The International Maritime Organization (IMO) defines grey water as the drainage from dishwater, galley sink, shower, laundry, bath, and washbasin drains, *not* including drainage from toilets, urinals, hospitals, and animal spaces which are defined as black water.

Grey water may contain a wide range of contaminants, including grease, oil, and fat; food particles; detergents/surfactants; flame retardants; pharmaceuticals and personal care products; disinfectants; fecal coliform; and micro-plastics among others. While different contaminants bring different concerns – and these vary based on their quantity and the receiving environment – the general parameters of water chemistry that are of concern for all wastewater are: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), fecal coliform, total phosphorus (TP), and nitrogen. The values of these parameters for untreated grey water are far from negligible and there is potential for impact of local ecosystems if grey water is discharged. Coastal areas are generally thought to be more sensitive to wastewater discharges than the open ocean. Other anthropogenic sources of contaminants leading to high nutrient loadings in coastal areas include untreated black water/sewage releases from vessels, release of sewage from shore, or runoff from agricultural or fertilized lands.

Nitrogen may also be higher for grey water than black water when food waste processing water is included.[1] Grey water - not including food waste processing water – is estimated to contain more fecal coliform, BOD, COD, and TSS than allowed by IMO standards for treated black water.[2] Furthermore, fecal coliform concentrations in untreated vessel grey water are one to three times higher than untreated domestic wastewater.

Other contaminants of concern in untreated grey water include endocrine disrupting compounds from personal care products, or byproducts from the on-board use of disinfectants containing chlorine or a variant. Microplastics (less than 5 mm but also including microbeads) are an emerging area of concern present in grey water and increasingly being banned in some products.[3]

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[1] Presentation by Nicole A. Poirier, “Overview of vessel grey water constituents and impacts,” (based on estimates developed by Wei Chen), Day 1.
[2] Presentation by Wei Chen, “Overview of IMO requirements and treatment technologies,” Day 1 (citing 2008 U.S. Environmental Protection Agency report).
[3] Presentation by Zhong Xie, “Overview of vessel grey water constituents, regulations, and treatments,” Day 1 (based on National Research Council of Canada study currently underway).

Potential impacts of grey water discharges will vary with the constituent components, their concentration, and the receiving environment. One participant noted that discharges to more confined waterways with concentrated populations of wildlife are more likely to have a negative impact than discharges to the open ocean. One participant also noted, however, that ocean currents can transport pollutants far from where they are actually discharged.

Like sewage, grey water discharges into the marine environment can lead to oxygen depletion, spread pathogenic bacteria and viruses, and increase nutrient levels in the surrounding ecosystem, possibly leading to toxic algal blooms and eutrophication that can cause harmful disturbances throughout food chains. People consuming marine resources can contract a range of illnesses from contaminated waters, which is of particular concern considering the number of Indigenous peoples whose diet heavily relies on marine species.

2.2 Volumes generated

Limited estimates of grey water generation are available. Vard Marine Inc. has estimated the volume of grey water generated by different vessel types in the Canadian Arctic.[4] The volume generated does not necessarily correlate to the volume discharged at any particular location.

The Vard Marine Inc. study used 2016 Automatic Identification System (AIS) data from exactEarth to estimate the amount of grey water generation by those vessels while in the NORDREG zone for 2016. They then forecasted grey water generation for 2025 and 2035.

The study assumed that 253.6 L/person/day of grey water is generated on cruise vessels and yachts and 125.0 L/person/day for commercial vessels. Based on vessel types and tracks determined through the AIS data and applying an assumed vessel speed between points, volumes of grey water generated estimated by vessel type as shown in Figure 1. Overall, passenger vessels have the highest volume of grey water generation per vessel but the relative number of other types of vessels (fishing, bulk carriers, sealift deliveries, etc.) and time spent in the region means they also generate a substantial volume of grey water.

[4] Information in this section based on presentation by Matthyw Thomas of Vard Marine, Inc.

