

ALASKA LEGISLATURE COMMITTEE FILES, 2003-2004 8672
11104 SENATE COMMUNITY & REGIONAL AFFAIRS

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AWRTA

Dear Representatives and Senators,

RE: Small cruise vessel legislation, HB 522 & SB 361

The Alaska Wilderness Recreation and Tourism Association (AWRTA) strongly supports both HB 522 and SB 361, bills relating to discharges from small commercial passenger vessels. AWRTA is a membership-driven trade association formed to be a collective voice for wilderness-dependent businesses. We advocate for the sustainability of Alaska's natural and cultural resources, responsible tourism and tourism planning for communities.

While we enthusiastically supported the Commercial Vessel Environmental Compliance Program via HB 260 passed in 2001, we recognize that the intent of this Program was based on the assumption that small cruise ship vessels could conform to the environmental technology developed by large-ship cruise vessels. In order for small ship cruise companies like Lindblad Expeditions, Alaska Sightseeing/Cruise West, and Glacier Bay Cruises to continue to operate in Alaskan waters, an alternative regulatory scheme that focuses on minimizing these ships discharges is required. HB 522 and SB 361 offer reasonable alternative plans that will allow these small ship companies to continue operation beyond July 2004.

Small ship cruise lines are highly valued partner in Alaska's tourism economy, and many AWRTA members depend small ship passengers for their livelihood. Small ship cruise vessels with 150 passengers or less operate with distinctly different philosophies than foreign-flagged large multi-national cruise ships. Small ships visit Alaskan communities where passengers spending power is directed to small businesses owned and operated by Alaskans. When passengers disembark these ships, many travel to other regions of Alaska with AWRTA member businesses that offer land based lodges, tours, and activities, thereby diversifying the economic reach to other Alaskan business sectors. Small ship cruise lines are flagged in the US, adhere to both Alaska and US labor laws, pay income taxes as well as the real costs associated with doing business in Alaska.

We support HB 522 and SB 361, and believe that these bills offer solid solutions utilizing best management practices to minimize stationary wastewater discharges.

Thank you for passing this important legislation.

Best Regards,

Catherine McDermott
Board of Directors
Alaska Wilderness Recreation and Tourism Association

2207 Speward Road, Suite 201 Anchorage, Alaska 99503 • (907) 258-3171 Fax (907) 258-3851
Linking Alaska Business, Community & Conservation

Small Cruise Vessel Alternate Compliance Program is not an exemption from environmental laws.

Recent media coverage suggests that legislation pending in the Alaska legislature (HB522 and SB361) would exempt small cruise vessels from wastewater discharge laws.

On the contrary this legislation, as recommended by Alaska Department of Environmental Conservation (ADEC), keeps small cruise vessels (50-249 berths) in the Commercial Passenger Compliance Program.

Under this legislation,

1. All small cruise vessels built after 2003 would fully comply with the wastewater discharge standards.
2. Older vessels built before 2003 (twelve in number), would remain in the program and utilize "Best Management Practices" under three-year plans, reviewed and approved by ADEC. This recognizes insurmountable difficulty and costs of substantial retrofitting older vessels.
3. "Best Management Practices" will include such things as:
 - a. On-board treatment of all wastewater to Federal U.S Coast Guard standards;
 - b. Whenever possible, require all vessel discharges be made at least one mile offshore, traveling at six knots,

The ADEC assessment report concluded:

"When large and small vessels discharge underway they are able to meet all Alaska water quality standards." see page 53, Assessment of Cruise Ship and Ferry Wastewater Assessment Impacts in Alaska;

- c. Adjust schedules to minimize stationary discharges;
 - d. Avoid doing laundry while stationary;
 - e. Work with manufacturers to develop new technology, capable of treating stationary discharges to higher levels on small vessels
 - f. Utilize holding tanks to maximum extent to avoid stationary discharges;
4. Continue to pay coastal protection fees to ADEC; and
5. Continue to test, monitor and report wastewater discharges to ADEC.

Under the 2001 Cruise Ship Legislation (HB260), small cruise vessels were given a three-year exemption. Subsequently, ADEC completed a comprehensive environmental assessment of the cruise discharge issues. This report, issued in January 24, 2004 found that discharges from state ferry's and small cruise vessels were 3% of total cruise vessel discharges, but suggested that small vessel stationary discharges needed to be addressed.

HB 522 and SB 361, implement this recommendation. It requires small cruise vessel operators to submit "Best Management Practices" plans to ADEC every three years. ADEC's approval of the plans are required to operate in Alaskan waters.

These bills were drafted in cooperation with ADEC and the small cruise vessel industry.

The legislation represents an environmentally sound, responsible approach to ensuring the small cruise vessels comply with wastewater standards to the maximum extent possible. As new technology is developed, capable of fitting on older vessels, ADEC has authority to require its use as part of the "Best Management Practices."

The small cruise vessels are ..American owned, crewed, great economic impacts etc.

Visit ports such as

Subject: Small Cruise Ship and Ferry Compliance on Wastewater

Date: Wed, 24 Mar 2004 23:52:36 -0900

From: "John Pearson" <jpearson@ptialaska.net>

To: "Georgianna Lincoln" <Senator_Georgianna_Lincoln@legis.state.ak.us>, "Senator Kim Elton" <Senator_Kim_Elton@legis.state.ak.us>, "Senator Bert Stedman" <Senator_Bert_Stedman@legis.state.ak.us>, "Representative Albert Kookesh" <Representative_Albert_Kookesh@legis.state.ak.us>, "Representative Peggy Wilson" <Representative_Peggy_Wilson@legis.state.ak.us>, "Representative Bill Williams" <Representative_Bill_Williams@legis.state.ak.us>, "Representative Carl Morgan" <Representative_Carl_Morgan@legis.state.ak.us>

CC: "Gary Benedict" <sealaskainn@yahoo.com>, "Dick West" <DickW@cruisewest.com>, "Larry Johansen" <cwjnu@gci.net>, "Len Laurance" <l.laurance@worldnet.att.net>, "Rob Allen" <rallen@allenmarine.com>, "Hugh Bevan" <hugh@cityofsitka.com>, "S Thomas Briggs" <tom_briggs@dot.state.ak.us>

Ref: HB522 and SB361

Unfortunately, we ran out of time yesterday afternoon at the Southeast Conference meeting, for me to request your support for the above referenced legislation. The two bills refer to the issue of wastewater discharge laws related to small cruise ships and the Alaska ferry system.

Recently the Juneau Empire gave the public a wrong image in their publication, with the impression that the small cruise vessels and the ferry system were getting exemptions to the law in dealing with the wastewater issue.

These Juneau Empire statements were totally inaccurate and misleading!

The 2001 Cruise Ship Legislation (HB 260) provides a very clear policy and intent statement addressing the requirements of small vessels operators as well as the ferries on the subject. Today, there are no exemptions, and the small vessels operators should be viewed as being good stewards of our waters.

As HB522 and SB361 come before your respective bodies, it is essential that our regional legislators stick together in their position and support for the legislation.

Today small vessel operators such as Cruise West and Lindblad Expeditions are in fact, going the extra mile in their concerns for the Alaska environment. In addition, they are an important economic factor in our local communities, especially our rural communities.

We request your full collective support as Southeast Legislators on the legislation and best efforts to correct the Juneau Empire impressions of this special and unique form of tourism.

John Pearson
Community Development Specialist
Hyder Board of Trade (Chamber)

JUNEAU EMPIRE

ROBERT HALE
Publisher

LORI THOMSON
Managing editor

LOLA LEAMER
Controller

CONNIE McGEE
New media (or

MARIE TOLAND
Advertising director

MARK WARMAN/GALEN WYATT
Production directors

Letters to the editor

Bill sets reasonable ship standards

The House and Senate will shortly take up House Bill 522. This piece of legislation is designed to craft a plan by which small ships can continue to comply with Alaska's high wastewater standards beyond the immediate future. HB 522 is a realization that the cookie cutter that was created for the large ships in the original bill doesn't fit for the small ship and seeks to create a reasonable path to small ship compliance.

Contrary to common misconceptions, the provisions in HB 522 do not exempt small ships from wastewater standards. They will be required to meet all benchmarks set under the original legislation. Why then is HB 522 needed?

First realize that the large ships comprised 97 percent of the total wastewater being emitted. The emerging technologies being developed to meet these standards were designed to be installed on these larger and much newer vessels. The market for this technology designed to fit into the dozen smaller (and in some cases 20 year old vessels) does not currently exist. The larger vessels have solved most of their issues by simply adding

massive holding tanks that a 140-foot vessel cannot accommodate. As these technologies develop it will be fully expected that the small ships will deploy them and all small ships currently being designed will be required to build to meet the standards as written.

So what's being done with these older boats? Second, realize that the American built small vessels do in fact meet all federal standards and that all discharges are being treated. It is a fact that the only time that the small ships do not meet the stringency of the Alaska standards is when they are stationary for a period of longer than four to six hours. While the vessel is underway at a speed of at least six knots and off shore one mile small ships far exceed state standards. While the vessel is stationary small ship operators are obligated to provide a best management plan of action, approved by ADEC, to minimize this impact. These include reducing water usage while in port, utilizing shore facilities, and minimizing stationary activity. For example in Juneau, Cruise West guest leave the vessel immediately upon arrival and proceed to check into a local hotel thus substantially reducing the need to discharge.

The small ships, and their unique circumstances, were caught up in the wake of the original law. HB 522 allows us the chance to achieve the standards set for us in a reasonable manner. Your understanding and support is appreciated.

Larry Johansen
Southeast Regional Manager
Cruise West
Juneau

LINDBLAD EXPEDITIONS ECONOMIC IMPACT

The following is a summary of what Lindblad Expeditions (LEX) will spend in Alaska in 2004:

1. Tours, transfers, entry fees, etc. To suppliers such as Sitka Tours, Princess in Juneau, various businesses and individuals in Sitka, Petersburg, and Juneau: \$270,000.
2. Options sold onboard for activities such as flight seeing in Petersburg and Juneau and fishing in Sitka and Juneau: \$80,000.
3. Docking, water, garbage removal, agency fees, laborers, miscellaneous wharfage fees, etc.: \$120,000.
4. Bunkers: \$180,000.
5. Provisions and other miscellaneous local purchases: \$50,000.
6. Guest spending ashore during voyage: \$180,000.
7. Guest independent travel in Alaska pre and post voyage: \$150,000.
8. Land costs for pre-sold extension to Anchorage and Denali national Park: \$520,000.
9. Tickets on Alaska Airlines: \$700,000. (even though this isn't a direct purchase in Alaska, there is indirect benefits as a result to employees of Alaska Airlines in Alaska and local support services)
Total excluding Alaska Airlines tickets: \$1,550,000.
Total including Alaska Airlines tickets: \$2,250,000.
10. In addition, LEX spends about \$500,000 promoting Alaska, mostly through direct mail to consumers.
 - 16-page Alaska brochure mailed to approximately 510,000 households. *
 - Catalog of all LEX offerings, including 5 pages dedicated to Alaska mailed to approximately 890,000 households.*

* Figures are for 2003. 2004 will be similar

CRUISE WEST ECONOMIC IMPACT

	<u>2003</u>	<u>2002</u>
Hotel costs.....	\$ 2,690,689	\$ 2,966,745
Land Tour and Included Shorex costs... ..	\$ 2,787,648	\$ 3,259,351
Optional Shorex and Alaska POS costs.....	\$ 1,144,532	\$ 1,176,992
Optional Air Costs.....	\$ 2,866,814	\$ 2,328,588
Marketing Costs.....	\$ 2,383,166	\$ 2,158,972
Fuel Costs.....	\$ 1,293,824	\$ 1,325,019
Alaska Payroll.....	\$ 1, 250,000	\$ 1,300,000
TOTAL ALASKA ECONOMIC IMPACT	\$ 14,416,682	\$ 14,515,667



M/S Nantucket Clipper • M/S Yorktown Clipper • M/S Clipper Adventurer • M/S Clipper Odyssey

20 February 2004

The State Legislature of Alaska
Juneau, Alaska

Re: Economic Impact of the Operations of Clipper Cruise Line

Honorable Senators and Representatives:

A review of actual expenditures in Alaska for 2003 for the operations of the two small cruise ships operated by Clipper Cruise Line, the MV Yorktown Clipper and the MV Clipper Odyssey, reveals the following data:

▪ Fuel and lubricating oil purchases:	\$ 525,000
▪ Port Charges: (includes dockage, pilotage, stevedoring, trash removal, etc.)	\$ 614,000
▪ Provisions: (includes local purchases, freight & handling)	\$ 253,200
▪ Alaska Airlines tickets (includes passengers & crew)	\$ 425,000
▪ Ground Operations: (includes pre and post-cruise hotel nights, shore excursions, transfers, flight-seeing, etc.)	\$ 650,900
▪ Brochure Production : (includes all costs, printing, postage, etc . connected with promoting Alaska)	\$ 550,000
▪ Individual Cruise Passenger Expenditures Ashore: (2873 passengers in 2003 x \$350 per person)	\$1,005,600

Grand Total \$ 4,024,100

Please feel free to contact me if I may provide any further information.

Sincerely,

A handwritten signature in black ink, appearing to read "G. Welsh". The signature is written in a cursive style and is positioned above the typed name and title.

Captain Gary B. Welsh
Vice President
Marine Operations
New World Ship Management



Architectural & Engineering Services for the Marine Industry

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Suite 200

Seattle, WA 98107

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fax 206.782.3449

www.ebdg.com

March 4, 2004

Ref: J04029-02L

Mr. Bryce Brockway
Cruise West
2401 4th Avenue, Suite 700
Seattle, WA 98121

Subject: Limitations on Modifying Small Commercial Passenger Vessels

References: a. Marine Safety Manual, COMDTINST M16000.9, United States Coast Guard,
24 Sept 1990

Dear Mr. Brockway,

I understand that you seek clarification as to when a vessel might require additional stability testing or re-licensing. Currently, the U.S. Coast Guard requires stability testing when a new vessel is constructed prior to issuing the certificate of inspection (COI) or license that allows the vessel to be used for carrying passengers. Only if changes are made to the vessel is re-testing of the stability required. Reference (a) contains the following language as to when a re-test is required:

Marine Safety Manual 6.D.4. Evaluation of Weight Changes to Lightship. During its service life a vessel may be modified without changing its buoyant hull form. A complete inclining is required unless the changes are minor or do not adversely impact the vessel's stability. Weight calculations are acceptable if the MSC determines they are accurate, or acceptable penalties in VCG are applied to the calculations. The nature of the weights changed is critical to the accuracy of calculations. Often, miscellaneous changes with a total weight greater than 2 percent of lightship displacement will necessitate a deadweight survey (or even a complete inclining) to verify calculations. Weight changes should be combined for the total change, when determining if a test is necessary, since the errors associated with weight additions and weight deletions are cumulative. If a deadweight survey proves the calculations to be inaccurate, a complete inclining may be necessary.

Please note that the 2 percent value refers to the total weight change, which is the sum of weights removed, weights relocated, and weights added. Vessels typically gain weight over time due to layers of paint, accumulated engine parts, additional stores, and minor changes to the equipment

or furnishings. This normal weight growth must be included in the total weight value. On most vessels, changes to the wastewater tankage and treatment system, combined with normal weight growth will almost certainly exceed 2% of the lightship displacement.

As noted in my previous letter, the vessel's COI is also based upon the admeasured volume of the vessel. If that volume is changed by lengthening the hull or adding sponsons to increase buoyancy then the gross tonnage must be re-measured and the stability must be re-tested. Once again, I caution that tonnage refers to volume in this case, not weight. This dates back to when vessels carried casks of wine, known as tuns, or tons, in their holds. In our modern measurements, one gross ton is equal to 100 cubic feet. If modifications to a vessel increase the admeasurement to over 100 gross tons then the vessel is no longer considered a small passenger vessel and must be re-licensed. Many of the small overnight passenger vessels have admeasurement values of 90 to 99 tons so there isn't much margin for change.

In closing, let me be clear that adding weight to a vessel can adversely impact the stability and have major consequences for an operator. As you know, the U.S. Coast Guard has strict requirements to ensure safe operation of passenger vessels. Most vessels have been designed to the limit of those requirements with little margin for change. A stability test can be the catalyst for expensive alterations to keep the stability in compliance with USCG requirements.

Sincerely,



EXPIRES 11/16/04

John W. Waterhouse, P.E.
President

Commercial Passenger Vessels

State of Alaska > DEC > Division of Water > Commercial Passenger Vessel Environmental Compliance Program

Assessment of Cruise Ship and Ferry Wastewater Impacts in Alaska

January 26, 2004

The 2001 state cruise ship legislation directed the Alaska Department of Environmental Conservation to submit a report to the Governor assessing commercial passenger vessels' discharges in Alaska marine waters. Using information from the 2000 – 2003 cruise ship seasons and other sources, this report satisfies the requirements to:

- Characterize, to the extent possible, the risks to the marine and human environments posed by the discharge of sewage and graywater from commercial passenger vessels;
- Evaluate the sewage and graywater treatment systems and technologies on the vessels, including an evaluation of whether small commercial passenger vessels should be made subject to the discharge limitations in AS 46.03.463; and
- Recommend further action by the state in relation to the matters discussed in the report.

This report also presents general background information and detailed appendices of wastewater sampling data, in response to the numerous requests received by ADEC staff from industry, environmental groups, and other government agencies.

Bilge and ballast water issues are a maritime wide concern and are beyond the scope of the 2001 legislation and this report.

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ALASKA STATE LEGISLATURE

SENATE COMMITTEE ON COMMUNITY & REGIONAL AFFAIRS

Senator Bert K. Stedman, Chair

Official Business

Senator Tom Wagoner, Vice-Chair
Senator Kim Elton
Senator Georgianna Lincoln
Senator Gary Stevens

State Capitol, Room 30
Juneau, AK 99801-1182
Phone: (907) 465-4989
Fax: (907) 465-3922

TO: Senate Secretary

FROM: Senator Bert K. Stedman

DATE: March 25, 2004

SUBJECT: C&RA Committee Schedule Week of March 29th, 2004

The following is the schedule for the Senate Committee on Community & Regional Affairs for the week of March 8th, 2004:

Mar 29 th	Monday	Fahrenkamp 203	1:30 PM
		NO MEETING SCHEDULED	
Mar 31 st	Wednesday	Fahrenkamp 203	1:30 PM
+*		SB 361 SMALL CRUISE SHIP DISCHARGES	
Apr 2 nd	Friday	Fahrenkamp 203	1:30 PM
		NO MEETING SCHEDULED	

+ Teleconferenced
* First Hearing
= Previously Heard

ALASKA STATE LEGISLATURE

REPRESENTATIVE BRUCE WEYHRAUCH



ALASKA
STATE CAPITOL
JUNEAU, ALASKA
99801-1182

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STATE AFFAIRS COMMITTEE

HB 522

Small Cruise Ship Discharge

Sponsor Statement

In 2001, the Alaska Legislature enacted the Commercial Vessel Environmental Compliance Program via HB 260. This was a collaborative effort by the cruise ship industry, the Legislature, and the Department of Environmental Conservation that established stringent guidelines for black and grey wastewater disposal in Alaskan waters. Since passage of HB 260, most large cruise ships discharging into Alaskan waters have installed advanced wastewater treatment systems resulting in dramatically improved water quality samplings, according to a recent report authored by DEC.*

In addition to the large cruise vessels, HB 260 also required the small cruise vessels to comply with the same standards. Even though the smaller vessels contribute approximately 3% of the wastewater discharged in Alaskan waters in 2001, the assumption was made that environmental technologies developed by the large vessels could "filter down" and be applied to the smaller vessels. HB 260 gave the industry, including the small commercial vessels until July 2004 to comply.

As it turned out, the technological advances route wasn't a simple fit for the smaller vessels and consequently, these vessels cannot feasibly comply with the Commercial Vessel Environmental Compliance Program. According to the Assessment Report, the small vessel's trouble spot are readings that exceed the Alaska Water Quality Standards (AWQS) while stationary. The discharge met the AWQS while underway due to the large dilution factor. As a consequence and in order for these vessels to continue plying Alaskan waters, an alternative regulatory scheme that takes focuses on minimizing discharge is required.

Recently, such an alternative plan has been devised. The Small Commercial Vessel Association and the DEC have reached an accord that both protects Alaska waters and enables the small cruise ship industry to continue operations in the state. The plan set out in HB 522 deals in terms of "Best Management Practices" or BMPs for small vessels that currently operate in Alaskan waters. HB 522 also stipulates that new vessels constructed after January 1, 2004 be engineered to comply with the Compliance Program if they are to be used in Alaskan waters. This is an agreeable solution that will work for Alaska's environmental and business communities.

*Assessment of Cruise Ship and Ferry Wastewater Impacts in Alaska
Alaska Department of Environmental Conservation
Commercial Passenger Vessel Environmental Compliance Program
January 23, 2004

Released: 2/26/04
Contact: Linda Sylvester
465-4963

ALASKA STATE LEGISLATURE

REPRESENTATIVE BRUCE WEYHRAUCH



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STATE AFFAIRS COMMITTEE

HB 522

Sectional Analysis

Section 1. This section states the findings by the legislature and the intent to allow older small commercial passenger vessels to continue to operate in Alaska while taking steps to minimize discharges and minimize harm to the marine waters of the state.

Section 2. A third option for terms and conditions of vessel discharges is recognized by this section through an amendment to AS 46.03.462(a).

Section 3. This section repeals the amendment in the previous section and would be effective January 1, 2016, under the effective date in section 16 of the bill.

Section 4. By amending AS 46.03.462(d), the Dept. of Environmental Conservation would have the power to waive portions of the discharge requirements and limitations in AS 46.03.463 for older small commercial passenger vessels.

Section 5. This section repeals the amendment in the previous section and would be effective January 1, 2016, under the effective date in section 16 of the bill.

Section 6. This section adds new subsection (e) and (f) to AS 46.03.462. Under subsection (e), a small commercial passenger vessel can submit a plan for alternative terms and conditions of vessel discharges based on best management practices if the keel of the vessel was laid before January 1, 2004. If DEC finds that the plan incorporates the best management practices as defined in this subsection, the department shall approve the plan for a three-year period. This amendment authorizes the department to adopt regulations and limits the extent to which the department may require retrofitting of a vessel. Despite the 3-year duration of a plan approved by the department under subsection (e), subsection (f) bars the duration of any plan to extend beyond December 31, 2015.

Section 7. This section amends AS 46.03.463(b) to conform to the amendments to AS 46.03.462 in sections 4 and 6 of the bill.

Section 8. This section repeals the amendment in the previous section and would be effective January 1, 2016, under the effective date in section 16.

Section 9. This section amends AS 46.03.463(c) to conform to the amendments to AS 46.03.462 in sections 4 and 6.

Section 10. This section repeals the amendment in the previous section and would be effective January 1, 2016, under the effective date in section 16.

Section 11. This section amends AS 46.03.463(e) to conform to the amendments to AS 46.03.462 in sections 4 and 6.

Section 12. This section repeals the amendment in the previous section and would be effective January 1, 2016, under the effective date in section 16.

Section 13. This section repeals subsections to AS 46.03.462 added by section 6.

Section 14. A new section to the uncodified law, providing for a retroactive effect of the Act for the 2004 season. The section sets the deadline for the owner or operator of an eligible vessel to submit a plan to DEC and describes the retroactive effect of the approval of the plan.

Section 15. This section makes sections 1, 2, 4, 6, 7, 9, and 11 retroactive to January 1, 2004.

Section 16. This section makes sections 3, 5, 8, 10, 12, and 13 take effect on January 1, 2016, thus sunsetting the changes made in sections 1, 2, 4, 6, 7, 9, and 11.

Section 17. Except for the future effective dates in the previous section, this section provides for an immediate effective date.

Alaska State Legislature

Senate Resources Committee

Senator Scott Ogan, Chair

Senator Fred Dyson
Senator Kim Elton
Senator Georgianna Lincoln
Senator Ralph Seekins
Senator Ben Stevens
Senator Tom Wagoner



State Capitol, Room 103
Juneau, AK. 99801-1182
Phone: (907) 465-4907
Fax: (907) 465-3265

Memorandum

DATE: March 25, 2004

TO: Senator Bert Stedman
Chairman, Senate Community & Regional Affairs Committee

FROM: Senator Scott Ogan,
Chairman, Senate Resources Committee

RE: Hearing request for SB 361
"Small Cruise Ship Discharges"

I respectfully request a Senate Community & Regional Affairs Committee hearing for SB 361, "Small Cruise Ship Discharges" at your earliest convenience.

A copy of the bill, sponsor statement, sectional analysis and other supporting documentation is attached. Please contact my office if you need additional information.

Thank you for your attention to this matter.

Alaska State Legislature

Senate Resources Committee

Senator Scott Ogan, Chair

Senator Fred Dyson
Senator Kim E'lon
Senator Georgianna Lincoln
Senator Ralph Seekins
Senator Ben Stevens
Senator Tom Wagoner



State Capitol, Room 103
Juneau, AK. 99801-1182
Phone: (907) 465-4907
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SB 361: Sectional Analysis

Section 1: This section states the findings by the legislature and the intent to allow older small commercial passenger vessels to continue to operate in Alaska while taking steps to minimize discharges and minimize harm to the marine waters of the state.

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Alaska State Legislature

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Senator Tom Wagoner



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Phone: (907) 465-4907
Fax: (907) 465-3265

SB 361: Sponsor Statement

Small Cruise Ship Discharge

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STATE OF ALASKA

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF WATER
DIRECTOR'S OFFICE

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April 5, 2004

The Honorable Burt Stedman, Chairman
Senate Community and Regional Affairs Committee
Alaska State Senate
State Capitol, Room 30
Juneau, Alaska 99801

Dear Senator Stedman:

This letter responds to questions posed during the March 31 Senate Community and Regional Affairs Committee hearing on SB 361, relating to discharges from small commercial passenger vessels.

Q. What is the department's position on the concept of limiting the new "alternative terms and conditions" option (AS 46.03.462(e)) to vessels that are currently in service in Alaska?

A. As a general rule, the department does not believe that environmental law should rely on limiting competition or access to markets as a means to achieve compliance with environmental standards. In this case, the department intends to regulate all small vessels such that all discharges result in compliance with state water quality standards. There is no need to restrict the new provision to vessels currently operating in Alaska waters in order to achieve compliance with environmental standards.

Q. What is the department's position on an amendment replacing the standard for approving a Best Management Plan from one of "protecting the environment" to one of "safeguarding public health and protecting important wildlife habitat" in AS 46.03.462(e).

A. DEC prefers "protecting the environment." We see no reason to narrow the standard to public health and wildlife habitat concerns. The department's general authorities include protecting water quality for all uses including public health and aquatic life as well as other uses such as recreational and commercial/industrial uses.

Q. AS 46.03.462(e) prohibits requiring an owner or operator to retrofit a vessel solely for the purpose of waste treatment if the retrofitting requires additional stability testing or relicensing by the U.S. Coast Guard. Does this limit DEC's ability to require new technologies as part of the Best Management Practices plan?

A. Yes, but the department believes that the small vessels can comply with water quality standards by changing practices – such as not discharging wastewater while at anchor or at port. If new wastewater treatment technologies for smaller vessels become available, we expect the industry will weigh the costs and advantages of installing the new technology against those of operating under a Best Management Practices plan. Either way, water quality will have to be protected.

Q. Clarify the various ways that a small vessel may comply with the Commercial Passenger Vessel Environmental Compliance law if SB 361 is passed.

A. The small vessel owner/operator may:

1. Adhere to the standard terms and conditions in AS 46.03.462(b)(1).
2. Request that DEC allow the vessel to follow alternative terms and conditions for a period of time that the department deems appropriate under the provisions of AS 46.03.462(c). Under this provision, DEC may allow alternative terms and conditions that: 1) provide an equivalent level of environmental protection as the standard terms and conditions, 2) allow additional time for an owner/operator to make changes to a vessel, or 3) allow the use of experimental technology.
3. Under SB 361's new subsection AS 46.03.462(e), DEC would develop regulations that allow a vessel whose keel was laid before January 1, 2004 to submit a Best Management Practices plan for DEC approval. The plan would protect the environment to the "maximum extent feasible," but could not require retrofitting a vessel solely for the purpose of waste treatment if the retrofitting were to require stability testing or relicensing by the U.S. Coast Guard. An approved plan would be valid for 3 years.

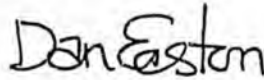
Q. What would be the effect of changing the word "may" to "shall" in the first sentence of AS 46.03.462(e)?

"The owner or operator of a small commercial passenger vessel may submit a plan for alternative terms and conditions of vessel discharges if the keel was laid before January 1, 2004."

A. This would have the effect of requiring all small commercial passenger vessels submit a Best Management Plan, even if the vessel intended to comply with the standard wastewater discharge terms and conditions. Use of the permissive term "may" allows owners/operators to choose from among the three options: complying with the standard terms and conditions as provided in AS 46.03.462(b)(1), complying with alternative terms and conditions as provided by AS 46.03.462(c), or complying with an approved Best Management Plan as provided by the new AS 46.03.462(e). We suggest that retaining the permissive "may" is necessary to preserve the intended choice.

If you have any other questions regarding the department's interpretation of the bill, please let me know.

Sincerely,

A handwritten signature in black ink that reads "Dan Easton". The signature is written in a cursive, slightly slanted style.

Dan Easton, Director
Division of Water

cc: Senator Tom Wagoner
Senator Gary Stevens
Senator Kim Elton
Senator Georgiana Lincoln



CRUISE LINE AGENCIES OF ALASKA

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Tuesday, March 30, 2004

Senate Community & Regional Affairs Committee
Chair: Senator Bert Stedman – Sitka
Alaska State Capitol, Room 30
Juneau, AK 99801-1182

RE: Small cruise vessel legislation SB 361/HB522

Dear Senator Stedman:

This is to ask your support for Senate Bill 361 and House Bill 522. These bills, when combined, will allow small-cruise vessels to continue to serve Alaska. They are an important part of our local and statewide economy.

SB 361 and HB 522 would allow the older small-ships to use best management practices to minimize stationary wastewater discharges. This alternative to complete retrofitting of the vessel is responsible and environmentally sound.

We urge you to support SB 361 and HB 255. This is vital to maintaining a strong visitor industry and responsibly managing the environment in Alaska. Your time and attention to this matter is greatly appreciated.

Sincerely,

Bob Berto
President
Cruise Line Agencies of Alaska



ALASKA STATE LEGISLATURE

SENATE COMMITTEE ON COMMUNITY & REGIONAL AFFAIRS

Senator Bert K. Stedman, Chair

Official Business

Senator Tom Wagoner, Vice-Chair
Senator Kim Elton
Senator Georgianna Lincoln
Senator Gary Stevens

State Capitol, Room 30
Juneau, AK 99801-1182
Phone: (907) 465-4989
Fax: (907) 465-3922

*March 31, 2004
1:30 – 3:30 PM
Fahrenkamp 203*

AGENDA

I. Call To Order

II. New Business

SB 361 Small Cruise Ship Discharge

Sponsor Testimony:

*Senator Scott Ogan, (R-Palmer) District H
Linda Hay, Staff Senator Ogan*

Invited Testimony:

*Brice Brockway, VP Marine & Hotel Operations
Cruise West
Mike Jones, Lindblad Expeditions*

Public Testimony

III. Adjourn

Senate C&RA SB 361 Discharges by Small Cruiseships

Chip Thoma, Box 21884, Juneau 99802 586-2117(h)
testifying as an individual

Served as a citizen representative on the Cruiseship Initiative... DEC/Coast Guard, 2000-01..collaborative process, by concensus, and eventual testing of cruiseship discharges

Backround Big Ships 22-25 Donut Holes ADN & NYTimes DEC Coast Guard Federal Legislation/ then-Senator Murkowski Black / Grey water levels through the roof..no maintenance, some switched over, replaced, some now dumping at sea, outside 3-mile limit. Ballast tanks switched to sewage holding.

Part of the process was a 3-year exemption for small ships, primarily because they were very helpful dealing with the large cruiseships and were US built and crewed.

SB 361 does try to address the gap in coverage that exists today in the DEC passenger vessel compliance program.

The concern I have is the statement by the ship owners that "these vessels cannot feasibly comply" with the program to eliminate unacceptable levels of grey and black water. That technology has not advanced.

I suppose, to attest to that, we received a statement from the industry, addressed to Cruise West, from a Mr. John Waterhouse, a marine engineer from Seattle. That's the one with the round Washington State Seal at the bottom.

IMPORTANTLY, he states throughout his letter, that "vessels cannot READILY be changed", that " vessel construction practices makes the ADDITION of new treatment equipment and holding tanks infeasible", that "ADDING additional volume is not simple", and "INCREASING the capacity of water waste tanks below the main deck will result in other space being made smaller".

I certainly appreciate those concerns, and understand the problems with ADDING volume, but his letter doesn't address the REPLACEMENT with new systems of equal or comparable weight. There shouldn't be a problem with that concept. Yet there doesn't seem to be any provision, or encouragement, to replace these older sewage systems, with those of comparable weight.

I believe TECHNOLOGY can cure the ships' discharge problems, without adding any weight or volume or stability problems. It is AMAZING to witness the advances in technology we are making these days, especially the ability to miniaturize and thus decrease weight. So I have a few suggestions to cure a few problems:

On Page 3, section 6 in the middle of the page, could use some changes, which I hope would be friendly amendments. On Page 3, line 20, in order to better define the environment, I suggest that the phrase "protecting the environment" is too vague, and should be replaced with "safeguarding public health and protecting important wildlife habitat". In order to do that, in Line 21, the first MAY, change to SHALL.

In the next clause of that sentence, and it is on P. 3, lines 21-24, the way I read it, this may preclude DEC's ability to EVEN TALK to the small ships about replacing or retrofitting their systems, because they'll just claim it will require "additional stability testing, or re-licensing by the Coast Guard".

You can then get a MARINE ENGINEER to say that there will be testing, or re-licensing, and that's it, end of discussion. So it's kind of a POISON PILL sentence.. you can't talk about it, it's off limits, and DEC loses the ability to recommend the replacement, even if it's based on new technology. And their ability to fold these ships into the program.

On P. 6, there are some very good clauses, 1-4 at the top of the page,

- that the vessel may discharge at not less than 6 knots
- at least one mile from shore, EXCEPT IN AREAS DESIGNATED BY THE DEPARTMENT

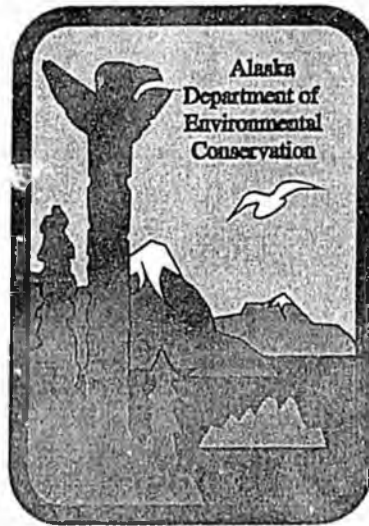
- and number 4, not in a prohibited area

Number 2 is a very important clause, because of a little known fact about these small ships:

Their NICHE market, that they tout in all their brochures, is viewing wildlife up close, and coincidentally, it's in the very same DONUT HOLES that the large ships were targeting to discharge sewage.

So there's all these smaller cruise ships, putting it on all their itineraries, that they're headed to the BROTHERS ISLANDS in Frederick Sound to view humpback whales and the big SEA LION rookery there, and the sea otters of Neka Sound, and the whales of Point Adolphus in Icy Strait.

I believe we have a real problem in these so-called DONUT HOLE areas..they are full of marine life..and are being targeted by small cruiseships with high sewage levels, and no prospect of changing for 10-12 years under this bill. So I would recommend that DEC, maybe though regulation, even referenced in the bill, determine some of those sensitive areas. DESIGNATE them as in clause #2, and stay 2 or 3 miles away to discharge. And please don't exempt these ships for 11-12 more years. Give them 5 years, until 2010, and let's see then where technology has advanced in this area. Thank You.
Questions?



Assessment of Cruise Ship and Ferry Wastewater Impacts in Alaska

Alaska Department of Environmental Conservation

Commercial Passenger Vessel Environmental Compliance Program

February 9, 2004

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Executive Summary

Cruise ships by their sheer size and passenger number are a highly visible industry in Alaska. Concerns about cruise ship pollution led to the creation of the Alaska Cruise Ship Initiative (ACSI) in 2000. Wastewater samples taken as part of the ACSI in 2000 indicated that the blackwater¹ treatment systems were not working properly and that graywater² quality was similar to blackwater. This information led to state and federal laws that now regulate cruise ship and ferry blackwater and graywater discharge in Alaska.