Vessel Type	Total Voyages	Total Distance (km)	Total Days	Unique Vessels	Grey Water Generated in NORDREG (L)	Grey Water Produced per day (L)	Grey Water produced per KM (L)	Grey Water produced per voyage (L)
Passenger Vessel	16	156,046	197	12	11,622,319	58,967	74	726,395
Fishing Vessel	114	339,018	1,586	26	5,771,964	3,639	17	50,631
Coast Guard Icebreaker	18	184,495	479	10	3,743,490	7,811	20	207,972
General Cargo	29	270,973	615	15	2,439,094	3,964	9	84,107
Bulk Carrier	49	204,370	530	26	3,474,563	6,552	17	70,909
Tug	40	98,252	928	19	1,623,021	1,749	17	40,576
Cruise Ship	1	17,328	12	1	1,541,667	124,831	89	1,541,667
Tanker	17	104,061	396	9	1,270,625	3,207	12	74,743
Military Vessel	4	34,901	63	2	676,057	10,712	19	169,014
Factory Ship	8	28,632	105	1	328,385	3,125	11	41,048
Chemical Tanker	3	26,964	108	1	228,703	2,125	8	76,234
Sailing Ship	26	79,221	259	13	204,505	791	3	7,866
Trawler	2	28,005	60	2	165,938	2,755	6	82,969
Coast Guard Tender	3	11,870	111	1	139,219	1,251	12	46,406
Research Vessel	2	19,574	25	2	109,833	4,420	6	54,917
Yacht	9	43,509	93	4	76,583	825	2	8,509
Adventurer	3	3,934	21	1	15,781	750	4	5,260

Figure 1. Table showing estimated grey water generated by vessel type in the Canadian Arctic based on 2016 AIS data (from report developed for WWF-Canada and available online at: http://d2akrl9rvxl3z3.cloudfront.net/downloads/wwf_canada_grey_water_report_2018_1.pdf)

Forecasted increases in grey water generation were developed based on predicted increases in voyages by different vessel types in the Arctic region. This includes assuming more passenger vessel traffic through the Northwest Passage and bulk carrier traffic to Baffinland. Forecasts are challenging, however, and can quickly become out of date as both project plans and the operating environment change.

Vard Marine Inc. is currently completing a similar study using 2017 data for the British Columbia coast. Preliminary results indicate an estimated 1.5 billion L of grey water may have been generated near the British Columbia coast in 2017. Forecasts are not included in the British Columbia study.

In addition, a study that includes estimates of grey water generated in the Bering Strait area is also forthcoming in *Marine Policy*. (This article was released after the workshop and is available at: https://www.sciencedirect.com/science/article/pii/S0308597X18308315.)

3 Community concerns

Several community representatives from Alaska and Arctic Canada participated in the workshop. Two presenters, Austin Ahmasuk (from Nome, Alaska) and Hans Lennie (from the Inuvialuit Settlement Region), spoke directly to their communities' concerns regarding grey water discharges. Both Austin and Hans emphasized the importance of a healthy ocean to their way of life and ability to feed their families. Sea ice has been a critical element of the

Arctic ocean environment, and reductions in sea ice in recent years threaten to undermine their subsistence lifestyle, at least as it has been known. Sea ice is changing faster than expected, which has a layered effect of reducing access to ice-dependent species while also expanding the season and areas accessible to vessel activity.

Although operating under different national and sub-national frameworks in Canada and the U.S., both Hans and Austin expressed frustration that the Indigenous people who live in the Arctic do not have input to the decisions of companies and governments that affect their way of life. Regarding grey water specifically, both are concerned about discharges in nearby waters and impacts to marine ecosystems that are already threatened. Both also anticipate increases in vessel activity in the context of uncertainties regarding the impacts to the ecosystem and gaps in regulations and enforcement.

In Alaska, there have been recent and unprecedented Harmful Algal Bloom (HAB) events resulting in high levels of toxins found in marine mammals harvested in the Bering Strait area. Causes of the HABs are unknown, but communities are concerned that they may result from vessel discharges to warming waters. (There are requirements related to cruise ship discharges but these apply only in state waters.) Austin's organization, Kawerak, Inc., has identified vessel discharges as one of the four types of impacts to their communities from increasing vessel traffic.

In the Inuvialuit Settlement Region (ISR), communities have lots of questions about the discharges from vessels, including grey water, and their impacts on the species people eat. The Joint Secretariat Shipping Working Group intends to work on the issue of grey water. In addition, the Inuvialuit Game Council recommends that vessel discharges in the area be sampled and screened by the ISR Environmental Impact Screening Committee and that vessels have to report the volume, location, and timing of any discharges. Currently, if a ship anchors near a community it must go through the EISC screening, which could include providing information about their grey water management while in the area. There is the potential for better understanding of these issues through a co-production of knowledge approach as is being applied to other issues affecting the region. Grey water is a topic being discussed in other forums and initiatives that bring together ISR communities and Canadian federal agencies.

4 Regulatory context

While the IMO has requirements for the treatment of sewage (black water), there are no IMO requirements related to grey water treatment or discharge. Grey water discharge regulations in place today are limited to specific national or sub-national areas. Most of these take the form of establishing no-discharge zones. A combination of state and federal regulations applicable to cruise ships in Alaska represents the sole grey water standard that requires the use of Advanced Wastewater Treatment Systems (AWTS) and associated monitoring to ensure compliance as part of a broader program there.

Figure 2 presents a table from a presentation by Wei Chen ("Overview of IMO Requirement and Treatment Technologies") which puts the IMO and limited U.S. discharge standards into context with grey water.

Standards	MEPC 2(VI)	MEPC 159(55)	MEPC 227(64) Exc. 4.2	MEPC 227(64) Inc. 4.2	33CFR159 Type II MSD	33CFR159 Subpart E Alaska	US EPA VGP	US EPA VGP
Enter into force	2008	2010	2016	2019/21	1975	2001	2013	2013-19
Waste stream	Black	Black	Black	Black	Black (Grey in G. Lakes)	Black &Grey	Grey	Grey
Applicable ships	>15 p >400T	>15 p >400T	>15 P >400T	>12 pa SA	All	cruise >500	cruise	All
Distance (nm)	12	12	12	12	12	3	3	1
Enforcement	No	No	No	No	No	Yes	No	No
F. Coli (/100ml)	200	100	100	100	200	20	20	
TSS (mg/l)	100	35	35 Qi/Qe	35 Qi/Qe	150	30	30	
BOD_5 (mg/l)	50	25	25 Qi/Qe	25 Qi/Qe		30	30	
COD (mg/l)		125	125 Qi/Qe	125 Qi/Qe				
pH		6~8.5	6~8.5	6~8.5		6~9	6~9	minimise
Chlorine(mg/l)		0.5	0.5	0.5		0.01	0.01	
T. Nitrogen (mgN/l)				20 Qi/Qe or 70%				
T.Phosphorus (mgP/l)				1 Qi/Qe or 80%				

Figure 2. Comparison of Marine Environmental Protection Committee (MEPC) of the IMO requirements for black water and grey water with U.S. federal requirement applicable in Alaska and the U.S. Environmental Protection Agency's Vessel General Permit

NOTE: Q_i and Q_e are metrics used by the IMO to account for the potential use of dilution to meet effluent standards.

4.1 Canada

Zhong Xie from the National Research Council of Canada presented an overview of Canadian regulations applicable to vessel grey water discharges.

Arctic (North of 60N)

The Arctic Waters Pollution Prevention Act (1970) prohibits any discharge of "waste" into Arctic waters; waste being any substance that will have a deleterious effect on the water column. This puts the onus on the operator to prove that grey water does not include any deleterious waste as defined above, which is extremely difficult. There is also no process for approval of any form of grey water treatment systems as these are not addressed under the regulations.

These regulations require that most operators process and discharge grey water before entering a zero-discharge region. However, remaining in the Arctic for an extended period without discharging grey water would require the vessels to have very large holding tanks, Transport Canada to certify a treatment system, or for the operator to ignore the regulations and discharge regardless. At this moment Transport Canada does not approve or certify any grey water treatment system for use in the Canadian Arctic.