Before the passage of the state cruise ship law, blackwater and graywater from large cruise ships did not meet Alaska Water Quality Standards for ammonia, free chlorine, fecal coliform, copper, and zinc at the end of pipe. These ships would have exceeded Alaska Water Quality Standards for free chlorine, fecal coliform, and dissolved copper if they discharged while stationary. However, Alaska Water Quality Standards, except fecal coliform, were probably met in the receiving water while ships discharged underway due to substantial dilution.

Since the passage of the state law in 2001 and federal cruise ship law in 2000, most large cruise ships discharging into Alaska waters³ have installed advanced wastewater treatment systems. The effluent quality produced by the advanced systems has dramatically improved from waste water discharged from most ships in 2000-2002. Therefore, ADEC considered the 2003 data to assess the impact of large cruise ship effluent in receiving waters. In 2003, these systems produced wastewater that met Alaska Water Quality Standards for most tested pollutants at the end of pipe. After applying a conservative dilution factor, Alaska Water Quality Standards were met in receiving water for all tested pollutants. Whole Effluent Toxicity (WET) testing conducted during 2003 in conjunction with dilution estimates indicates that effluent from ships with advanced wastewater treatment systems does not pose a risk to aquatic organisms, even during stationary discharge. No tested pollutant is present in concentrations that cause risks to human health.

Small cruise ships and Alaska Marine Highway System (AMHS) ferries use traditional treatment, not advanced systems to treat their blackwater. The quality of small ship effluent has remained relatively consistent from 2001 to 2003. Therefore, ADEC used all the data available to assess the impact of small vessel effluent on receiving waters. The wastewater produced by small vessels frequently exceeds eight (ammonia, free chlorine, fecal coliform, arsenic, copper, nickel, selenium, and zinc) Alaska Water Quality Standards at the end of pipe. After applying a conservative dilution factor, four (free chlorine, fecal coliform, copper, and zinc) Alaska Water Quality Standards may be exceeded in receiving water during stationary discharge. The discharge met Alaska Water Quality Standards for all tested pollutants in the receiving water during underway discharge due to the large dilution factor. In addition, WET testing conducted on six small vessels in conjunction with the sampling results indicates that small ship stationary effluent does pose some risk to the marine environment. Due to the high concentration of fecal coliform, the effluent from some small ships may pose a risk to human health in areas where aquatic life is harvested for raw consumption.

¹ Black water is sewage.

² Graywater originates from showers, galley, laundry, etc.

³ Alaska water is defined as 3 nautical miles from shore and the waters of the Alexander Archipelago defined in AS 46.03.490(18).

The wastewater samples taken from large and small vessels to date indicate that hazardous chemicals are not being discharged through these wastewater systems.

ADEC recommends that small vessels remain in the commercial passenger vessel program. Small vessels were granted three years to come into compliance with the cruise ship wastewater effluent standards. Further, in 2004, these vessels may submit an interim protection plan that, if approved by ADEC, extends the time for compliance with the effluent standards. This plan must detail the steps that the owner is taking to comply with the wastewater discharge limits including a description of the practices used to limit the adverse impacts of their discharges. Violations and fines could be levied against ships that are found violating the terms of their approved plan.

1. INTRODUCTION

1.1. Assessment Report

The 2001 state cruise ship legislation directed the Alaska Department of Environmental Conservation (ADEC) to submit a report to the Governor assessing commercial passenger vessels' discharges in Alaska marine waters. Using information from the 2000 – 2003 cruise ship seasons and other sources, this report satisfies the requirements to:

1. Characterize, to the extent possible, the risks to the marine and human environments posed by the discharge of sewage and graywater from commercial passenger vessels;
2. Evaluate the sewage and graywater treatment systems and technologies on the vessels, including an evaluation of whether small commercial passenger vessels should be made subject to the discharge limitations in AS 46.03.463; and
3. Recommend further action by the state in relation to the matters discussed in the report.

This report also presents general background information and detailed appendices of wastewater sampling data, in response to the numerous requests received by ADEC staff from industry, environmental groups, and other government agencies. Bilge and ballast water issues are a maritime wide concern and are beyond the scope of the 2001 legislation and this report.

1.2. Cruise Ship Industry Trends in Alaska

The first steamships began carrying tourists to Alaska in 1884,⁴ making tourism one of Alaska's oldest industries. The number of cruise ship passengers that visit Alaska has increased by almost three and a half times since 1990. In 1990, 235,000 passengers traveled to Southeast Alaska. By 2003, the number of cruise ship passengers in Southeast Alaska increased to roughly 800,000⁵ with tens of thousands of crew (Figure 1). By comparison, the state's population is approximately 650,000.⁶ Roughly 95% of the current cruise ship traffic is concentrated in Southeast Alaska, a region with a population of approximately 73,000 people.⁷ This makes the cruise ship industry extremely visible in the region. For example, Skagway - with a summer population of 1,200 people – often has more than 12,000 people visiting in a day. The other 5% of cruise ship traffic is directed primarily toward Southcentral Alaska, but a few small cruise ships visit Western Alaska.

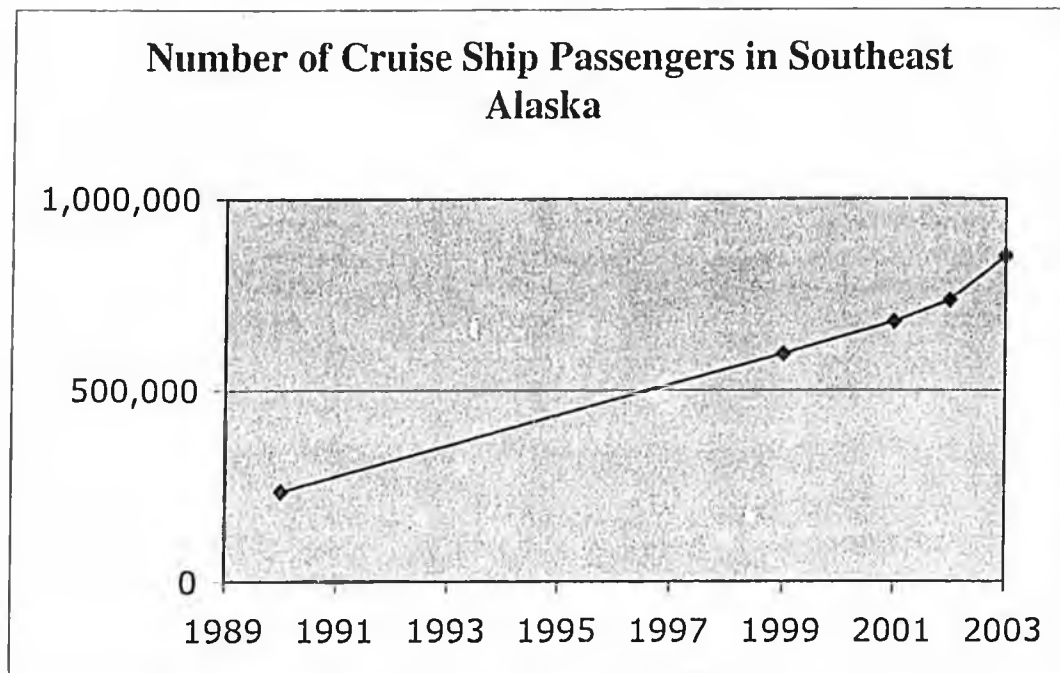
⁴ Alaska Permanent Fund Corporation Alaska History Page <http://www.apfc.org/library/AKHistoryD.cfm?s=5>

⁵ ADEC 2003 registration information

⁶ Alaska Department of Labor and Workforce Development, Workforce Info Home Page <http://almis.labor.state.ak.us/?PAGEID=67&SUBID=115>

⁷ Alaska Department of Labor and Workforce Development, Borough & Census Area Estimates 2000 – 2003, <http://146.63.75.50/research/pop/estimates/02T2-1.xls>

Figure 1. Cruise Ship Passenger Increase in Southeast Alaska



Source: Southeast Conference Report and ADEC Registration Statistics

The three most popular large cruise ship ports are Juneau, Ketchikan, and Skagway. Large ships tend to stop at the main Southeast Alaska ports and a large tidewater glacier (Glacier Bay or Hubbard). Some large cruise lines have trips that start in Southcentral Alaska (Seward) travel through southeast Alaska and end in Vancouver. The next voyage is reversed.

Alaska Marine Highway System (AMHS) ferries travel between Southeastern Alaska communities including Ketchikan, Juneau, and Skagway. These calls generally only last an hour or two. Small cruise lines explore remote bays and channels. They call on smaller Alaska ports and Native villages as well as the larger ports for most of a day. The small ships may venture from Alaska ports across the Bering Sea to the Russian Far East. The most popular ports for small ships are Sitka, Bartlett Cove, Skagway, Ketchikan, and Juneau.

Table 1 shows the number of cruise ship visits per port per year in 2003.⁸ There are often multiple ships in a port in a single day.

⁸ These numbers are derived from the 2003 Cruise Line Agencies of Alaska ship schedule. The actual visits may have varied slightly.

Table 1. Cruise Ship Visits Per Port in 2003

Place Name	Description	Number of small ship visits per year	Number of large ship visits per year
Adak	Port in Aleutian Islands	1	0
Anchorage	Port in Southcentral Alaska	8	0
Attu	Port in the Aleutian Islands	5	
Baranof Warm Springs	Port in Southeast Alaska	1	0
Bartlett Cove	Port inside Glacier Bay National Park	122	0
Cold Bay	Remote site	1	0
College Fiord	Tidewater Glacier in South central Alaska	7	147
Cordova	Port in Southcentral Alaska	16	0
Dutch Harbor	Unalaska Island (one of the Fox Is.) in the Aleutian Is.	7	3
Elfin Cove	Port in Southeast Alaska	25	0
Glacier Bay	Tidewater Glaciers, National Park in SE AK	See Bartlett Cove	207
Haines	Port in Southeast Alaska (Northern Lynn Canal)	67	13
Homer	Port in Southcentral (western Kenai Peninsula)	10	2
Hubbard Glacier	Tidewater Glacier near Yakutat on Gulf of Alaska	0	151
Icy Bay	Tidewater Glacier near Yakutat on Gulf of Alaska	0	2
Juneau	Port in Southeast Alaska	96	448
Ketchikan	Port in Southeast Alaska	100	408
Kodiak	Port in Kodiak Island (South central Alaska)	4	3
Misty Fiords	National Monument near Ketchikan	50	33
Nome	Western Alaska	2	3
Petersburg	Port in Southeast Alaska	96	0
Seward	Port in South Kenai Peninsula	0	98
Sitka	Port in Southeast Alaska (outside coast)	140	140
Skagway	Port in Southeast Alaska (Northern Lynn Canal)	100	328

Place Name	Description	Number of small ship visits per year	Number of large ship visits per year
St. Matthew	Island in the Bering Sea	9	0
St. Paul	Island in the Bering Sea	9	0
Tracy Arm	Tidewater Glacier in Southeast Alaska (between Juneau & Wrangell)	100	128
Valdez	Port in South central Alaska	16	0
Whittier	Port in South central Alaska	32	0
Wrangell	Port in Southeast Alaska	32	8

1.3. Concern about Cruise Ship Industry Environmental Practices

Tourism shares the rich marine environment with commercial fisheries, one of Alaska's largest private employers. Over 50% of America's seafood (5.1 billion of 9.4 billion pounds) is harvested from Alaska's waters.⁹ The commercial fishing industry depends on the perception and actuality that Alaskan fish come from uncontaminated waters.

Alaska's Native peoples subsist off the bounty of the sea, relying heavily upon marine resources for nutrition, sustenance, cultural integrity, and spiritual well being. Alaska Natives were alarmed over potential cruise ship pollution and the fouling of especially vulnerable food items such as filter feeding mollusks.

In July 1999, Royal Caribbean Cruise Lines (RCCL) entered a federal criminal plea agreement involving total penalties of \$6,500,000 for 1994 and 1995 environmental violations in Alaska including knowingly discharging oil and hazardous substances (dry-cleaning and photo processing chemicals) and making false entries in federally required Oil Record Books. RCCL admitted to a "fleet-wide practice of discharging oil contaminated bilge waste" and to submitting false statements in numerous jurisdictions. The \$6,500,000 for Alaska violations was part of a larger \$18,000,000 total federal plea agreement. In January 2000, RCCL entered into a state civil settlement for the Alaska violations. The state settlement required RCCL expenditures of over \$3,325,000. This illegal discharge outraged many Alaskans, who began to question whether cruise ships met Alaska Water Quality Standards enforced by the Alaska Department of Environmental Conservation (ADEC).

Because of its international nature, the cruise industry was excluded from many of the U.S. environmental laws and regulations that land-based industries are required to meet. EPA did not issue a permit under the federal Clean Water Act for cruise ship wastewater discharges because of a marine vessels exemption that dates from the 1970s. The U.S. Coast Guard certifies marine sanitation devices (MSDs) for American flagged ships and checks to ensure that all applicable vessels have certified MSDs during ship inspections. They did not, however, monitor the wastewater effluent quality.

Large cruise ships operate under MARPOL (International Convention for the Prevention of Pollution from Ships), an environmental treaty drafted by the International Maritime

⁹ "Fisheries of the United States 2002." September 2003. National Marine Fisheries Service, NOAA, U.S. Dept. of Commerce.

Organization (IMO), an agency of the United Nations. Annex IV of MARPOL addresses the disposal of sewage. Since the United States did not sign Annex IV, it is not mandatory, that ships follow Annex IV in the United States.¹⁰

1.4. Alaska Cruise Ship Initiative (ACSI)

In December 1999, ADEC responded to public concern and convened a forum to review and discuss the cruise industry's waste management and disposal practices in Alaska. The participants included the U.S. Coast Guard, the U.S. Environmental Protection Agency (EPA), Southeast Alaska communities, industry, Tribes, environmental groups, and concerned Alaskans. This effort became known as the Alaska Cruise Ship Initiative (ACSI). Goals of the ACSI included:

- (1) identifying cruise ship waste streams,
- (2) developing pollution prevention and waste management solutions,
- (3) assessing and verifying compliance of volunteer wastewater sampling, and
- (4) keeping the Alaskan public informed.

Voluntary sampling of large cruise ships in 2000 indicated that the marine sanitation devices (MSD) on most ships did not function well. U.S. Coast Guard regulations require that effluent from the type II MSD treatment systems installed on cruise ships contain no more than 200 fecal coliforms per 100 ml and 150 mg/l total suspended solids at installation.¹¹ Surprisingly, the fecal coliform results were as high as 16 million¹² in blackwater and 32 million in graywater.¹³

1.5. Alaska Specific Legislation

As a result of the ACSI efforts, the U.S. Congress enacted Title XIV – Certain Alaskan Cruise Ship Operations on December 21, 2000.¹⁴ The law creates wastewater standards for vessels with 500 or more overnight passengers, and prohibits cruise ships from discharging raw sewage in areas that are more than 3 nautical miles from shore but still within the Inside Passage. These “donut holes” are now closed to discharge. (See Figure 2.) The regulations to implement the law became effective in July 2001¹⁵ and are enforced by the U.S. Coast Guard.

¹⁰ EPA MARPOL 73/78 overview <http://www.epa.gov/OWOW/OCPID/marpol.html>

¹¹ 33 CFR Part 159 – Marine Sanitation Devices

<http://www.uscg.mil/d14/units/msohono/references/cfrs/sub%20o/part%20159.htm>

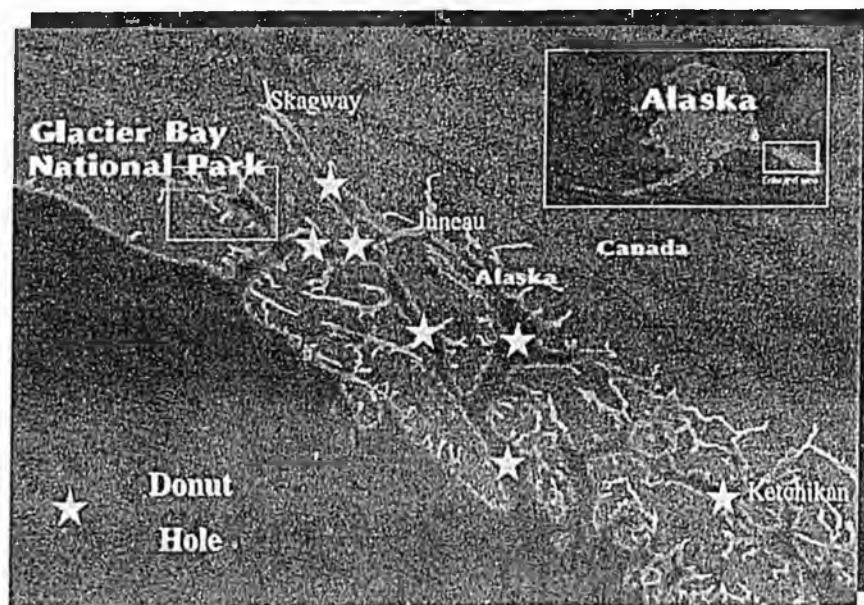
¹² The geometric mean of fecal coliform samples was 12,824 for blackwater and 1,163,188 for graywater. See Appendix B. Large Ship Sampling Data Tables 47B & 51.

¹³ Blackwater originates in toilets. Graywater comes from showers, sinks, kitchens, and laundry.

¹⁴ “Title XIV—Certain Alaskan Cruise Ship Operations” of the Miscellaneous Appropriations Bill (H.R. 5666) on December 21, 2000 in the Consolidated Appropriations Act of 2001 (P.L. 106-554).

¹⁵ 33 CFR Part 159 Subpart E – Discharge of Effluents in Certain Alaskan Waters by Cruise Vessel Operations.