South of 60N

Elsewhere in Canada, the Canada Shipping Act requires that passenger vessels with more than 500 passengers must pass grey water through a Marine Sanitation Device (MSD) or discharge it more than 3 nm from shore. Older vessels or those with fewer than 500 passengers must ensure any release of grey water does not result in the deposit of solids in the water or leave a sheen on the water. Transport Canada used to have *Pollution Prevention Guidelines for the Operation of Cruise Ships under Canadian Jurisdiction*, though these guidelines are now outdated and reference obsolete legislation.

Inland Waters

Inland waters are governed by provincial laws. In British Columbia, for example, grey water discharges to inland waters are prohibited under the Environmental Management Act's Municipal Wastewater Regulation unless otherwise authorized.

4.2 U.S.

Federal

In the waters of the U.S. (including navigable waters out to 3 mi from shore), grey water discharges from vessels 79 feet or longer are allowed under a Vessel General Permit issued through the National Pollutant Discharge Elimination System (NPDES) Program administered by the U.S. Environmental Protection Agency. Since 2008 (with an update in 2013), this has meant that discharges from subject vessels must comply with permit requirements. For grey water, this includes a requirement for most vessels to discharge more than 1 nm offshore if they have the capacity to store grey water on board and do not treat waste water to treatment standards in the permit. There are also suggestions regarding products used onboard (e.g., using phosphate-free and minimally-toxic soaps) or practices (removing as much food and residue from dishes before washing them onboard). The permit also identifies areas where grey water discharge is prohibited *if* the vessel has adequate capacity to store it instead.[5] The U.S. Environmental Protection Agency is in the process of promulgating new performance standards for vessel discharges under the Vessel Incidental Discharge Act (2018). These will be implemented and enforced by the U.S. Coast Guard and will eventually replace the Vessel General Permit.[6]

[5] There was not a presentation specifically on U.S. regulations at the workshop, but regulations were addressed by different presenters. Some of the information from this paragraph comes from the Final 2013 Vessel General Permit, available online at: https://www.regulations.gov/document?D=EPA-HQ-OW-2011-0141-0949

[6] For more information: https://www.epa.gov/npdes/vessels-vgp

Alaska State Waters
Federal and state regulations in Alaska apply to passenger vessels in state waters only. Ed White described the program that exists there focused on Southeast Alaska. There are different requirements for commercial passenger vessels with more than 250 passengers than those with 50-249 passengers (which include state ferries). Larger vessels are subject to wastewater treatment requirements for both black and grey water as well as monitoring, inspections, and requirements related to other emissions and impacts. They must have an Advanced Wastewater Treatment Systems (AWTS) on board.

The program in Alaska began with an initiative in 1999 intended to address concerns about vessel discharges as cruise ship activity in Southeast Alaska increased. While the requirements to treat wastewater exist under state regulations and thus apply to state waters (out to 3 nautical miles from shore), an overlapping federal regulation was put in place in 2000 (33 CFR 159 Subpart E) to address gaps in Southeast Alaska and Kachemak Bay (Cook Inlet) where state waters do not cover all waters within the archipelago. Discharges of any kind are not allowed in herring spawning areas.

The State of Alaska samples vessel discharges and port areas frequented by cruise ships. Vessel discharges are tested against State of Alaska and U.S. EPA permit requirements. A significant component of Alaska's program is compliance education, including sharing lessons learned and ensuring that samples are taken appropriately (including disinfecting the sample ports, flushing the lines, and establishing a system maintenance plan that can be validated through sampling.)

5 Treatment options

In buildings, grey water is typically mixed with black water, or sewage, and this combined wastewater is treated in a municipal or on-site sewage treatment system. By contrast, on vessels typically only the black water (from toilets or urinals) is treated before discharge (and then only when inside 12 nm from shore, or territorial waters). Food wastes may be managed in different ways, but are sometimes included in grey water discharges (and can bring a high organic load which can drive up BOD).

IMO sewage treatment requirements only specify the discharge parameters that must be met for treated sewage. Treatment of grey water is not considered. Treatment typically includes primary treatment, biological (or secondary) treatment, and, sometimes, disinfection using chlorination.

AWTS provide a higher level of treatment than the typical sewage treatment systems used on vessels since they typically involve some form of membrane treatment. While there is no standardized definition of these systems or global standard for the resulting effluent, they typically provide a higher level of biological treatment, solids removal, and disinfection.

About 10 companies make AWTS that treat grey water and black water, most of which use biological technologies though some rely on an electrolytic process. Treating black water and grey water together requires a larger capacity system since the volume of grey water generated is many times that of black water alone (especially because onboard toilets typically use a vacuum system and very little water as compared to toilets in buildings), takes more space on the ship, costs more in maintenance and capital and operating costs, and can be impacted by fluctuations in the loading of different compounds. (While black water generation is fairly constant if the vessel is used to capacity, the volume of grey water generated and its components can vary throughout a voyage.)

Issues associated with treatment options and associated standards are discussed further in Section 7.

6 Operator perspectives

Vessel operations vary depending on vessel type, use, and voyage. A large cruise ship can generally store grey water for 2-5 days. Some of the bulk carriers operating in Arctic Canada have holding tanks of 80-100 tonnes and can hold grey water for discharge outside Canadian Arctic waters. Ultimately, consistent requirements both geographically and over time would remove a challenging patchwork of regulation for operators. Changing vessel systems is costly due not only to the equipment, but the time it takes to install and reconfigure vessel systems accordingly. Operators need to know that their on-board systems will satisfy regulatory requirements for years to come. Furthermore, since ships such as bulk carriers operate globally, it is easier for operators if there are consistent requirements for which vessels need to be equipped and crews trained instead of complying with a patchwork of regulations.

Some ports in Europe have grey water management systems; Vancouver Fraser Port Authority, the only port represented at the workshop, does not. While treatment in ports may provide an option for vessels needing to discharge grey water, many vessels are not in port as often as they would need to discharge based on their holding tank capacity.

7 Considerations related to potential mitigation measures

Host organizations identified four general mitigation approaches for the group's consideration: (1) waste minimization, (2) treatment standards and technologies, (3) location of discharges, and (4) monitoring and oversight. The group reviewed these on the afternoon of Day 1, and, absent any suggestions to add to the list, a breakout group was formed to explore each topic on Day 2. Participants chose which group to join. Information here is based on the discussions at the workshop and not otherwise verified. The discussions provided an initial opportunity to share ideas on the four topics, but were not conducted with the goal that this group would reach consensus on a path forward.

7.1 Waste minimization

As grey water is a waste issue, it makes sense to consider how the waste stream – or the pollutants of concern in the waste stream – could be reduced. In this context, using less water is not the focus but rather reducing the contaminants within the grey water. There are not regulations that mandate what products can be used on board, but guidance as from the U.S. EPA's Vessel General Permit to use phosphate-free detergents.

Re-use of grey water onboard is challenging since some treatment would be required. While treatment to the level of potable water is not feasible, treated grey water could possibly be used for laundry or cooling systems (in place of water drawn from the ocean where this is the case).

Cruise ship operators can recommend or provide products for passengers to use that would minimize harmful grey water constituents. Many already provide extensive guidance related to minimizing negative impacts on the areas they visit, or use sustainably produced or harvested resources on board.

Cleaning products present a particular challenge because sometimes health regulations require the use of certain types of products such as bleach. Other products may bring toxicity concerns but also benefits that need to be considered.

7.2 Treatment standards and technologies

Treatment standards and technologies exist in a sort of chicken-and-egg relationship. Technologies are designed to meet standards, and at the same time, establishing standards that are not feasible for vessels to achieve is impractical. (As discussed, Alaska currently has the most stringent standards for grey water discharges in the world.)

When setting discharge standards, it is important to consider:

- Standards should be set with cumulative effects in mind, not just the releases from a single vessel.
- There are still many things about the Arctic marine ecosystem that are unknown (even as it changes rapidly due to climate change) which may be needed to inform the development of any discharge standards. The precautionary principle should be applied.
- Standards drive technological developments and define the marketplace. Vessel owners typically will not spend money on equipment they do not need.
- Standards should be based on the actual water discharged instead of requiring the use of a specific technology. This is both because a technology may or may not perform as intended once installed and because it creates the opportunity for competition in the marketplace.