Figure 2. Donut Holes Closed by Federal Cruise Ship Legislation



Under the federal legislation, large cruise ships may discharge blackwater and graywater in Alaska while underway.¹⁶ During an underway discharge, blackwater effluent must contain no more than 200 fecal coliforms per 100 ml and no more than 150 mg/l total suspended solids. There are currently no federal effluent standards for underway graywater discharges.¹⁷ Ships that discharge blackwater in Alaska while underway must take at least two blackwater samples per cruise ship season. The federal law allows continuous discharge of blackwater and graywater that meet more stringent standards (Table 2). A ship approved by the U.S. Coast Guard to discharge continuously must sample their wastewater twice per month

State of Alaska cruise ship legislation, AS 46.03.460 – AS 46.03.490,¹⁸ was passed during a 2001 special session of the Alaska Legislature and became effective on July 1, 2001. The legislation establishes the Commercial Passenger Vessel Environmental Compliance (CPVEC) program in the ADEC. The regulations to implement the program, 18 AAC 69, were effective November 15, 2002.¹⁹

The state law sets standards and sampling requirements for the underway discharge of blackwater in Alaska that are identical to the blackwater standards in the federal law (Table 2). Because of the high fecal coliform counts detected in graywater during 2000, the state law also set graywater standards (Table 2). It also has provisions regarding the disclosure of solid waste and hazardous waste disposal information.

¹⁶ Traveling at least 6 knots while at least 1 nautical mile from shore.

¹⁷ The Administrator of the EPA may promulgate different wastewater effluent standards in the future. EPA recently began the process of evaluating whether the current federal standards are consistent with Alaska Water Quality Standards.

¹⁸ Available at: <http://old-www.legis.state.ak.us/cgi-bin/fojiojsa.dll/stattx01/querly=as+46!2E03!2E460/doc/1@176771?>

¹⁹ Regulations were drafted by stakeholder committee and brought through formal rule making process. They are available at <http://www.state.ak.us/dec/title18/vpfiles/69mas.doc>

The CPVEC program applies to both large and small commercial passenger vessels. A small commercial passenger vessel provides overnight accommodations for 50 to 249 passengers. State law defines a large commercial passenger vessel as one that provides overnight accommodations for 250 or more passengers.²⁰ Several key aspects of the CPVEC program, such as payment of environmental compliance fees and compliance with wastewater discharge standards, did not apply to small commercial passenger vessels until January 1, 2004.²¹ These vessels did, however, have to adhere to the wastewater sampling, record keeping, and reporting requirements as soon as the law was effective.

Table 2. Comparison of State and Federal Laws

Law	State	Federal
# Overnight Passengers	50+	500+
Discharge Limits	At Least 1 mile from shore @ min. 6 knots	
	BW & GW	BW only
Fecal Coliform/100 ml	Geometric Mean of 200	200
Total Suspended Solids (mg/l)	150	150
Discharge Limits	Continuous Discharge (at anchor)	
	BW & GW	BW & GW
Fecal Coliform/100 ml	Refers to Fed Law	Geometric Mean of 20
Chlorine (mg/l)		10
Total Suspended Solids (mg/l)		30

1.6. Science Advisory Panel

During the ACSI, a Science Advisory Panel was organized to independently address the scientific questions surrounding the impact of cruise ship waste in Alaska. The Science Advisory Panel is a group of scientists and engineers whose work and conclusions are not subject to government or industry approval. The nine core members of the Panel include an oceanography professor, NOAA physical oceanographer, ADEC environmental engineer, civil engineering professor, oceanographer for a law firm, microbiologist, NOAA senior staff scientist, chemistry professor, and an EPA senior toxicologist. While Panel members were not compensated, a paid facilitator, who is a retired U.S. Coast Guard Captain-of-the-Port and industrial toxicologist, supported the Panel's work.

²⁰ AS 46.03.490

²¹ Small ship owners/operators may obtain an extension of time for compliance with AS 46.03.463(a) - (d) by submitting an approved plan for interim protective measures. See 18 AAC 69.045 for details.

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The North West Cruiseship Association funded the facilitator and travel expenses for non-governmental panel members in 2000 - 2001. ADEC funded the facilitator and travel expenses for non-governmental panel members in 2002. The efforts of the Science Advisory Panel culminated in the publication of *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters*²² in November 2002 and several other papers available on the following website: <http://www.state.ak.us/dec/press/cruise/documents/sciencepanel.htm> Science Advisory Panel work is referenced throughout this report.

²² <http://www.state.ak.us/dec/press/cruise/documents/impactcruise.htm>

2. WASTEWATER SAMPLING DESIGN, RATIONALE, and STATISTICS

2.1. Data Reliability and Representative Nature

It is crucial that wastewater sample data is reliable²³ and representative.²⁴ This data is used to determine compliance with the cruise ship laws and to conduct scientific analysis. Large vessels that discharge in Alaska take at least two compliance samples per cruise ship season to satisfy both state and federal cruise ship laws. ADEC, U.S. Coast Guard, and the Northwest Cruiseship Association have established a Quality Assurance/Quality Control (QAQC) plan that ensures that the sample results are reliable.²⁵

The QAQC plan includes standard sampling and laboratory quality control elements with additional instructions tailored to a maritime facility. It lists all the pollutants to be tested and the EPA analytical methods to be used. The QAQC requirements include duplicate sampling, sampling audits, and a lab technical systems audit. The U.S. Coast Guard cruise ship regulations require third party sampling. ADEC regulations are consistent with other state wastewater programs and allow industry to collect samples using their own staff. However, large cruise ships sample to satisfy the requirements of both the federal and state law. Therefore, a third party sampler takes all required large vessel wastewater samples. Small ship operators are not bound by the federal law but have also chosen to use third party samplers.

ADEC also performs independent compliance sampling and analysis. ADEC tests for pollutants listed in the QAQC plan as well as other pollutants of concern.

Because each ship is configured differently and follows unique wastewater management practices, the state also requires the owner/operator to submit a vessel specific sampling plan (VSSP). The VSSP plan, approved by ADEC before sampling begins, must demonstrate that the sample will be representative of the wastewater discharged from the particular ship.

From 2001 through 2002, wastewater sampling on large cruise ships was dictated by the ability to discharge underway and to get the samples to the laboratory within the EPA mandated six hour holding time for fecal coliform analysis. This frequently meant that wastewater samples were taken in the middle of the night when the volume of wastewater was low. The ideal wastewater sample would have been taken during daytime when the volume of wastewater production was high. These samples did not sample the treatment abilities at normal flow conditions and therefore are not representative. By 2003, only large cruise ships with advanced wastewater treatment systems discharged wastewater in Alaska. These vessels were approved for continuous discharge and were sampled during the day in port while the vessel was discharging into receiving water. These continuous discharge samples should be representative of the wastewater effluent produced by the wastewater treatment systems and discharged into receiving water.

²³ Reliability reflects the degree of certainty.

²⁴ The objective of representative sampling is to ensure a sample or group of samples accurately characterizes site conditions. ASTM Method 6044-96 Standard Guide for Representative Sampling for Management of Wastes and Contaminated Media. <http://www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/PAGES/D6044.htm?L+mystore+nhpu4885>

²⁵ The most current version, "Northwest CruiseShip Association, Discharge of Effluents in Certain Alaska Waters by Cruise Vessel Operations, 2003 Operating Season Quality Assurance/Quality Control Plan For Sampling and Analysis of Treated Sewage and Graywater From Commercial Passenger Vessels," is available at: <http://www.state.ak.us/dec/press/cruise/pdf/03qaqc.pdf>

Small cruise ships are sampled in port because of the economic hardship it would cause if third party samplers traveled with the vessels. The time spent in Juneau, where small cruise ships do their wastewater sampling, is often used to disembark passengers and to get ready for the next cruise. There is usually little to no wastewater produced during this day. State cruise ship regulations²⁶ effective November 2002 gave small ships the ability to have their crew sample their wastewater and submit it to a laboratory for analysis. This would enable underway sampling; however, none of the ships have exercised this option. Despite these issues, the data obtained over the last three seasons, when considered in its entirety, does provide a reasonable picture of the pollutants that are present in small cruise ship wastewater discharges.

Alaska Marine Highway System ferries were usually sampled in port; however, there were usually passengers still aboard the vessel. The wastewater samples from the ferries were therefore representative of the wastewater effluent produced by its wastewater treatment system.

2.2. Sampling Program Evolution from 2000 - 2003

The sampling strategy that guided the voluntary sampling program in 2000 differs from the regulatory program existing today. Table 3 and Table 4 highlight the evolution of the sampling program. The pollutants with asterisks are defined as conventional pollutants in 40 CFR Part 401.16 and are typically tested in the effluent of wastewater treatment plants. On the advice of the Science Advisory Panel, ADEC expanded this sampling list. This group is referred to as conventional pollutants throughout this report. Priority pollutants refer to an EPA list of 126 specific pollutants that include heavy metals and specific organic chemicals.

Table 3. Conventional Pollutants

Pollutant	2000	2001	2002	2003
Ammonia	√	√	√	√
pH*	√	√	√	√
Biochemical Oxygen Demand (BOD)*	√	√	√	√
Chemical Oxygen Demand (COD)	√	√	√	√
Total Suspended Solids (TSS)*	√	√	√	√
Total and Free Chlorine	√	√	√	√
Fecal Coliform*	√	√	√	√
Settleable Solids		√	√	√
Oil and Grease*		√	√	√
Total Organic Carbon (TOC)		√	√	√
Conductivity		√	√	√

²⁶ 18 AAC 69, <http://www.state.ak.us/dec/title18/wpfiles/69mas.pdf>

Pollutant	2000	2001	2002	2003
Alkalinity		√	√	√
Total Nitrogen ²⁷		√	√	√
Total Phosphorus		√	√	√

Table 4. Priority Pollutants

Pollutant	2000	2001	2002	2003
Base, Neutral, Acids (BNAs)	√	√	√	√
Pesticides ²⁸	√			
Polychlorinated Biphenyls (PCBs)	√	√	√	
Volatile Organic Chemicals (VOC)	√	√	√	√
Trace Metals	√	√	√	√
Cyanide	√			

2000 Season's Voluntary Program

The voluntary ACSI program in 2000 applied to large ships only. The goals of the 2000 sampling program were to characterize wastewater quality and to determine if hazardous substances were discharged to receiving water through the wastewater systems. The voluntary program included two samples per season.

2001 Season - Moving from Voluntary Sampling to Compliance Sampling

In 2001, the purpose of the sampling shifted to assess compliance with the laws as well as conducting scientific impact analyses. All ships discharging in Alaska water are required by Alaska statute²⁹ to sample twice a year. On the advice of the Science Advisory Panel, ADEC increased conventional pollutants monitoring requirements. The pesticides and their metabolites on the 2000 priority pollutant list³⁰ have not been used in the U.S. for many years and were not detected in any of the 2000 samples. The U.S. Coast Guard and ADEC therefore removed pesticides from the priority pollutant list in 2001.

2002 Season

The sampling strategy for the majority of the large ships was the same as in 2001. However, six of seven large ships, with advanced wastewater treatment systems, had U.S. Coast Guard

²⁷ Total nitrogen includes ammonia, nitrate, nitrite, and total kjeldahl nitrogen (TKN).

²⁸ aldrin, chlordane, dieldrin, 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, alpha endosulfan, beta endosulfan, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, alpha BHC, beta BHC, gamma BHC, delta BHC and toxaphene

²⁹ AS 46.03.465(d)

approval for continuous discharge and were sampled in port.³¹ Small ships took their first priority pollutant samples in 2002 and began sampling for the expanded list of conventional pollutants.

2003 Season

In 2003, the wastewater data from large ships reflected the continued increase in the number of large vessels with advanced treatment technology, from seven of 25 (28%) in 2002 to eighteen³² of 32 (56%) in 2003. Small vessels continued to discharge and be sampled in port.

As in previous years, one of the two sampling events included testing for priority pollutants. ADEC and U.S. Coast Guard dropped PCBs from the priority pollutant sampling list for 2003 season because of the 2000 - 2002 history of non-detects. The priority pollutants (Base/Neutrals & Acids, Volatile Organic Chemicals, and Trace Metals) analyzed in 2003 are listed in Appendix A.

At the recommendation of the Science Panel, ADEC also tested vessel wastewater for commonly used organophosphorus pesticides at the end of 2003 season. No pesticides were detected. ADEC will continue to test for organophosphorus during the 2004 cruise ship season.

³¹ The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: *Celebrity Mercury* and *Holland America Ryndam, Statendam, Volendam, Veendam, and Zaandam*. The *Radisson Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.

³² *Princess - Star Princess, Sun Princess, Dawn Princess, Coral Princess, Pacific Princess, Island Princess*
Celebrity - Mercury
Holland America - Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam
Carnival - Carnival Spirit (graywater only)
Norwegian - Norwegian Sun, Norwegian Sky, Norwegian Wind
Radisson - Seven Seas Mariner

3. APPLYING ALASKA WATER QUALITY STANDARDS TO RECEIVING WATER

The State of Alaska has Water Quality Standards adopted in regulation. These standards help protect human health and the environment. ADEC tested for pollutants in samples taken at the discharge point inside the vessel. These effluent samples are also referred to as "end of pipe" samples. Discharges from the ship mix with the receiving water. ADEC, therefore, applied modeled dilution factors to the vessels' end of pipe sample results to determine whether Water Quality Standards were met in receiving waters.

In this document, ADEC refers to the Water Quality Standards located in *ALASKA WATER QUALITY CRITERIA MANUAL FOR TOXIC AND OTHER DELETERIOUS ORGANIC AND INORGANIC SUBSTANCES* amended through May 15, 2003, TABLE IV. AQUATIC LIFE CRITERIA FOR MARINE WATERS.³³ ADEC took a conservative approach and applied the more stringent chronic rather than acute water quality standards.

³³ This document is available at <http://www.state.ak.us/dec/dawq/wqs/documents/70wqsmanual.doc>

4. WASTEWATER CHARACTERISTICS – LARGE SHIPS

4.1. Statistics

Since 2000, ADEC has collected substantial amounts of wastewater sampling data on cruise ships and ferries subject to the Commercial Passenger Vessel Environmental Compliance Program. In order to characterize the central tendency of the large quantity of data, the median was used. The median is the middle of a distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than an average and is thus a better measure for skewed distributions. Medians are used to present all pollutant data in this report except for fecal coliform. Much of the fecal coliform data was highly skewed so a geometric mean was used to summarize this data.

Geometric Mean

When distributions are more highly skewed, a geometric mean is used. A geometric mean moderates the effect of a single high value. A geometric mean is computed as follows:

$$(X_1 X_2 \dots X_n)^{1/n} =$$

Example:

$$(1 \times 2 \times 10 \times 10,000)^{1/4} = 21$$

4.2. Summary of Conventional Pollutant Data

2000 Sampling Data

Table 5 compares the median and geometric mean values of conventional pollutants tested in 2000 wastewater samples. Appendix B Large Ship Sampling Data presents the detailed sampling results from individual ships. Table 5 and subsequent tables also present the applicable Alaska Water Quality Standards³⁴ for comparison.

³⁴ ADEC, Alaska Water Quality Criteria Manual For Toxic and other Deleterious Organic & Inorganic Substances May 15, 2003, Table IV located at: <http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/documents/70wqsmanual.doc>. Fecal coliform standards and pH standards from ADEC Water Quality Standards, 18 AAC 70, <http://www.state.ak.us/dec/title18/wpfiles/70mas.pdf>. The most conservative standard is listed.

Table 5. 2000 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

Water Type (# samples) Large Ship Appendix B Table #	Collected from	Fecal Coliform (MPN/100 ml)	TSS mg/l	BOD mg/l	COD mg/l	Ammonia mg/l	pH	Total Cl mg/l	Free Cl mg/l
	AK WQS	14	n/a	n/a	n/a	17.00 ³⁵	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW - Accommodations. & Laundry (3) Table 51.	CT	6	138.7	61	240.0	25.12	6.8	0.37	0.26
GW - Accommodations (3) Table 52.	CT	104	455.0	355	1,340.0	24.94	8.4	0.78	ND
GW - Laundry (10) Table 53.	CT	8	39.0	86	300.0	0.39	9.2	0.28	ND
GW - Galley (11) Table 54.	CT	13,750	223.5	850	940.0	2.19	6.9	ND	ND
Mixed GW (24) Table 55.	CT	118,052	92.0	170	405.0	1.40	6.8	ND	ND
Mixed GW (13) Table 56.	DB	1,163,188	250.0	450	940	0.20	5.95	ND	ND
BW&GW (11) Table 60.	DB	12,824	110.0	130	395.0	8.50	7.0	ND	ND
BW (22) Table 61.	MSD	18,213	407.0	130	1,210.0	100.00	7.6	0.33	ND

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

CT= Collecting Tank DB =Double Bottom Tank

MSD = Marine Sanitation Device ND= Non Detect

*Note that the MDL for chlorine is higher than the chronic water quality standard.

The graywater sampled from accommodations & laundry, accommodations only, and laundry only had low fecal coliform counts. Galley graywater and mixed graywater had very high levels of fecal coliforms. Graywater sampled from double bottom tanks had higher fecal coliform results than the corresponding wastewater type sampled from collecting tanks. This is illustrated in Table 7.

³⁵ The ammonia Water Quality Standard is for unionized ammonia. All samples were analyzed for total ammonia. Salinity, temperature, and pH affect the unionized portion of total ammonia. ADEC used TABLE IX. TOTAL AMMONIA CHRONIC CRITERIA FOR SALTWATER AQUATIC LIFE to calculate the total ammonia that corresponds to the unionized ammonia Water Quality Standard. Southeast Alaska port conditions were used for this calculation: 10 psu salinity; pH of 7.0; and temperature of 12.5 degrees Celsius. Using these ambient conditions, the total ammonia equivalency to the unionized Water Quality Standard is 17 mg/L.

The treated blackwater results included two samples that had been treated with a reverse osmosis treatment system before being stored in the double bottom tank. These samples had results below the limit of detection for fecal coliforms, which lowered the geometric mean substantially. Even with the addition of these two samples, the treated blackwater had a high geometric mean of fecal coliform, 18,213 MPN/100ml, as well as a high median of ammonia, 100.0 mg/l, and COD, 1,210.0 mg/l. These results indicate that the blackwater treatment systems were not functioning properly.

2001 Sampling Data

The state cruise ship law was effective in the summer of 2001. From this year forward, blackwater samples were taken primarily to ensure compliance with effluent standards. (When blackwater and graywater are mixed, it is considered blackwater.) Graywater was phased into the state program. Any graywater discharged in the state needed to be sampled as of 2001 but was not subject to the effluent standards until 2003. This is the cause of the disparity between the graywater effluent samples and the blackwater effluent samples presented in Table 6.