- Discharges could be allowed only if a vessel is moving, as this enhances the dilution of the pollutants released. This approach is used in Alaska's program. On the other hand, the observation was also made that regardless of the location of the discharge or immediacy of dilution, contaminants discharged will go somewhere in the water column. (See Section 3.3.)
- Applying a land-based (municipal) standard across all vessel types over a certain size would likely reduce the overall impact of grey water releases more than applying a more stringent standard to a subset of vessels.
- Alaska's compliance program really pushed industry – for example, regarding the copper standard the state worked with industry to identify sources of copper onboard (pipes, etc.) and identify best practices.

Regarding treatment technologies, in addition to determining that a technology can meet a discharge standard, it is important to consider:

- Ensuring that treatment technologies operate as intended. Just because a system is installed does not mean it is being operated correctly or is adequately maintained. The best way to determine that a system is meeting its intended purpose is to sample the actual discharge on a regular basis. AWTS require more skill to operate than a typical Type 2 sewage treatment system. While vendors provide training when the vessel is commissioned, this does not necessarily carry through past crew turnover.
- Even as "Advanced Wastewater Treatment Systems" (AWTS) are being used on some offshore platforms, ferries, and naval vessels (in addition to cruise ships), there is no standard definition of what this means aside from what Alaska's regulations require of cruise ships.
- It is possible for an AWTS to be used selectively – such that it is used where required but otherwise discharges are untreated. While systems are tested in Alaska, whether or how they are used elsewhere is unknown.
- Companies need predictability in standards they must meet in order to invest in the appropriate technology. This is most easily done when a vessel is constructed, because the management of different waste streams generated on board requires that the entire plumbing system be configured appropriately in addition to any actual on-board treatment.
- 62% of Cruise Line Industry Association (CLIA) members have AWTS onboard, and all large cruise ships are now being built with this type of system.
- Ships are typically drydocked every 3-5 years, which represents a bare minimum amount of time that would be warranted for any new standards necessitating new equipment to take effect. (It took 10 years for the AWTS to be fully adopted for compliance with the Alaska program and there was extensive work between the industry and State to achieve this.) Applying new standards to newly built vessels first is most feasible and has been implemented in the shipping industry in the past.
- Treatment takes money, energy, and often chemicals. When selecting treatment options (or setting standards to drive treatment options) it is important to consider the environmental cost-benefit. For example, technology can be developed to reduce the

discharge of some contaminants to almost nothing, but at some point the energy expenditure and costs may not be worth it. This balance may look different to different people.
- Space on a vessel is at a premium. Treatment technologies would ideally take up minimal space and be easy to operate and maintain.
- Cleaning chemicals such as bleach can damage a treatment system that is based on biological treatment. This is one reason a wholistic management plan is important, as well as the type of issue that can be detected through periodic sampling of discharges.
- AWTS vary in cost (e.g., around $1 million for on large cruise ships) but just as important are the costs associated with taking a ship out of service and reconfiguring the plumbing system and other aspects of the vessel design in order to install a treatment system.

A participant suggested that another option may be to segregate out different sources of grey water; for example, if water from the galley poses the biggest problem, perhaps this could be treated but shower water discharged. This could reduce the problem but without requiring storage of grey water from all sources.

It was noted that in order for communities to be comfortable with a treatment system, information needs to be available regarding the performance standard the system is designed to meet. That performance must then be verified to ensure the system is working correctly.

7.3 Location of discharges

There are different approaches to determining areas where discharges should not occur or should be limited. This may be due to the concentration of vessel activity (such as in a passage or port) or the presence of sensitive species and/or habitats. Areas identified as sensitive or requiring special management should be identified based on science and Indigenous Knowledge.

Participants agreed that geographically defining a sensitive area is challenging due to seasonal occurrences, such as whale migrations and herring spawning, or changes over time due to climate change. There are also seasonal changes in the physical ocean environment, such as tides and currents which can influence downstream areas, or polynyas and ice leads. When defining a sensitive area, we not only need to consider science but also indigenous knowledge.

Some participants suggested that existing sensitive areas that have already been recognized, including Marine Protected Areas and critical habitats, should be no-discharge zones. Several participants expressed that current no-discharge areas, such as within 3nm of the coast, are inadequate to protect sensitive resources.

Limitations on grey water discharges in the Polar Code area would be one option, though it was acknowledged that there are also sensitive areas that may warrant no-discharge zones south of the Polar Code region.

A challenge that was discussed was how to manage grey water appropriately for the size of the geographic area. Should a zero-discharge zone be established that is too large for ships to have adequate storage capacity to hold grey water during the time spent in the area, then this would lead to non-compliance with the regulations.

7.4 Sampling, monitoring and reporting

Sampling, monitoring and reporting discharges provides information for communities and other stakeholders regarding the type and concentration of contaminants released. As noted, sampling and monitoring discharges can also detect system malfunctions or failures which can then be addressed. There are different elements of sampling and monitoring to consider, including what is tested, how and where monitoring occurs, who conducts it, how this is information us reported and how data are used.

Considerations related to sampling and monitoring include:

- Most vessels maintain logbooks of their discharges, and some are required or have signed agreements to share logbooks publicly (e.g. CLIA cruise ships share logbooks with State of Washington, which can be accessed via a request to the State of Washington government).
- Concern was raised about gaps in information or opportunities for verification. Alaska is one of the few places random spot-checks of logbooks occur to ensure they are correct.
- If information is available that shows a ship met requirements or specific standards, this may put communities at ease or on alert, depending on historic performance.
- Third-party monitoring is the most reputable solution to ensure non-bias.
- It is important that sampling and reporting information gets to the right place for use. Some participants expressed concerns about reporting not getting to the Federal government.
- Enforcement of sampling and reporting requirements (if they exist) is essentially non-existent in Arctic today.
- Public concern and EPA studies drove the push for sampling and monitoring in Alaska.
- Depending on what is being monitored, access to a laboratory may be necessary (Alaska requires this for some discharge monitoring).
- Smaller cruise vessels in AK that have participated in self-monitoring have seen successful results. Self-monitoring can ensure function of equipment. Vessels can elect to test onboard with a small monitoring kit (indicator tabs, not too expensive multimeter).
- Sampling to ensure proper function of equipment could occur before entering a remote area without capabilities.

- Airborne monitoring can be used, but limited in geographic scope, weather limitations, etc.
- Sensors may be used to detect when a discharge valve opens, for how long, and where the vessel is located when the discharge occurs. Norway has recommended the use of sensors to minimize non-compliance with IMO sewage requirements.
- It would be helpful if information about the vessel's grey water generation, holding capacity, or discharge flow rate could be included with AIS data. Communities would like to know which ships are discharging in the area and what is being discharged.

8 Implementation

As with many environmental issues, there was discussion of the merits of proceeding to better management of grey water discharge versus studying the issue more. Detecting impacts to ocean ecosystems from grey water specifically will be challenging; what Alaska's program has shown is that wastewater contamination from vessels (both grey water and sewage) can be managed and significantly reduced.

Implementation of grey water management measures should be global in nature and predictable for the regulated industry. Any requirements that involve installation of treatment systems should be implemented with several years of advance notice before taking effect, and/or apply first to new-builds and allow more time for retrofits. Since grey water is produced in larger quantities onboard passenger vessels, due to the number of people and facilities, a suggestion was to focus first on larger passenger vessels. Incorporating grey water discharge management requirements into pending IMO efforts to improve implementation of the sewage/black water regulations is one possible approach. While this work provides an opportunity, it was also acknowledged that Indigenous representation at the IMO is inadequate and this should be rectified as well. The view was shared that the IMO process can be slow. Something at a national or regional level or voluntary measures by some operators may yield results sooner.

Discharge standards should be protective of the environment and human health. This dual goal supports both food security and preservation of a quality experience for economic activity related to recreation or tourism whether cruise ships or a wider range of recreational activities on the ocean and coast.

There is the potential to foster communication between vessel operators and coastal communities concerned about vessel impacts. This is likely to be more feasible in the Arctic than South of 60, however, since there are fewer vessels. In Canada, for example, there are already established structures for community engagement with industry in ISR and Nunavut.