The low fecal coliform and TSS level of the mixed black and graywater occurred because 12 of the 16 samples were taken from advanced wastewater treatment systems on the *Celebrity Mercury* and *Holland America Statendam*. No fecal coliforms or TSS were detected in the effluent from those systems. The other ship that sampled its mixed black and graywater discharged outside Alaska water and was sampled voluntarily.

Table 6. 2001 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

<u>Water Type (# samples)</u> <u>Large Ship Appendix B</u> <u>Table #</u>	<u>Collected from</u>	<u>Fecal Coliform</u> <u>(MPN/100 ml)</u>	<u>TSS</u> <u>mg/l</u>	<u>BOD</u> <u>mg/l</u>	<u>COD mg/l</u>	<u>Ammonia</u> <u>mg/L</u>	<u>pH</u>	<u>Total Cl</u> <u>mg/L</u>	<u>Free Cl</u> <u>mg/l</u>
	AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW - Accommodations (15) Table 32.	DB	10,896	66.0	217	460.0	0.11	6.8	ND	ND
GW - Accommodations (15) Table 33.	CT	2,189	55.5	170	300.0	0.99	7.6	3.00	0.30
GW - Galley (10) Table 34.	DB	784,072	383.0	1,300	1,707.0	0.65	4.4	ND	ND
GW - Galley (23) Table 35.	CT	402**	266.0	740	1,110.0	1.00	7.0	4.00	1.30
Mixed GW (4) Table 36.	DB	649,994	151.3	194	289.0	0.32	6.5	ND	ND
Mixed GW (13) Table 37.	CT	38,933	76.5	220	520.0	0.48	7.2	ND	ND
GW - Laundry (7) Table 38.	DB	651,460	43.0	160	410.0	0.40	8.3	0.20	ND
GW - Laundry (2) Table 39.	CT	30	22.0	100	650.0	Not taken	8.4	1.03	1.03
Mixed BW&GW (16) Table 46.	MSD	2	0.7	3	11.5	0.63	7.1	ND	ND

*Note that the MDL for chlorine is higher than the chronic water quality standard.

** Some samples did not meet the fecal coliform 6 hour holding time and were not analyzed.

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<u>Water Type (# samples) Large Ship Appendix B Table #</u>	<u>Alkalinity mg/l</u>	<u>Conductivity (Umhos/cm)</u>	<u>Oil & Grease mg/l</u>	<u>Phosphorous Total mg/l</u>	<u>Nitrate as N mg/l</u>	<u>TOC mg/l</u>	<u>Total Kjeldahl Nitrogen mg/l</u>	<u>Settleable Solids mg/l</u>
AK WQS								
MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
GW (15) Table 40.	59.6	883	47.0	5.54	0.0	305.0	12.0	0.2
BW (5) Table 47.	125.4	3,590	0.2	9.05	0.6	100.0	27.8	4.5

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
 CT= Collecting Tank DB =Double Bottom Tank
 MSD = Marine Sanitation Device ND= Non Detect

Table 7 compares 2000 and 2001 samples of wastewater that were held for up to 20 hours in double bottom (DB) tanks with wastewater collected and discharged immediately from collecting tanks (CT). The concentration of fecal coliform, TSS, and BOD increased when wastewater was stored in the double bottom tanks indicating a degradation of the effluent quality.

Table 7. Comparison of 2000 and 2001 Large Ship Wastewater Samples Held in Double Bottom vs. Collecting Tanks

# Samples	Sample Date	Sample From	Waste Type	Fecal ³⁶	TSS	BOD	COD	Ammonia	pH	Total Cl	Free Cl
			Units	MPN/100ml	mg/l	mg/l	mg/l	mg/l			mg/l
			AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075	0.0075
			MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
13	2000	DB	Mixed Graywater	1,163,188	250.0	450	940	0.20	5.95	ND	ND
15	2001	DB	GW accommodation	10,896	66.0	217	460.0	0.11	6.8	ND	ND
10	2001	DB	GW Galley	784,072	383.0	1,300	1,707.0	0.65	4.4	ND	ND
4	2001	DB	Mixed GW	649,994	151.3	194	289.0	0.32	6.5	ND	ND
7	2001	DB	GW laundry	651,460	43.0	160	410.0	0.40	8.3	0.20	ND
11	2000	DB	BW&GW	12,824	110.0	130	395.0	8.50	7.0	ND	ND
3	2000	CT	GW Accommodation and Laundry	6	138.7	61	240.0	25.12	6.8	0.37	0.26
3	2000	CT	GW accommodation	104	455.0	355	1,340.00	24.94	8.4	0.78	ND
10	2000	CT	GW laundry	8	39.0	86	300.0	0.39	9.2	0.28	ND
11	2000	CT	GW galley	13,750	223.5	850	940.0	2.19	6.9	ND	ND
24	2000	CT	Mixed GW	118,052	92.0	170	405.0	1.40	6.8	ND	ND
15	2001	CT	GW Accommodation	2,189	55.5	170	300.0	0.99	7.6	3.00	0.30
23	2001	CT	GW Galley	402	266.0	740	1,410.0	1.00	7.0	4.00	1.30
13	2001	CT	Mixed GW	38,933	76.5	220	520.0	0.48	7.2	ND	ND
2	2001	CT	GW laundry	30	22.0	100	650.0	Not taken	8.4	1.03	1.03
			Median DB	194,343	130.7	206	435.0	0.36	6.7	ND	ND
			Median CT	587	92.0	170	520.0	1.20	7.2	.37	ND

2002 Sampling Data

In 2002, the graywater from large ships was still exempt from the fecal coliform and total suspended solids standards. The graywater effluent quality that year was still quite poor. The median and geometric mean values of both the 2002 graywater and blackwater are presented in Table 8.

³⁶ This value is geometric mean not median.

Table 8. 2002 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

<u>Water Type (# samples) Large Ship Appendix B Table #</u>	<u>Collected from</u>	<u>Fecal Coliform (MPN/100 ml)</u>	<u>TSS mg/l</u>	<u>BOD mg/l</u>	<u>COD mg/l</u>	<u>Ammonia mg/L</u>	<u>pH</u>	<u>Total Cl mg/l</u>	<u>Free Cl mg/l</u>
	AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW - Galley (7) Table 21.	DB or CT	6,279	1,320.0	2,790	5,110.0	2.66	4.11	ND	ND
GW - Accom & Laundry (12) Table 23.	DB or CT	47,357	130.5	367	615.0	1.07	6.72	ND	ND
Mixed GW (19) Table 25.	CT or DB	38,603	190.0	328	621.0	1.00	6.14	ND	ND
BW (21) Table 15.	Various	5	0.1	3	61.6	18.80	7.5	ND	ND

<u>Water Type (# samples) Large Ship Appendix B Table #</u>	<u>Collected From</u>	<u>Alkalinity mg/l</u>	<u>Conductivity (Umhos/cm)</u>	<u>Oil & Grease mg/l</u>	<u>Phosphorous Total mg/l</u>	<u>Nitrate as N mg/l</u>	<u>TKN mg/L</u>	<u>TOC mg/l</u>	<u>Settleable Solids mg/l</u>
	AK WQS								
	MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
GW - Galley (7) Table 22.	DB or CT	0.25	1,810	520.0	14.10	0.2	0.2	1,600.0	44.0
Accom. & Laundry (12) Table 24.	DB or CT	73.5	5,090	140.0	5.50	0.2	0.2	209.5	0.1
Mixed GW (19) Table 26.	CT or DB	53.4	1,920	95.0	3.99	0.2	0.2	162.5	0.5
BW (21) Table 15.	DB, CT, or MSD	135.0	685	0.9	3.21	0.1	0.1	23.0	0.1

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

CT= Collecting Tank DB =Double Bottom Tank

MSD = Marine Sanitation Device ND= Non Detect

*Note that the MDL for chlorine is higher than the chronic water quality standard.

Galley graywater showed lower levels of fecal coliform bacteria than the accommodations or mixed graywater but the levels of BOD, COD, and TSS are much higher. Galley graywater is a more complex wastewater to treat than laundry or domestic wastewater because of the high amount of oil, grease, and solids.

The conventional pollutant results for blackwater were much lower than the graywater results with the exception of a high ammonia median of 18.80 mg/l. The seven ships that discharged blackwater in Alaska had advanced wastewater treatment systems,³⁷ which resulted in a low fecal coliform geometric mean of 5 MPN/100ml and median TSS of 0.1 mg/L.

2003 Sampling Data

In 2003, large cruise ship graywater and blackwater were subject to the fecal coliform and total suspended solids standards. The median and geometric mean values of pollutants detected in graywater and blackwater are presented in Table 9.

³⁷ The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: *Celebrity Mercury* and *Holland America Ryndam, Statendam, Volendam, Veendam, and Zaandam*. The *Radisson Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.

Table 9. 2003 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

<u>Water Type (# samples)</u> <u>Large Ship Appendix B</u> <u>Table #</u>	<u>Fecal Coliform</u> <u>(MPN/100 ml)</u>	<u>TSS</u> <u>mg/l</u>	<u>BOD</u> <u>mg/l</u>	<u>COD</u> <u>mg/l</u>	<u>Ammonia</u> <u>mg/l</u>	<u>pH</u>	<u>Total Cl</u> <u>mg/l</u>	<u>Free Cl</u> <u>mg/l</u>
AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
Graywater (3) Table 3.	7	0.0	23	67.0	1.30	7.3	ND	ND
Blackwater (57) Table 1.	1	0.0	4	72.0	25.10	7.4	ND	ND

<u>Water Type (# samples)</u> <u>Large Ship Appendix B</u> <u>Table #</u>	<u>Alkalinity</u> <u>mg/l</u>	<u>Conductivity</u> <u>(Umhos/cm)</u>	<u>Oil & Grease</u> <u>mg/l</u>	<u>Phosphorous</u> <u>Total</u> <u>mg/l</u>	<u>Nitrate</u> <u>as N</u> <u>mg/l</u>	<u>TOC</u> <u>mg/l</u>	<u>Total</u> <u>Kjeldahl</u> <u>Nitrogen</u> <u>mg/l</u>	<u>Settleable</u> <u>Solids</u> <u>mg/l</u>
AK WQS								
MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
Graywater (3) Table 4.	34.1	199	6.2	0.23	0.0	12.7	4.8	0.0
Blackwater (57) Table 2.	219.5	987	0.0	3.60	0.0	19.4	29.0	0.0

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

CT= Collecting Tank DB =Double Bottom Tank

MSD = Marine Sanitation Device ND= Non Detect

*Note that the MDL for chlorine is higher than the chronic water quality standard.

Only one ship, the *Carnival Spirit*, discharged graywater in Alaska. The graywater from this ship was treated through a reverse osmosis advanced wastewater treatment system. This was the cause of the dramatic improvement in the 2003 graywater quality. It should be noted, however, that the COD level was still high.

In 2003, the number of ships with advanced wastewater treatment systems increased to 18.³⁸ These ships discharged their wastewater in Alaska. Most of these ships mixed their graywater

³⁸ Princess - *Star Princess, Sun Princess, Dawn Princess, Coral Princess, Pacific Princess, Island Princess*
Celebrity - *Mercury*
Holland America - *Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam*
Carnival - *Carnival Spirit* (graywater only)
Norwegian - *Norwegian Sun, Norwegian Sky, Norwegian Wind*
Radisson - *Seven Seas Mariner*

and blackwater together resulting in blackwater. The blackwater effluent was of high quality but still had elevated levels of ammonia and COD.

4.3. Pollutants in Effluent that Exceed Alaska Water Quality Standards

The medians of most pollutants in effluent were below Alaska Water Quality Standards. Table 10 draws upon Table 5 – 9 for conventional pollutants and Appendix C. Summary of Large Ship Sampling for Priority Pollutants to highlight the medians that do not meet Alaska Water Quality Standards at the end of pipe. A shaded cell indicates that the concentration in effluent was below the standard.

Table 10. End of Pipe - Large Ship Pollutant Medians that Do Not Meet Alaska Water Quality Standards

			Blackwater				Graywater			
Pollutant	Units	AWQS	2003	2002	2001	2000	2003	2002	2001	2000
Ammonia	mg/l	17.00	25.10	18.80		100.00				25.12
Free Chlorine	mg/l	0.0075							1.30	0.26
Fecal Coliform	MPN/100 ml	14.0				18,213		47,357	784,072	1,163,188
Copper, dissolved	ug/l	3.1	10.70	7.72	133.85	225.00		31.65	255	31.01
Nickel, dissolved	ug/l	8.2	12.60	16.70	20.50			12.70	15.0	
Zinc, dissolved	ug/l	81.0	109.5	195.5	169.5	425.0		262.0	270.0	

Note: Fecal coliform information is a geometric mean.

4.4. Pollutants that Exceed Alaska Water Quality Standards in Receiving Water

The Science Advisory Panel concluded in their November 2002 *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* report that even the wastewater discharged in 2000 from vessels moving at a minimum of 6 knots, 1 mile from shore, met Alaska Water Quality Standards in the receiving water.³⁹ For large ships, this is due to a minimum underway dilution factor of 50,000.⁴⁰

ADEC therefore focused on the impact that cruise ship wastewater effluent has on the receiving waters during stationary discharge. ADEC modeled the dilution of large cruise ship effluent during stationary discharge during a very conservative scenario, a neap tide⁴¹ in Skagway, using the EPA approved Visual Plumes model and information provided by operators in their Vessel Specific Sampling Plans. ADEC calculated a dilution factor for each ship's discharge. (More detailed information on the model used to calculate the dilution factor is included in Appendix D, Cruise Ship Stationary Discharge Modeling.) The lowest dilution factor calculated by the model was 8 for blackwater and 5 for graywater. The concentration of a pollutant in Table 10 was divided by these factors to arrive at the pollutant concentration that is expected in the receiving waters (Table 11). If the pollutant concentration met the Alaska Water Quality Standards in receiving water after applying the dilution factor, the cell is shaded.

Table 11. Modeled Large Ship Median Pollutant Concentrations in Receiving Waters during Stationary Discharge (Fecal coliform information is a geometric mean.)

Pollutant	Units	AWQS	Blackwater				Graywater			
			2003	2002	2001	2000	2003	2002	2001	2000
Free Chlorine	mg/l	0.0075							0.26	0.052
Fecal Coliform	MPN/100 ml	14.0				2,276.63		9,471	156,814	232,638
Copper, dissolved	ug/l	3.1			16.73	28.13		6.33	51.0	6.2

Of the many (176) pollutants that were tested in effluent during 2003, none are expected to exceed Alaska Water Quality Standards in the receiving water during stationary discharge.

4.5. Whole Effluent Toxicity Testing

Whole Effluent Toxicity (WET) testing is an alternative to directly analyzing environmental samples for individual constituents. WET testing addresses the effect that simultaneous exposure to a mixture of pollutants has on an organism.

³⁹ Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters", November 2002 <http://www.state.ak.us/dcc/press/cruise/documents/impact/executivesummary.htm>

⁴⁰ Large Cruise Ship Dilution factor = $4 \times (\text{ship width} \times \text{ship draft} \times \text{ship speed}) / (\text{volume discharge rate})$ $4 \times (30 \text{ m} \times 8 \text{ m} \times 3.10 \text{ m sec}^{-1}) / (0.06 \text{ m}^3 \text{sec}^{-1}) \approx 50,000$

⁴¹ A tide of minimum range occurring at the first and the third quarters of the moon.

There are two ways to perform the WET test: static non-renewal and static renewal. In a static non-renewal test, organisms are exposed to a single portion of the solution for the duration of the test. In a static renewal test, organisms are exposed to fresh changes of the test water every day. This testing method is more conservative because the organisms are exposed to the effluent at the same strength for a longer time period. ADEC conducted WET testing using the static renewal method on commercial passenger vessels in 2002⁴² and again in 2003.⁴³

2002 Testing

This test was designed to simulate exposure to the concentration of pollutants that could be found in the receiving waters behind a moving cruise ship. Because of the high dilution rates associated with moving cruise ships, the dilution series started at 50% effluent and increased by a factor of 10 such that the percent effluent progressively decreased. The concentrations tested were 50%, 5%, 0.5%, 0.05%, 0.005%, and 0.0005% effluent. The dilution series represented concentrations that are attained in receiving waters with dilution factors (df) of 2, 20, 200, 2,000, 20,000, and 200,000. A typical large cruise ship discharging 200 cubic meters per hour while traveling at 6 knots (11 km/hour) would have a dilution factor of about 50,000.⁴⁴

WET results are presented in Table 12. The percentages represent the highest effluent concentration at which the tests exhibited no observable acute or chronic effects. Values in parentheses show dilution factors associated with the no observed effect concentrations (NOEC).

Table 12. Large Ship 2002 No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC	Echinoderm Fertilization NOEC
<i>Dawn Princess</i> Graywater	Chlorine added to collection tanks	5% (df=20)	5% (df=20)	0.5% (df=200)	0.5% (df=200)
<i>Mercury</i> Mixed Effluent	Reverse Osmosis	50% (df=2)	50% (df=2)	50% (df=2)	50% (df=2)
<i>Volendam</i> Mixed Effluent	Aerated Membrane (Ultrafiltration)	50% (df=2)	5% (df=20)	5% (df=20)	5% (df=20)

The *Dawn Princess* graywater demonstrated some effect at 50% concentration (one part sea water to one part wastewater) in the acute test and some effect at 5% wastewater concentration in the chronic tests. This limited toxicity occurred despite the fact that no residual chlorine was found in the sample. However, the ammonia concentration was 10 mg/L. Samples from the *Mercury* did not demonstrate any toxicity, even at a 1:2 dilution. The *Volendam* sample

⁴² Science Advisory Panel "Review and Comment Regarding Whole Effluent Toxicity Test Results for Five Commercial Passenger Vessels in Alaska July 2002" <http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm> and "Lab results for Whole Effluent Toxicity test (WET) – August 2002" <http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm>

⁴³ ADEC "2003 Whole Effluent Toxicity Results for Commercial Passenger Vessels in Alaska" [http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20\(WET\)%20Test%20Discussion.pdf](http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20(WET)%20Test%20Discussion.pdf)

⁴⁴ The Panel has developed a formula for predicting dilution/dispersion in the wake of large cruise ships.

$$\text{Dilution factor} = 4 \times (\text{ship width} \times \text{ship draft} \times \text{ship speed}) / (\text{volume discharge rate})$$

demonstrated an effect at 50% for the Topsmelt acute test and on both chronic test species but had no effect on the Mysid acute test with as little as a 1:2 dilution.

The observed WET values would not be of concern during underway discharge because dilution factors of greater than 1:200 would be easily achieved in the receiving water. During 2002, *Dawn Princess* discharged its graywater underway a minimum one nautical mile from shore going at least 6 knots. The vessel held its blackwater until it was outside Alaska waters. As of 2003, this vessel mixes its accommodations graywater with its blackwater and then treats it through an advanced wastewater treatment system that meets the stringent standards for continuous discharge. (See Table 2.) Wastewater from the *Mercury* and *Volendam* continue to be discharged in port. *Mercury* effluent is diluted by a factor of 18 and *Volendam* effluent is diluted by a factor of 60, even during stationary discharge during a neap tide. (See Appendix D. Cruise Ship Stationary Discharge Modeling Table 4.) Therefore, the effluent from these three ships is not expected to cause toxicity to marine organisms.

2003 Testing

From the period of June through September 2003, ADEC conducted WET testing on the following large vessels: *Norwegian Wind*, *Sun Princess*, *Carnival Spirit*, and *Ryndam*. These ships represented all four of the advanced treatment systems operated on cruise ships in Alaska. These large vessels had obtained U.S. Coast Guard certification to discharge wastewater any time anywhere, including in port.

ADEC designed the 2003 WET test to determine if there are any negative effects to the marine environment during stationary discharges when dilution factor will be low. Therefore, the dilution series only increased by a factor of 2 instead of 10. The dilution series was 50%, 25%, 12.5%, 6.25%, 3.125%, and 1.5% effluent. This series represented concentrations that are attained in receiving waters with dilution factors (df) of 2, 4, 8, 16, 32, and 66.7.

ADEC calculated the ship specific dilution factors during a worst case scenario, a stationary discharge during a neap tide in Skagway, using the Visual Plumes model.⁴⁵ (See Appendix D. Cruise Ship Stationary Discharge Modeling.) When the ship specific dilution factor calculated by the Visual Plumes model is greater than the No Observed Effect Concentration dilution factor (df), no toxicity is expected.

⁴⁵ ADEC used the Visual Plumes mode UM3 with the Brooks far field solution. For more information on this model go to <http://www.epa.gov/ccampubl/swater/vplume/>

Table 13. Large Ship 2003 Whole Effluent Toxicity Test Results & Ship Specific Dilution Factor during Neap Tide

No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Ship Specific Dilution Factor from Visual Plumes model	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC		Echinoderm Fertilization NOEC
					Normality ⁴⁶	Survival	
<i>Norwegian Wind</i> Mixed Effluent	Scanship Bioreactor/ultra-filtration	24	>50% (df=2)	12.5% (df=8)	6.25% (df=16)	50% (df=2)	25% (df=4)
<i>Ryndam</i> Mixed Effluent	Aerated Membrane (Ultrafiltration)	60	>50% (df=2)	50% (df=2)	12.5% (df=8)	50% (df=2)	50% (df=2)
<i>Sun Princess</i> Mixed Effluent	Hamworthy Bioreactor and Ultrafiltration	15	12.5% (df=8)	12.5% (df=8)	<1.5% ⁴⁷ (unknown)	50% (df=2)	<1.5% (unknown)
<i>Spirit</i> Graywater	Reverse Osmosis	5	>50% (df=2)	50% (df=2)	25% (df=4)	50% (df=2)	Unable to run ⁴⁸

These results indicate that large ships' wastewater effluent will not cause toxicity in receiving waters, even during periods of minimal tidal flux.

4.6. Summary of Large Ship Data 2000 – 2003

Wastewater production volumes depend primarily on the number of passengers and crew on a vessel. The volumes are also affected by ship waste management practices and configuration. The average large cruise ship with 2,500 people (including crew) produces 800 cubic meters or 211,200 gallons of wastewater per day. Between 90-95% of that wastewater is graywater.

Before the passage of the state cruise ship law, blackwater and/or graywater from large cruise ship samples taken at the end of pipe did not meet Alaska Water Quality Standards for ammonia, free chlorine, fecal coliform, copper, and zinc (Table 10). Wastewater effluent is diluted by a small factor during stationary discharge. If large ships discharged while stationary, the Water Quality Standards would have been exceeded for free chlorine, fecal coliform, and copper in the receiving water. However due to substantial dilution, all Alaska Water Quality Standards, except fecal coliform, were met in the receiving water while ships discharged underway.

⁴⁶ Normality measures the normal development of the bivalve larvae.

⁴⁷ *S. purpuratus* gametes is not a bivalve but was substituted because the mussels and oysters would not spawn due to elevated summer temperatures.

⁴⁸ The organisms were not available when the sample arrived in September.

The state cruise ship law, effective in July 2001, allowed large cruise ships to seek interim protective measures that extended the time for compliance with the graywater standards until January 1, 2003.⁴⁹ All ships that discharged graywater in state water from 2000 through 2002 sought and were granted this extension. Under the interim protective measures, the ships could only discharge graywater while underway. In contrast, the blackwater discharged from large ships was subject to the state effluent standards in July 2001. This is the cause of the drastic difference in the effluent quality of the gray and blackwater until 2003 when the standards applied to both wastewater types.

In 2001, the data reflect that 21 of the 24 large ships stopped discharging blackwater into Alaska water. The fecal coliform levels in blackwater fall drastically because the two ships⁵⁰ that continued to discharge blackwater in Alaska waters had advanced wastewater treatment technology. The other ship⁵¹ treated blackwater through a traditional macerator chlorination system. The graywater results, especially the galley water, continued to indicate poor effluent quality.

The 2000 and 2001 data also indicate that holding water in double bottom tanks for later discharge increases the concentration of fecal coliform, TSS, and BOD. It is possible that the double bottom tanks were contaminated with blackwater and that fecal coliform multiplied in the warm holding environment.

In 2002, the overall quality of the graywater was still poor. Seven ships⁵² had advanced wastewater treatment systems and discharged blackwater in Alaska. The blackwater quality was dramatically better than the graywater but still had elevated levels of ammonia.

In 2003, the only large ships that discharged wastewater in Alaska had advanced wastewater treatment systems. Most of these systems treated blackwater but one system treated graywater. Most tested pollutants met Water Quality Standards at the end of pipe without dilution. Even considering the minimal dilution that occurs during stationary discharge during a neap tide, the concentration of tested pollutants met all Alaska Water Quality Standards in receiving water. (See Table 11.)

The quality of large cruise ship wastewater reflected the continued increase in the number of vessels that installed advanced treatment technology, from two of 24 (8%) in 2001 to seven of 25 (28%) in 2002 to eighteen⁵³ of 32 (56%) in 2003.

⁴⁹ AS 46.03.463(c)

⁵⁰ *Celebrity Mercury* and *Holland America Statendam*

⁵¹ *Universe Explorer*

⁵² The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: *Celebrity Mercury* and *Holland America Ryndam, Statendam, Volendam, Veendam, Zaandam*. The *Radisson Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.

⁵³ *Princess - Star Princess, Sun Princess, Dawn Princess, Coral Princess, Pacific Princess, Island Princess*

Celebrity - Mercury

Holland America - Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam

Carnival - Carnival Spirit (graywater only)

Norwegian - Norwegian Sun, Norwegian Sky, Norwegian Wind

Radisson - Seven Seas Mariner

Risk Characterization

ADEC expects that only large cruise ships with advanced wastewater treatment systems will discharge wastewater in Alaska in the future. WET testing results and a comparison of sample results with Alaska Water Quality Standards indicate that the effluent from these advanced systems is not expected to cause toxicity to the marine environment. No human health risk is posed by the low concentration of tested pollutants found in wastewater samples.

The wastewater samples indicate that hazardous materials are not being discharged through these wastewater treatment systems.

5. WASTEWATER CHARACTERISTICS – SMALL SHIPS

5.1. Statistics

Since 2001, ADEC has collected substantial amounts of wastewater sampling data on cruise ships and ferries subject to the Commercial Passenger Vessel Environmental Compliance Program. In order to characterize the central tendency of the large quantity of data, the median was used. The median is the middle of a distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than an average and is thus a better measure for skewed distributions. Medians are used to present all pollutant data in this report. Much of the fecal coliform data was highly skewed so a geometric mean was used to summarize this data.

Geometric Mean

When distributions are more highly skewed, a geometric mean is used. A geometric mean moderates the effect of a single high value. A geometric mean is computed as follows:

$$(X_1 X_2 \dots X_n)^{1/n} =$$

Example:

$$(1 \times 2 \times 10 \times 10,000)^{1/4} = 21$$

5.2. Summary of Conventional Pollutant Data

There were only three small ship wastewater samples taken in 2000, too few to analyze. Only a short list of conventional pollutants was sampled during 2001. In 2002 and 2003, small ship wastewater samples were analyzed for the expanded list of conventional pollutants as well as for priority pollutants.

Small vessel conventional pollutant data taken in 2001 through 2003 is summarized according to wastewater effluent type in Table 14. Detailed sampling results from individual ships can be found in Appendix E: Small Ship Sampling Data.

Table 14. Small Ship Conventional Pollutants

The values for all pollutants, except fecal coliform, are medians. Fecal coliform information is represented as a geometric mean.

Year Wastewater Type Small Ship Appendix E Table #	Number of Samples	Ammonia total (as N) mg/l	pH	BOD5 mg/l	COD mg/l	TSS mg/l	Total Chlorine Residual mg/l	Fecal Coliform MPN/10 0	Free Chlorine Residual Mg/l
MDL		0.03	0.10	2	3.0	1.3	0.10	2	0.10
AK WQS		17.00	6.5 – 8.5	n/a	n/a	n/a	0.0075*	14	0.0075*
2001 GW Table 30	25	1.03	7.5	212	525.0	49.6	ND	103	ND
2002 GW Table 16	11	0.31	7.2	175	400.0	54.1	0.65	222 ⁵⁴	ND
2003 GW Table 1	23	0.46	7.3	199	330.0	55.6	0.70	48	ND
2001 BW Table 32	16	3.30	7.8	60	863.0	115.8	0.03	10,561	ND
2002 BW Table 20	12	16.15	7.5	137	805.5	133.0	ND	11,582	ND
2003 BW Table 5	21	11.50	7.9	39	625.0	87.1	ND	500	ND
2001 BW&GW Mixed Table 31	10	7.72	7.3	130	814.0	108.0	1.00	3,720	0.10
2002 BW&GW Mixed (Table 18)	17	16.80	7.5	154	835.0	77.0	0.25	5,487	1.10 ⁵⁵
2003 BW&GW Mixed Table 3	18	29.00	7.0	346	545.0	128.5	ND	56,513	ND

*Note that the MDL for chlorine is higher than the chronic water quality standard.

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

ND= Non Detect

⁵⁴ Results skewed by one result of 16,000,000.

⁵⁵ In several instances only free chlorine was tested. This resulted in higher medians for free than total chlorine.

	Number of Samples	Conductivity	Oil & Grease	Total Organic carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MDL		1.0	1.5	1.0	0.5	1.0	0.01	1.0	0.1
WQS		n/a							
2002 GW (Table 17)	1	369	52.0	352.0	61.0	0.5	0.86	0.4	0.1
2003 GW (Table 2)	23	429	15.0	68.9	76.3	0.0	1.60	6.3	0.0
2002 BW (Table 21)	1	34,500	8.5	299.0	116.0	0.5	2.33	5.7	0.1
2003 BW (Table 6)	21	28,800	7.3	29.7	125.0	0.0	3.30	39.0	2.0
2002 BW&GW Mixed (Table 19)	4	29,750 ⁵⁶	20.0	305.0	77.9	0.5	1.36	23.2	0.1
2003 BW&GW (Table 4)	18	17,900	62.0	158.5	204.5	0.0	3.50	35.0	2.4

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
 ND= Non Detect

Fecal coliform was at its lowest level in graywater and blackwater during 2003.

In the mixed black and graywater, there is a substantial increase in the concentration of fecal coliform from 3,720 MPN/100 ml in 2001 to 56,513 MPN/100 ml in 2003.

5.3. Pollutants in Effluent that Exceed Alaska Water Quality Standards

The medians of most pollutants in effluent were below Alaska Water Quality Standards. Table 15 draws from Table 14 for conventional pollutants and Appendix F. Summary of Small Ship Sampling for Priority Pollutants to highlight the pollutant medians that do not meet Alaska Water Quality Standards at the end of pipe. A shaded cell indicates that the concentration in the effluent was below the standard.

⁵⁶ Eight samples were analyzed for conductivity.

Table 15. End of Pipe - Small Ship Pollutants Medians that Do Not Meet Alaska Water Quality Standards

Pollutant	Units	AWQS	Graywater		Treated Blackwater		Treated Blackwater & Graywater Mixed	
			2003	2002	2003	2002	2003	2002
Ammonia	mg/l	17.00					29.00	
Free Chlorine	mg/l	0.0075	ND	ND				1.10
Fecal Coliform	MPN/100 ml	14	48	222	500	11,582	56,513	5,487
Arsenic	ug/l	36.0			42.8	44.9		
Copper	ug/l	3.1	74.8	27.4	6.4	11.1	22.0	76.3
Nickel	ug/l	8.2			13.0	14.9	12.2	16.6
Selenium	ug/l	71.0			171.0	170.0	98.2	134.0
Zinc	ug/l	81.0	150.0	86.9			98.5	165.0

Note: Fecal coliform information is a geometric mean.

5.4. Pollutants that Exceed Alaska Water Quality Standards in Receiving Water

The Science Advisory Panel concluded in *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* report that the wastewater discharges from vessels moving at a minimum of 6 knots, 1 mile from shore, would meet Alaska Water Quality Standards in the receiving water.⁵⁷

ADEC therefore focused on the impact that cruise ship wastewater effluent has on receiving waters during stationary discharge. ADEC modeled the dilution of small ship effluent during stationary discharge during a very conservative scenario, a neap tide⁵⁸ in Skagway, using the EPA approved Visual Plumes model and the information provided by operators in their Vessel Specific Sampling Plans. ADEC calculated a dilution factor for each ship's discharge. (More detailed information on the model used to calculate the dilution factor can be found in Appendix D Cruise Ship Stationary Discharge Modeling.) The lowest dilution factor calculated by the model was 1.5 for graywater, 38 for blackwater, and 8 for mixed wastewater. The concentration of a pollutant in Table 15 was divided by these factors to arrive at the pollutant concentration that is expected in the receiving waters (Table 16). If the predicted pollutant concentration met the Alaska Water Quality Standards in receiving water after applying the dilution factor, the cell is shaded.

⁵⁷ Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002
<http://www.state.ak.us/dec/press/cruise/documents/impact/executivesummary.htm>

⁵⁸ A tide of minimum range occurring at the first and the third quarters of the moon.

Table 16. Modeled Small Ship Median Pollutant Concentrations in Receiving Waters during Stationary Discharge

Pollutant	Units	AKWQS	Graywater		Treated Blackwater		Mixed Blackwater & Graywater	
			2003	2002	2003	2002	2003	2002
Free Chlorine	mg/l	.0075						0.14
Fecal Coliform	MPN/100 ml	14	32	148		305	7,064	686
Copper	ug/l	3.1	49.8	18.3				9.5
Zinc	ug/l	81.0	100.0					

Note: Fecal coliform information is a geometric mean

In 2003, of all the pollutants that were tested (176), only three pollutants are expected to regularly exceed Water Quality Standards during stationary discharge.

5.5. Whole Effluent Toxicity Testing

Whole Effluent Toxicity (WET) testing is an alternative to directly analyzing environmental samples for individual constituents. WET testing addresses the effect that simultaneous exposure to a mixture of pollutants has on an organism.

There are two ways to perform the WET test: static non-renewal and static renewal. In a static non-renewal test, test organisms are exposed to a single portion of the solution for the duration of the test. In a static renewal test, test organisms are exposed to fresh changes of water every day for the duration of the test. Static renewal testing is more conservative because the test organisms are exposed to the effluent at the same strength for a longer time period. ADEC conducted WET testing using the static renewal method on commercial passenger vessels in 2002⁵⁹ and again in 2003.⁶⁰

2002

This test was designed to simulate exposure to the concentration of pollutants that would likely be found in the receiving waters behind a moving ship. Because of the high dilution rates associated with moving ships, the dilution series started at 50% effluent and increased by a factor of 10 such that the percent effluent tested progressively decreased. The concentrations tested were 50%, 5%, 0.5%, 0.05%, 0.005%, and 0.0005% effluent. The dilution series represented

⁵⁹ Science Advisory Panel "Review and Comment Regarding Whole Effluent Toxicity Test Results for Five Commercial Passenger Vessels in Alaska July 2002" <http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm> and "Lab results for Whole Effluent Toxicity test (WET) - August 2002" <http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm>

⁶⁰ ADEC "2003 Whole Effluent Toxicity Results for Commercial Passenger Vessels in Alaska" [http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20\(WET\)%20Test%20Discussion.pdf](http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20(WET)%20Test%20Discussion.pdf)

concentrations that are attained in receiving waters with dilution factors (df) of 2, 20, 200, 2,000, 20,000, and 200,000. For comparison, a small cruise ship with a width of 10 meters and a draft of 1 meter, discharging 0.4 cubic meters per hour (0.0001 cubic meters per second) while traveling at 6 knots (3.09 m/s) multiplied by the small ship factor of 3 would give a dilution factor of about 927,000.⁶¹

WET test results are presented in Table 17. The percentages represent the highest effluent concentration at which the tests exhibited no observable acute or chronic effects. Values in parentheses show dilution factors associated with the no observed effect concentrations (NOEC).