Transparency around how vessels manage their waste water (across vessel types and trades[7]), what they discharge and where (if anything), and what discharges contain is necessary to building trust with communities concerned about the health of the ocean environments on which they depend for both immediate food security and sustaining their way of life. Communities should have input to the development of standards, whether through the IMO or another mechanism.

A market survey of vessel wastewater treatment systems would inform the development of a strategy to mitigate grey water impacts. Knowing what type of treatment systems are being purchased for new-built vessels, what standards those systems can achieve, and how this compares to the current fleet would inform the development of grey water mitigation approaches. It would also be an opportunity to understand and potentially influence decisions made regarding what system to purchase.

Through the Alaska's program, the cruise industry has been able to meet standards that satisfy State requirements and generally address some community concerns in Southeast Alaska. Information about the program and on-board practices are shared within the CLIA membership globally. (This relates to issues beyond grey water).

Oversight and monitoring are important elements of any grey water mitigation effort. As mentioned previously, this should include periodic third-party sampling, monitoring and reporting of any discharges to verify that treatment systems are meeting any standards set for grey water/wastewater discharge.

9 Conclusion

This workshop provided a first opportunity for stakeholders to exchange information and viewpoints regarding vessel grey water discharge impacts and management options. Information shared included both technical details regarding water chemistry and wastewater treatment technologies as well as viewpoints from participating communities, government, and industry. Information and commentary were shared on both the nature of the issue and considerations related to potential mitigation options. Following this, WWF-Canada and Ocean Conservancy plan to: (1) continue engaging at relevant international organizations like the International Maritime Organization, (2) work with industry on realistic solutions, and (3) continue to support communities and community concerns.

[7] Sea lift to communities in Canada is a uniquely challenging issue. Vessels engaged in this service (not represented at the workshop) are unable to hold their waste water for their entire voyage. Voyages are dictated by community demand for goods and seasonal access.

Appendix A: Agenda

(A presentation by the National Research Council of was added to the morning of Day 1.)

Bilateral Workshop
Grey Water Discharges from Vessels
May 1-2, 2019

Quarterdeck Bridge Room
Granville Island Hotel
Vancouver, British Columbia

AGENDA

Day 1

8:30 am	*Registration and breakfast*	
9:00 am	Welcome and introductions	
9:30 am	Workshop scope and purpose	Melissa Nacke (WWF-Canada), Sarah Bobbe (Ocean Conservancy)
10:00 am	Overview of vessel grey water constituents and impacts	Dr. Nicole Poirier and Dr. Ramona Pristavita (Terragon Environmental Technologies Inc.)
10:30 am	*Break*	
10:45 am	Grey water and marine traffic	Matthyw Thomas (Vard Marine Inc.)
11:15 am	Inuvialuit perspective on grey water impacts and potential solutions	Hans Lennie (Inuvialuit Game Council, Inuvik)
12:00 pm	*Lunch*	
1:00 pm	Alaska's cruise ship grey water regulations	Ed White (Alaska Department of Environmental Conservation)
1:45 pm	Bering Strait region perspective on grey water discharges & solutions	Austin Ahmasuk (Kawerak, Inc., Nome)
2:15 pm	*Break*	
2:30 pm	Treatment technologies	
	- Overview of treatment technologies and IMO requirements	Wei Chen (Wärtsilä)
	- Perspectives on marine grey water treatment in Canada's Polar Region	Dr. Nicole Poirier and Dr. Ramona Pristavita (Terragon Environmental Technologies Inc.)
4:00 pm	Other perspectives & potential mitigation measures -- discussion	
5:00 pm	*Adjourn*	

****Reception at hotel immediately following meeting****

Day 2

8:30 am	*Breakfast*
9:00 am	Recap of Day 1 and review agenda
9:15 am	Grey water mitigation measures – large and small group discussions - Innovative waste minimization - Discharge standards and treatment options - Geographic limitations of discharges - Sampling, monitoring & reporting
10:30 am	*Break*
10:45 am	Report-back on mitigation measure
Noon	*Lunch*
1:00 pm	Mechanisms for implementation
2:00 pm	Concluding discussion
2:30 pm	Adjourn