Table 17. Small Ship 2002 No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC	Echinoderm Fertilization NOEC
<i>Kennicott</i> Mixed Effluent	Macerator/ Chlorinator	5% (df=20)	5% (df=20)	5% (df=20)	0.5% (df=200)
<i>Yorktown Clipper</i> Blackwater	Macerator/ Chlorinator	50% (df=2)	50% (df=2)	50% (df=2)	50% (df=2)
<i>Yorktown Clipper</i> Graywater	Chlorine injection	0.5% (df=200)	0.5% (df=200)	0.5% (df=200)	0.05% (df=2,000)

The WET tests indicated that acute or chronic toxic effects on marine organisms are not expected to occur in receiving water when vessels discharge underway. However, the *Kennicott* mixed effluent could cause chronic effects (echinoderm fertilization) during stationary discharge, even when considering the ship specific dilution factor of 23 calculated by the Visual Plumes model. The *Yorktown Clipper* blackwater effluent would not cause toxicity even during stationary discharge. The *Yorktown Clipper* graywater effluent could cause both chronic and acute toxicity during stationary discharge, even when ship specific dilution factor of 1.5 is applied. (See Appendix D. Cruise Ship Stationary Discharge Modeling Table 5 for ship specific dilution factors.) The chronic toxicity of the *Kennicott* mixed effluent and the *Yorktown Clipper* graywater may be explained by the excessive chlorination of the effluent. Alaska's Water Quality Standard for total residual chlorine is 7.5 ug/l. The total residual chlorine in the *Kennicott* mixed effluent and the *Yorktown Clipper* graywater was 30,300 ug/l and 16,200 ug/l respectively.

⁶¹ The Science Panel has developed a formula for predicting dilution/dispersion in the wake of small cruise ships.

$Dilution\ factor = 3 \times (ship\ width \times ship\ draft \times ship\ speed) / (volume\ discharge\ rate);$

<http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm>

The dilution factor is large for small ships compared to large ships because of the much smaller volume discharge rate.

2003

ADEC designed the 2003 WET test to determine the likelihood of negative effects to the marine environment during stationary discharges when dilution factor will be low. Therefore, the dilution series only increased by a factor of 2 instead of 10. The dilution series was 50%, 25%, 12.5%, 6.25%, 3.125%, and 1.5% effluent. This series represented concentrations that are attained in receiving waters with dilution factors of 2, 4, 8, 16, 32, and 66.7.

ADEC calculated the dilution factors during a worst case scenario, a stationary discharge during a neap tide in Skagway, using the Visual Plumes model.⁶² (See Appendix D. Cruise Ship Stationary Discharge Modeling.) When the ship specific dilution factor calculated by the Visual Plumes model is greater than the No Observed Effect Concentration dilution factor (df), no toxicity is expected.

Table 18. Small Ship 2003 Whole Effluent Toxicity Test Results & Dilution Factor during Neap Tide
No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Ship Specific Dilution Factor from Visual Plumes model	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC		Echinoderm Fertilization NOEC
					Normality ⁶³	Survival	
<i>Spirit of Oceanus</i> Mixed Effluent	BW Biological GW untreated	8	25% (df=4)	12.5% (df=8)	<1.5% (unknown)	12.5% (df=8)	<1.5% (unknown)
<i>Spirit of Columbia</i> Blackwater	Macerator/ Chlorinator	50 ⁶⁴	>50% (df=2)	50% (df=2)	50% (df=2)	50% (df=2)	25% (df=4)
<i>Spirit of Columbia</i> Graywater	Untreated	2.5 ⁶⁵	12.5% (df=8)	25% (df=4)	6.25% (df=16)	25% (df=4)	<1.5% (unknown)

On the *Spirit of Oceanus*, the blackwater is treated with a biological system and the graywater is untreated. The effluent is mixed before it is discharged. The mixed effluent is only expected to receive a dilution factor of 8 in the receiving water during stationary discharge. We do not expect the mixed effluent would cause acute toxicity even at this small dilution factor. The tests show that the effluent exhibits some chronic toxicity (bivalve larvae normality and echinoderm

⁶² ADEC used the Visual Plumes mode UM3 with the Brooks far field solution. For more information on this model go to <http://www.epa.gov/ccampubl/swater/vplume/>

⁶³ Normality is the normal development of the bivalve larvae.

⁶⁴ *Spirit of Columbia's* blackwater is discharged from a pump under the waterline, which increases dilution.

⁶⁵ *Spirit of Columbia's* graywater is discharged directly from drains by means of gravity, which decreases dilution.

fertilization) at this dilution rate. However, in practice this vessel only discharges while underway when the effluent is expected to be diluted by a factor of approximately 100,000.⁶⁶ Therefore no toxicity to marine organisms is expected to result under normal operating procedures.

The *Spirit of Columbia* blackwater should not cause acute or chronic effects to marine organisms in receiving waters, even during stationary discharge.

The *Spirit of Columbia* graywater may cause acute and chronic effects on marine organisms while discharging in port. There is little dilution of its graywater because it is discharged above waterline. Graywater from this vessel is not expected to cause toxicity in receiving water during underway discharge because of the high dilution factor experienced while underway.

5.6. Summary of Small Ship Data 2001 – 2003

The state defines small ships as vessels that carry between 50 and 249 overnight passengers for hire. The average small cruise ship with 100 people (including crew) produces 9.5 cubic meters or 2,500 gallons of waste water per day. Of that amount 830 gallons is seawater used for toilets. There is roughly 16.7 gallons of graywater used per person or 1,670 gallons total.⁶⁷

Small cruise ships and Alaska Marine Highway System (AMHS) ferries treat their blackwater with marine sanitation device (MSD). Some mix their blackwater and graywater together and then treat the wastewater through a MSD. Some vessels treat their graywater with chlorine before discharge while others discharge untreated graywater.

In 2001, small ships were only sampled for a short list of conventional pollutants. In 2002 and 2003, small ships sampled for the expanded list of conventional pollutants as well as for priority pollutants. Graywater effluent usually met the fecal coliform and total suspended solids effluent standards established by the state law. Blackwater and mixed black and graywater usually met the total suspended solids standards but exceeded the fecal coliform standard.

Risk Characterization

The wastewater samples indicate that hazardous chemicals are not being discharged through these wastewater systems. However, small ship effluent may not meet Alaska Water Quality Standards for free chlorine, fecal coliform, copper, and zinc in receiving water during stationary discharge.

The 2003 WET results were less toxic than those of 2002. In both years, the level of toxicity did not present a concern during underway discharge but graywater would, in all likelihood, cause marine toxicity during stationary discharge.

⁶⁶ Dilution calculation for small ships Dilution factor = $3 \times (\text{ship width} \times \text{ship draft} \times \text{ship speed}) / (\text{volume discharge rate}) = 3 \times (15.3 \text{ m} \times 4.15 \text{ m} \times 3.09 \text{ m sec}^{-1}) / (.0057 \text{ m}^3 \text{ sec}^{-1})$, the vessel's width is 15.3 m with a maximum draft of 4.15 m. ADEC Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters" November 2002, Section I located at <http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm>

⁶⁷ Figures taken from Wilderness Discoverer 2003 VSSP. Small ship water production varies with ship capacity and configuration.

Assessment of Cruise Ship and Ferry Wastewater Impacts in Alaska

During stationary discharge, small ship effluent may pose a risk to human health in areas where aquatic life is harvested for raw consumption due to the high concentration of fecal coliform.

6. EVALUATION OF WASTEWATER TREATMENT TECHNOLOGY

6.1. TRADITIONAL TREATMENT SYSTEMS

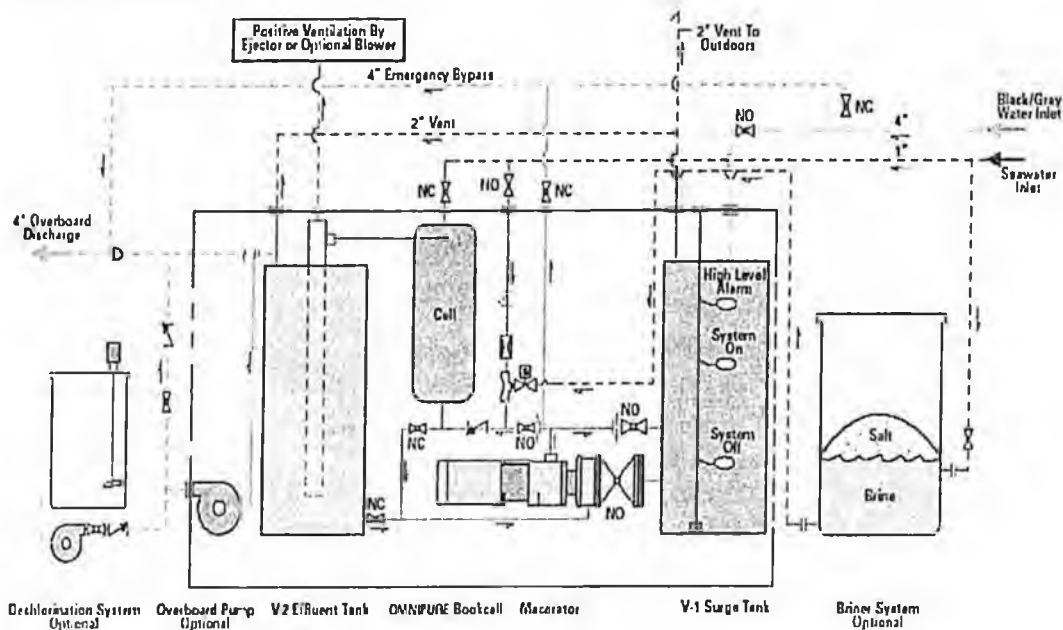
Prior to 2001, vessels used one of two marine sanitation devices (MSDs) to treat sewage on ships: maceration-chlorination or biological-chemical disinfection systems.

Maceration-chlorination systems

Maceration-chlorination systems are installed on most of the small cruise ships and ferries that ply Alaska waters.⁶⁸ This system reduces bio-solids through maceration, internal dilution, oxidation, and chlorine disinfection. The macerator pump breaks up solids in the sewage influent to a maximum particle size of 1.5 mm. The wastewater is then mixed with ambient seawater and passed between charged cell plates where a number of reactions occur simultaneously. The reactions cause the electrolytic breakdown of organic molecules. The electrocatalytic process also produces sodium hypochlorite from the salt in the seawater. This disinfectant continues to oxidize the waste stream in a contact tank with a 90-95% oxidation rate that kills total bacterial within minutes.⁶⁹ The treated water remains in the contact tank, usually for a minimum of 30 minutes. In low salt brackish water, some operators add chlorine to the tank to ensure disinfection is complete or add salt to the waste stream. Material that is not oxidized (i.e. cellulose) is returned for further treatment. No sludge is produced. Gases produced from reactions are mixed with ambient air and exhausted. (Figure 3.)

Figure 3. Maceration-Chlorination System

Engineering Flow Diagram



⁶⁸ ADEC, 2003 Small Commercial Passenger Vessel Wastewater Treatment Table, <http://www.state.ak.us/dec/press/cruise/documents/2003smallshiptable.htm>

⁶⁹ Information from Exceltech website <http://www.21mainstreet.com/alpha/exceltec.usp>

Maceration-chlorination systems often produce effluent that does not meet the Alaska commercial passenger vessel fecal coliform standard. (See Section 4 "Wastewater Characteristics - Small Ships.") Another disadvantage of this system is that operators tend to chlorinate in excess of the manufacturer's recommendations in order to meet this standard. Marine life is very sensitive to chlorine. The chlorine concentration in ambient water must be less than 7.5 ug/l to protect aquatic life.⁷⁰ Whole Effluent Toxicity (WET) Testing conducted in July 2002 demonstrated that chlorine level in wastewater effluent can be toxic to marine life.⁷¹

Alaska Marine Highway System (AMHS) ferries present an interesting case study on the importance of properly operating maceration-chlorination systems as well as sampling in the proper location in the treatment cycle. In April 2002, AMHS engineers discovered that their wastewater had been sampled before it had sufficient chlorine contact time, and subsequently began sampling in the correct location. This explains the high geometric mean of fecal coliform in samples taken prior to May 1, 2002 (4,212 MPN/100 ml) versus those samples taken during the remainder of 2002 (94 MPN/100 ml).⁷² (See Table 19.) Samples taken from May through December 2002 also had lower chemical oxygen demand (COD) and total suspended solids (TSS) and higher chlorine residual.

In 2003 however, wastewater samples had the highest level of fecal coliform and lowest level of chlorine of all three years. ADEC audited the samplers during a July 29, 2003 sampling event. The sampler took the sample 15 minutes into the pumping cycle and the fecal coliform result was 11,000 MPN/100 ml. This seems to suggest that the timing of the sample did not make any difference as was suggested comparing the 2001 with the 2002 data. The AMHS information indicates that maceration-chlorination treatment systems are sensitive devices that produce variable results depending upon operation. However, the 2002 data demonstrated that maceration-chlorination systems can achieve fecal coliform levels that are in compliance with the state cruise ship law.

⁷⁰ ADEC Saltwater Aquatic Life Criteria Comparison
<http://www.state.ak.us/dec/dawq/wqs/documents/saltwateraquaticlifecriteria.htm>

⁷¹ The Science Panel interpretation of the WET test is located at <http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm>. The laboratory results for the WET test are located at <http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm>.

⁷² This number is different than the number in Section 9 of "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters" November 2002 by Science Advisory Panel. ADEC wrote Section 9 with all sampling data received by September 30, 2002. This report includes additional data points for 2002.

Table 19. Alaska Marine Highway System Samples

All values are medians except fecal coliform which is expressed as a geometric mean.

Date (Table in Appendix E)	Number of Samples	Total Ammonia as N	BOD 5- Day	COD	Fecal coliform	Free chlorine	pH	Total chlori ne	TSS
		mg/L	mg/L	mg/L	MPN/10 0 ml	mg/L		mg/L	mg/ L
	MDL	0.03	2.0	3.0	2	0.10	0.1	0.10	1.3
January 2001 - April 2002 (Table 38)	8	7.61	99	765.0	4,212	0.55	7.5	1.10	89.4
May 2002 - December 2002 (Table 37)	10	9.50	102	557.0	94	2.25	7.5	1.78	64.8
January - December 2003 (Table 36)	9	11.00	185	365.0	13,990	0.00	7.2	0.00	99.2

Biological And Chemical Disinfecting Systems

Marine biological treatment systems are similar to land based municipal treatment systems. A marine biological treatment system has three steps: (1) aeration; (2) clarification & filtration; and (3) final chemical disinfecting.⁷³ All sludge is re-circulated to the activated sludge aeration section.⁷⁴

The raw sewage passes through a screen, which removes grit, then enters the marine sanitation device (MSD) aeration chamber. The raw sewage mixes with a large concentration of active aerobic bacteria that consume the organic waste in the sewage. The chamber contains air diffusers that provide oxygen to keep the aerobic bacteria healthy.

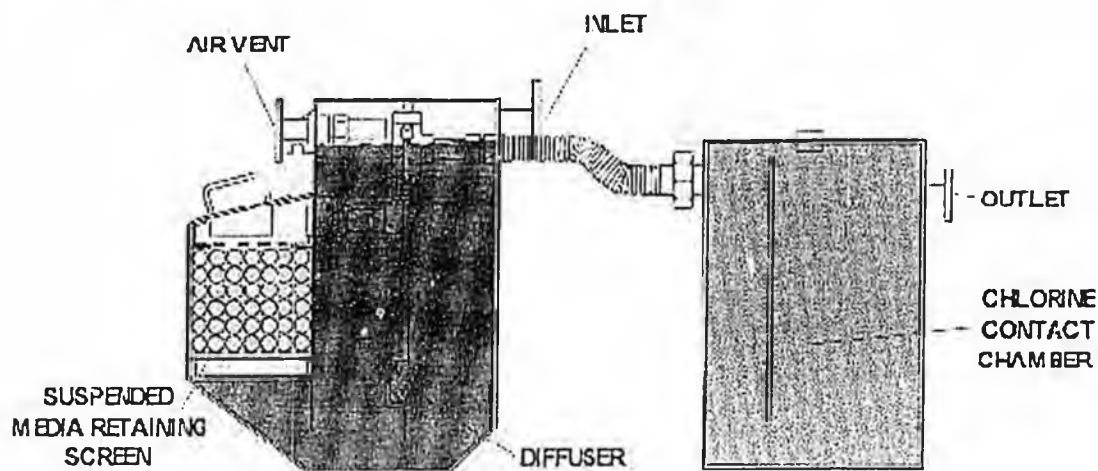
The wastewater flows from the aeration chamber into the clarification and filtration chambers. The filter media removes larger pieces of organic waste not consumed by bacteria in the aeration chamber. The aerobic bacteria also consume the biomass on the filter. After clarification and filtration, wastewater flows into the chlorine contact chamber. The wastewater stays in this chamber until virtually all bacteria are killed resulting in a chlorine residual of 1 – 2 mg/l (ppm).

Unlike a land based biological system, marine systems process a concentrated blackwater stream without dilution from graywater or storm water. Biological systems thrive on a constant, even flow of nutrients and constant pH. This constant flow is difficult to achieve since the demand on a ship's treatment system is intermittent with periods of low or no flow.

⁷³ Fox-Pac MSD home page <http://www.recfoxenviro.com/foxpacmarinemsd.html>

⁷⁴ Waste treatment systems: <http://www.haraworthyksc.com/docGallery/29.PDF>

Figure 4. Biological and Chemical Disinfection System⁷⁵



6.2. Advanced Treatment Systems

The fecal coliform and total suspended solids standards in the state and federal cruise ship laws have prompted large ships to either install advanced treatment systems that meet secondary treatment standards or to hold all of their wastewater for discharge outside of Alaska. Large cruise ship operators have evaluated several advanced wastewater treatment designs. These include chemical treatment and mechanical decanting; activated oxidation and oxidant disinfection; reverse osmosis filtration, and bio-reactor/filtration. The overall value and efficiency of each system, which includes evaluation of the installation cost, maintenance, operator training and monitoring, continues to be a subject of research by the cruise lines.

Generally, cruise ships using advanced technology have combined enhanced aerobic digestion with filtration to clean shipboard wastewater. These treatment systems do not use chlorine in the normal treatment process; however, some ships may use chlorine to control fecal re-growth that occurs in the discharge piping.

These treatment systems all produce solid sludge, which is discharged 12 miles from shore, incinerated, or offloaded to land based disposal sites.

Chemical treatment and mechanical decanting

This system uses chemical treatment and a mechanical decanter, followed up by a UV purifier. The design is used successfully in shore-based applications and showed promise in large-scale laboratory tests. However, the pilot program on a cruise ship indicated that modifications were necessary for a fully operational treatment system.⁷⁶ No additional information is available to ADEC on this system.

⁷⁵ Fox-Pac MSD home page <http://www.redfoxenviro.com/foxpacmarinemsd.html>

⁷⁶ From a wastewater technology paper prepared by David Eley for the Governor's Briefing Papers and Alaska Regional Response Team updated June 2002. For more information contact Mr. Eley at 907-586-2685 or capedec@alaska.com

Activated Oxidation Process

This treatment process is currently operated on ten small ferries in British Columbia.⁷⁷ It has four major components: (1) a primary screening system, (2) a primary solids separation and oxidizing system, (3) a secondary oxidation tank, and (4) oxidant generation equipment, which eliminate the need for chlorine disinfection. Ozone disinfection presents fewer known environmental and health effects than chlorine and its byproducts.⁷⁸ It is more effective than chlorine at killing bacteria and viruses. In addition, ozone is unstable in the environment and decomposes to oxygen in a short period of time.⁷⁹

An enhanced system with a biological oxidation component has been installed on Royal Caribbean's *Vision of the Seas*.⁸⁰ A polymer is also added to the preliminary stage to cause the solids to clump together and form a sludge "mat". The process removes the mat before the effluent enters the treatment system.⁸¹ The treatment system is comprised of six main system components: (1) primary solids separation/oxidation tank; (2) bioreactors (Hydroxyl-F³R); (3) secondary solids separation; (4) oxidation/disinfection tank; (5) controls and oxidant generation equipment; and (6) sludge dewatering and drying equipment.

The sludge is dewatered and incineration onboard or offloaded to shore. No discharge at sea is necessary. The system manufacturer is conducting tests on the *Vision of the Seas* to ensure that it meets U. S. Coast Guard discharge standards for stationary discharge in Alaska. ADEC has not yet received wastewater effluent data from this system.

Reverse Osmosis Filtration

Osmotic theory dictates that pure water will move across a semi-permeable membrane into wastewater until the contaminant concentrations of both liquids are equal. However, if external pressure is exerted on the contaminant solution, water will flow in the reverse direction from the wastewater into the pure water. This phenomenon is known as reverse osmosis (RO). Reverse osmosis treatment systems have been installed on two ships⁸² operating in Alaska. Both systems use ultraviolet (UV) disinfection after the RO unit and were approved by the U.S. Coast Guard for stationary discharge during 2003. The effluent from both systems has a slightly low pH which requires some buffering. *Mercury's* treatment system includes a final run through activated charcoal canisters before discharge. The sample points on both ships are less than 50 feet from the overboard discharge point.

⁷⁷ Hydroxyl Systems B.C Ferry Services Inc. case study website: <http://www.hydroxyl.com/marine/index.html>

⁷⁸ EPA/625/1-86/021 EPA Design Manual Municipal Wastewater Disinfection

⁷⁹ EPA 832F99063, EPA Ozone Fact Sheet, September 1999. <http://www.epa.gov/npdes/pubs/ozon.pdf>

⁸⁰ Hydroxyl Systems *Vision of the Seas* case study website: <http://www.hydroxyl.com/marine/index.html>

⁸¹ Hydroxyl system described on website <http://www.hydroxyl.com/index.html>

⁸² Celebrity *Mercury* blackwater and Carnival *Spirit* graywater

Table 20. Samples Taken after RO/UV Treatment Unit (2003)

	pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
Number of Samples = 21		mg/L	mg/L	Mg/L	mg/L	MPN/100
Minimum	6.6	0	0.0	0.00	0.00	0
Median	7.3	15	0.0	0.00	0.00	0
Maximum	9.1	27	0.0	0.00	0.00	4

Large Ship Sampling Data Appendix B, Table 5

Bio-reactor/filtration

These units employ an integrated system of enhanced aerobic digestion and low-pressure membrane filtration to treat blackwater and graywater. Currently, sixteen large cruise ships operating in Alaska have installed this process using Zenon, Scanship, or Hamworthy systems.⁸³

After only a brief holding period in the bio-reactor, the Zenon system passes the influent through membrane filtration modules that have very large surface area and an extremely small pore size (0.035 micron or 0.035 X 10⁻⁶ meters).⁸⁴ Wastewater then passes through a UV disinfection unit. Samples are taken immediately after the UV unit. The distance from the UV unit to the discharge point varies from vessel to vessel.

Table 21. Zenon/UV Treatment System (2003)⁸⁵

Number of Samples = 24	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		Mg/L	mg/L	mg/L	mg/L	MPN/100
Minimum	7.2	0	0.0	0.00	0.00	0
Median	7.6	0	0.0	0.00	0.00	0
Maximum	8.4	5	0.0	0.00	0.00	0

Large Ship Sampling Data Appendix B, Table 6.

The Scanship system relies more heavily on biological digestion. This unit enhances the capacity and effectiveness of the bio-reactor with plastic carrier elements (biofilm) suspended in the wastewater to increase reactor surface area with eventual polishing microfiltration and UV

⁸³ ADEC, 2003 Large Commercial Passenger Vessels Discharge Status and Wastewater Treatment, <http://www.state.ak.us/dec/press/cruise/documents/2003largeshipwwtable.htm>

⁸⁴ From a wastewater technology paper prepared by David Eley for the Governor's Briefing Papers and Alaska Regional Response Team, updated June 2002 and discussions with Rick Softye former VP of Holland America.. For more information contact Mr. Eley at 907-586-2685 or capedec@alaska.com.

⁸⁵ Holland America *Maasdam, Ryndam, Statendam, Veendam, Volendam, and Zaandam*

disinfection.⁸⁶ At the beginning of the season, samples were taken after the UV. By mid-season, the samples were taken at the end of the discharge line before the overboard port.

Table 22. Scanship/UV (2003)⁸⁷

Number of Samples = 18	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		mg/L	mg/L	mg/L	mg/L	MPN/100
Minimum	6.3	5	0.0	0.00	0.00	0
Median	6.9	11	7.0	0.00	0.00	0
Maximum	7.6	26	28.6	0.00	0.00	240

Large Ship Sampling Data Appendix B, Table 7

In a Hamworthy system, wastewater is passed through an aerobic biological treatment system and ultrafiltration units. It is then chlorinated to kill remaining bacteria. The chlorine levels in the effluent were occasionally over the 10 mg/l limit for continuous discharge allowed by the U.S. Coast Guard and the Alaska Water Quality Standard of 7.5 ug/l. Princess has installed UV on two of their ships with the Hamworthy system and is considering substituting UV for chlorine disinfection on all ships in the future. Samples of this system were taken on the discharge line near the overboard port. Some samples indicated that there was fecal contamination within the discharge line.

Hamworthy (2003)⁸⁸

Number of Samples = 58	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		mg/L	mg/L	mg/L	mg/L	MPN/100
Minimum	6.6	0	0.0	0.00	0.00	0
Median	7.3	2	0.0	0.00	0.00	0
Maximum	8.1	86	19.1	55.00	50.00	220

Large Ship Sampling Data Appendix B, Table 8.

All four of the treatment systems listed above regularly satisfy the requirements necessary to maintain U.S. Coast Guard continuous discharge certification. (See Table 2.)

⁸⁶ Scanship Environmental website: <http://www.scanship.no/>

⁸⁷ Norwegian Sky, Sun, and Wind

⁸⁸ Princess Dawn, Island, Pacific, Star and Sun; Radisson Seven Seas Mariner

Table 23. Comparison of Advanced Treatment System Medians

Number of Samples = 58	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		mg/L	mg/L	mg/L	mg/L	MPN/100
RO (21)	7.28	14.9	0.0	0.00	0.00	0
Zenon (24)	7.64	0.0	0.0	0.00	0.00	0
Scanship (18)	6.94	10.9	7.0	0.00	0.00	0
Hanworthy (58)	7.33	2.2	0.0	0.00	0.00	0

Sample data demonstrated that fecal coliform contamination of the effluent sometimes occurred in the discharge pipe. The probability of fecal contamination increased as the pipe length increased. ADEC will therefore require that samples be taken within 50 feet of the overboard discharge location in the future.

7. RISK CHARACTERIZATION

7.1. Toxicological Profile of Detected Pollutants

Sections 3 and 4 discuss the large ship and small ship wastewater data. Table 11 and Table 16 list the pollutants that exceed water quality standards in receiving water. This section will discuss those pollutants in greater detail.

CONVENTIONAL POLLUTANTS

Ammonia

Ammonia is present in two forms in saltwater: un-ionized ammonia (NH_3) and the ammonium ion (NH_4^+). The un-ionized ammonia form has been demonstrated to be the more toxic form of ammonia.⁸⁹ Ammonia affects the life cycle as well as survival of some species.⁹⁰ Water quality parameters, particularly pH and temperature, but also salinity, affect the proportion of un-ionized ammonia.

Ammonia at concentrations slightly less than those chronically toxic to animals may stimulate growth and reduce reproduction of a red macroalgal species.⁹¹

Ammonia has a strong and suffocating odor. Ammonia's short term human health effects include lung irritation, causing coughing and/or shortness of breath. Higher exposures cause fluid buildup in the lungs (pulmonary edema), which can cause death. In addition, ammonia is a corrosive chemical, which can severely burn the eyes and skin. Repeated exposure to ammonia can cause chronic irritation of the eyes, nose, mouth, and throat.

Chlorine

Free residual chlorine is described as the portion of the chlorine injected into water that remains as molecular chlorine, hypochlorous acid, or hypochlorite ions after the solution has reached a state of equilibrium. Combined residual chlorine is described as the portion of chlorine injected into water that remains combined with ammonia or nitrogenous compounds after the equilibrium has been reached. Both free and residual chlorine have a very short half-life in marine waters; therefore, it is difficult to assess the effects of chlorine on aquatic life.⁹² ADEC saltwater criteria for chlorine are 13 $\mu\text{g/L}$ (acute criterion) and 7.5 $\mu\text{g/L}$ (chronic criterion).⁹³

In humans, ingestion of large doses of chlorine may cause gastrointestinal irritation, including vomiting and nausea. If dehydration occurs, body temperature increases and circulatory and central nervous system damage may result. Exposure of the eyes to sodium chloride may cause

⁸⁹ EPA 440/5-88-004 Ambient Aquatic Life Water Quality Criteria. page 7

⁹⁰ Details of the testing results is located in EPA 440/5-88-004 located at <http://www.epa.gov/waterscience/pc/ambientwqc/ammoniasalt1989.pdf>

⁹¹ EPA 1989, Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, EPA Office of Water, Regulations and Standards Division, Washington DC, EPA 440/5-88-004

⁹² EPA January 1985, Ambient Water Quality Criteria for Chlorine, Office of Water, EPA 440/5-84/030

⁹³ ADEC, Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic & Inorganic Substances, May 15, 2003, Table IV or V available at <http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/pdf/70wqsmmanual.pdf>

stinging while exposure to other forms of chlorine, including free and residual chlorine, may cause stinging or irritation of the skin.

Fecal Coliform

Bacteria water quality standards are set to protect human health from diseases associated with water that has been contaminated with feces. The presence of fecal coliforms usually indicates the presence of pathogens. Shellfish concentrate fecal coliform bacteria and other pathogens that may be present with coliform bacteria. Shellfish beds are closed to harvesting when the geometric mean of fecal coliform bacteria exceeds 14 colonies per 100 milliliters of water. While most fecal coliform bacteria are harmless to humans, exposure to some may cause short-term adverse effects, including rash, ear infections, gastrointestinal pain, nausea, diarrhea, vomiting, and fever.⁹⁴

PRIORITY POLLUTANTS

Copper

Copper is highly toxic in aquatic environments. Copper will bio-concentrate in many different organs in fish and mollusks. Copper is an effective algacide. Free ions of copper are the lethal agent. Single cell and filamentous algae and cyanobacteria are more susceptible to the acute effects, which include reductions in photosynthesis and growth, loss of photosynthetic pigments, disruption of potassium regulation, and mortality. Mammals are not as sensitive to copper as are other aquatic organisms. The predominant mammalian effects include hepatic and renal toxicity, and fetal mortality.⁹⁵ However, high doses are usually required to elicit these effects in mammals.

Alaska has a water quality standard of 3.1 µg/L dissolved copper in saltwater based on chronic effects to aquatic life.

Low levels of copper are essential for humans. Exposure to high levels of copper may cause mouth and eye irritation and may induce vomiting, nausea, and intestinal pain.⁹⁶

Zinc

Zinc is very soluble in water and is almost never found free in nature. It is one of the most mobile of the heavy metals. Most of the zinc introduced into the aquatic environment is partitioned into the sediments by sorption onto hydrous iron, manganese oxides, clay, and organic materials.⁹⁷ Variables affecting the mobility of zinc include the concentration and composition of suspended and bed sediments, dissolved and particulate iron and manganese concentrations, pH, salinity, concentration of ions or molecules that bind to transition-metal ions, and the concentration of zinc.

⁹⁴ Washington State Department of Ecology, March 2002, *Focus: Fecal coliform bacteria and Washington's water quality standards*, Publication No. 02-10-010.

⁹⁵ EPA, 2002a, National Recommended Water Quality Criteria – Correction, EPA Office of Water, Washington, DC, EPA 822-Z-99-001.

⁹⁶ Agency for Toxic Substances and Disease Registry (ATSDR), United States Department of Health and Human Services, Center for Disease Control, September 2002, ToxFAQs for Copper.

⁹⁷ EPA 440/5-87-003 EPA Ambient Water Quality Criteria for Zinc February 1987.

Most organisms need some minimum concentration of zinc to function properly. Toxicity of zinc to an organism depends on feeding habits. Plants and most fish would not be adversely affected, but many invertebrates could be affected by ingestion of sufficient quantity of particulates containing zinc. The toxicity of zinc, as well as other metals, is reported to be influenced by a number of chemical factors including cadmium, magnesium, hardness, pH, and ionic strength. These factors appear to affect the toxicity of zinc by influencing the proportion of available zinc or by inhibiting the sorption or binding available by biological tissues. Alaska has a water quality standard of 81.0 µg/L of dissolved zinc in saltwater based on chronic effects to aquatic life.

As with copper, zinc is an essential element in humans at low doses. Human ingestion of zinc is generally not a concern. The Recommended Daily Allowances for adults is 15 mg/day.⁹⁸

7.2. Cumulative Impact

Large Ships

Since the passage of the Alaska cruise ship laws, large cruise ships installed advanced wastewater treatment systems that meet the stringent U.S. Coast Guard requirements for continuous discharge. The quality of the wastewater on large ships has therefore improved dramatically. During 2003, all the large cruise ships that discharged wastewater in Alaska had these advanced systems. Ships that did not have advanced systems discharged outside 3 nautical miles. The 2003 data is the most representative of the wastewater quality that ADEC expects in the future. Therefore, we will focus on the risks presented by the 2003 data.

In 2003, ships were sampled for 16 conventional pollutants and 160 priority pollutants. **The vast majority of these pollutants were not detected.** Only ammonia, copper, nickel, and zinc did not regularly meet Alaska Water Quality Standards at the end of pipe (Table 10).

The Science Advisory Panel concluded in *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* that effluent from a typical large ship will be diluted by a factor of at least 50,000 during underway discharge.⁹⁹ By applying this dilution factor, the concentration of all pollutants would meet Alaska Water Quality Standards in the receiving water during underway discharge.

ADEC was concerned about the impacts on the receiving water caused by stationary wastewater discharge. In order to address this issue, ADEC calculated the dilution factor during stationary discharge for each large ship during a worst case scenario. (See Appendix D Cruise Ship Stationary Discharge Modeling for more information.) The lowest dilution value for each effluent type was then used to calculate the anticipated concentration of each pollutant in receiving water during stationary discharge (Table 11). After applying the dilution factor, no tested pollutant would exceed Water Quality Standards.

Whole Effluent Toxicity (WET) testing was done in 2003 on 4 of the 18 large ships that discharged in Alaska. Test results indicate that **wastewater effluent from large ships with advanced wastewater treatment systems does not pose a risk to aquatic organisms, even**

⁹⁸ EPA 440/5-80-079 October 1980 Ambient Water Quality Criteria for Zinc.

⁹⁹ Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002
<http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm>

during stationary discharges. ADEC will continue WET testing on the advanced wastewater treatment systems during 2004. This test gives insight into the wastewater's effect on marine organisms. This test indicates that exceedances of ammonia, copper, nickel and zinc Water Quality Standards at the end of pipe are not harming aquatic life.

None of the pollutants mentioned above are present in concentrations should cause risks to human health.

Small Ships

ADEC reviewed data collected from small commercial passenger vessels from 2001 through 2003. These ships have not installed new wastewater treatment systems on their vessels and the effluent quality has remained relatively consistent.

During the evolution of the sampling protocol, pollutants have been added and deleted as appropriate. In 2003, ships were sampled for 16 conventional pollutants and 160 priority pollutants. **The vast majority of these pollutants were not detected.** The eight (8) pollutants that did not regularly meet Alaska Water Quality Standards at the end of pipe are included in Table 15.

The Science Advisory Panel concluded that the dilution factor caused by the underway discharge by a small ship would be based on the width, draft, and speed of the vessel divided by the discharge rate and multiplied by a factor of 3.¹⁰⁰ With the aid of this dilution, we would expect all pollutants to meet Alaska Water Quality Standards during underway discharge.

ADEC was concerned about the impacts on the receiving water caused by stationary wastewater discharge. In order to address this issue, ADEC calculated the dilution factor caused by stationary discharge for each small ship during a worst case scenario. (See Appendix D Cruise Ship Stationary Discharge Modeling for more information.) The lowest dilution value for each effluent type was then used to calculate the expected concentration of each pollutant in receiving water during stationary discharge (Table 16). Even with the benefit of dilution, we predict the stationary discharge of wastewater from small ships contain concentrations of free chlorine, fecal coliform, copper, and zinc that exceed Alaska Water Quality Standards.

The marine environment is very sensitive to the concentrations of free chlorine. In fact the water quality standards are below the methods of detection for chlorine. The concentration of chlorine in mixed blackwater and graywater during 2002 was found in excess of 100 times the Alaska Water Quality Standards. The predicted concentration of chlorine from this discharge was 10 times the standard in receiving water and therefore did pose a risk to aquatic life during stationary discharges.

The fecal coliform concentrations in receiving water indicate that it is important for these ships to avoid anchoring in areas used for shellfish aquaculture or areas frequently used for subsistence and recreational shellfish harvesting. Most of the shellfish farms in Southeast Alaska are located between Ketchikan and Petersburg. ADEC evaluated the small ship routes and the location of

¹⁰⁰ The Science Panel has developed a formula for predicting dilution/dispersion in the wake of small cruise ships.

Dilution factor = 3 x (ship width x ship draft x ship speed)/(volume discharge rate);
<http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm>